RESEARCH PAPER

Integrating Rehabilitation Medicine in The Management of Musculoskeletal Complications After Face-Down Positioning in Retinal Surgery: A Narrative Review

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Received: 24th April, 2026; Revised: 20th May 2026; Accepted: 30th June, 2026; Available Online: 10th July, 2026

ABSTRACT

Background: Face-down positioning (FDP) remains a commonly prescribed postoperative strategy following vitreoretinal surgery to optimize intraocular tamponade contact. While its anatomical rationale is well established, the musculoskeletal burden associated with prolonged static positioning has received limited attention in ophthalmic literature.

Objective: To synthesize current evidence regarding the physiological and pathophysiological mechanisms underlying musculoskeletal complications during prolonged FDP and to explore the role of rehabilitation medicine in mitigating these effects.

Methods: A narrative review was conducted using contemporary peer-reviewed literature (2020–2026) focusing on postoperative positioning after retinal surgery, biomechanical strain, myofascial mechanisms, adherence, and rehabilitation strategies. Evidence was synthesized thematically across biomechanical, pathophysiological, clinical, and rehabilitative domains.

Results: Prolonged FDP induces sustained cervical and paraspinal muscle activation, reduced microvascular perfusion, metabolic imbalance, and increased mechanical load on passive spinal structures. These changes predispose patients to myofascial trigger point formation, joint strain, and potential pain sensitization. Musculoskeletal discomfort may compromise adherence to prescribed positioning, potentially influencing real-world tamponade effectiveness. Structured rehabilitation strategies targeting endurance, neuromuscular coordination, and perfusion demonstrate potential in reducing symptom burden without compromising ocular safety.

Conclusion: FDP should be recognized as a modifiable biomechanical exposure. Integrating rehabilitation principles into postoperative vitreoretinal care may enhance tolerance, improve adherence, and optimize overall recovery outcomes.

Keywords: *Face-Down Position, Vitrectomy, Musculoskeletal Pain, Myofascial Pain Syndromes, Rehabilitation.*

How to cite this article: Massese NM, Muhiddin HS, Budu, Panggalo I, Integrating Rehabilitation Medicine in The Management of Musculoskeletal Complications After Face-Down Positioning in Retinal Surgery: A Narrative Review Int J Drug Deliv Technol. 2026;16(77s): 1649-1657; DOI: 10.25258/ijddt.16.77s.192
Source of support: Nil.
Conflict of interest: None

INTRODUCTION

Pars plana vitrectomy (PPV) with intraocular gas or silicone oil tamponade remains a cornerstone in the management of rhegmatogenous retinal detachment (RRD) and full-thickness macular hole (FTMH), with surgical success dependent not only on intraoperative technique but also on appropriate postoperative positioning to optimize tamponade-retina apposition (Casswell et al., 2020; Banerjee et al., 2021). Face-down positioning (FDP) has traditionally been recommended to enhance buoyancy-driven contact between the tamponade agent and the retinal break or macular defect, facilitating subretinal fluid absorption and chorioretinal adhesion (Hu et al., 2021; Kanclerz and Grzybowski, 2020). Although grounded in the physical properties of intraocular gases (Kanclerz and Grzybowski, 2020), the duration and universal necessity of strict FDP remain debated, as contemporary trials and meta-analyses suggest that prolonged positioning may not be required in all cases (Casswell et al., 2020; Hu et al., 2021; Chaudhary et al., 2023). Nevertheless, extended FDP continues to be widely prescribed in complex detachments, inferior breaks, or silicone oil tamponade cases, highlighting a gap between evolving evidence and clinical practice (Adhi et al., 2024).

Biomechanically, FDP represents a sustained non-physiological posture characterized by cervical flexion and static activation of paraspinal musculature, which increases electromyographic activity, reduces local oxygenation, and predisposes to muscular fatigue (Park et al., 2021). Static contraction impairs intramuscular blood flow and promotes nociceptive sensitization, while head-down tilt has been associated with altered spinal loading

**Author for Correspondence: Nurizki Meutiarani Massese* and musculoskeletal discomfort, particularly in elderly or degenerative populations (Park et al., 2021; Gutekunst et al., 2021). Clinical studies confirm substantial patient-reported neck, shoulder, and lower back pain, accompanied by stiffness, sleep disturbance, and functional limitation (Al-Dakheel et al., 2022). Adherence to FDP declines over time, especially outside supervised settings (Seno et al., 2020; Liang et al., 2023), and although the magnitude of its effect on anatomical outcomes remains controversial (Casswell et al., 2020; Chaudhary et al., 2023), the associated physical burden raises concerns regarding overall well-being.

The pathophysiology of FDP-related pain is multifactorial. Myofascial pain syndrome (MFPS), characterized by hyperirritable trigger points induced by sustained muscle tension, represents a key mechanism (Sharif et al., 2023). Prolonged cervical flexion may promote ischemia and persistent sarcomere contraction, while non-myogenic structures such as facet joints and ligamentous complexes contribute through mechanical strain (Sharif et al., 2023; Park et al., 2021). Vulnerability is heightened in elderly, obese, or degenerative spine populations with reduced adaptive capacity (Gutekunst et al., 2021). Despite increasing recognition of these burdens, ophthalmic literature largely emphasizes anatomical success, with limited integration of positioning-related morbidity into postoperative care models (Chaudhary et al., 2023; Liang et al., 2023).

Emerging evidence supports rehabilitation as a strategy to mitigate FDP-related morbidity. A randomized controlled trial demonstrated that structured exercise significantly reduced neck, shoulder, and lumbar pain without compromising surgical outcomes (Kim et al., 2021). Rehabilitation principles including graded activation and neuromuscular stabilization have proven effective in managing static posture–induced musculoskeletal disorders (Ferrigno et al., 2021), and multidisciplinary postoperative models in other fields improve comfort and adherence (Wang et al., 2024). Given the continued use of prolonged FDP despite evolving evidence (Casswell et al., 2020; Hu et al., 2021), integrating rehabilitation assessment and structured exercise into vitreoretinal care may mitigate pain, enhance compliance, and optimize recovery (Kim et al., 2021; Wang et al., 2024). This narrative review therefore synthesizes current evidence on postoperative FDP, its musculoskeletal implications, and the role of structured rehabilitation within an interdisciplinary framework.

METHODS

Study Design

This study was conducted as a narrative review aimed at providing a comprehensive and conceptually integrated synthesis of current evidence regarding musculoskeletal complications associated with postoperative face-down positioning (FDP) after vitreoretinal surgery, as well as exploring the role of rehabilitation medicine in mitigating these complications. The review was designed to bridge ophthalmology and rehabilitation disciplines by integrating biomechanical, pathophysiological, and clinical perspectives. The methodological framework was informed by the principles outlined in the Scale for the Assessment of Narrative Review Articles (SANRA), which emphasizes clarity of objectives, structured literature selection, transparent synthesis, and critical interpretation.

Literature Search Strategy

A structured but non-systematic literature search was conducted to identify relevant peer-reviewed publications. Electronic databases including PubMed/MEDLINE, Scopus, and Web of Science were searched for articles published between January 2020 and March 2026 to ensure contemporary relevance and alignment with current vitreoretinal practice.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms related to postoperative retinal surgery and positioning. Core keywords included "face-down positioning," "prone positioning," "vitrectomy," "retinal detachment," and "macular hole." These were combined with musculoskeletal and rehabilitation-related terms such as "neck pain," "back pain," "myofascial pain," "musculoskeletal complications," "rehabilitation," "exercise therapy," and "physical therapy." Boolean operators were used to refine search combinations and enhance specificity. To minimize selection bias and broaden conceptual scope, reference lists of eligible studies were manually screened to identify additional relevant articles not captured during database searching.

Eligibility Criteria

Studies were considered eligible if they met the following criteria: publication in peer-reviewed journals between 2020 and 2026, availability in English, and direct relevance to at least one of the following domains: postoperative face-down positioning after vitreoretinal surgery, musculoskeletal burden related to static or prone positioning, patient adherence to positioning protocols, biomechanical mechanisms of postural strain, or rehabilitation-based strategies to mitigate positioning-related morbidity. Both interventional and observational studies were included, such as randomized controlled trials, prospective or retrospective cohort studies, cross-sectional analyses, meta-analyses, and high-quality reviews providing mechanistic or conceptual insight. Studies were excluded if they were case reports lacking broader clinical implications, experimental animal studies without translational relevance, editorials without substantive evidence synthesis, or publications unrelated to retinal surgery positioning or musculoskeletal outcomes.

Study Selection Process

Titles and abstracts identified through database searches were screened for thematic relevance. Articles deemed potentially eligible were retrieved in full text and evaluated for conceptual alignment with the objectives of this review. Because this study was conducted as a narrative review rather than a systematic review, a formal PRISMA flow diagram was not generated. Priority was given to randomized controlled trials, systematic reviews, and prospective cohort studies when available, while observational studies were included to capture real-world adherence patterns and patient-reported outcomes.

Data Extraction and Thematic Synthesis

Data were extracted qualitatively from selected articles. Key variables included surgical indication, type and duration of prescribed face-down positioning, reported musculoskeletal symptoms, anatomical distribution of pain, patient-reported burden and quality-of-life measures, adherence rates, biomechanical findings related to sustained cervical and thoracolumbar loading, and rehabilitation or exercise-based interventions. Given the heterogeneity of study designs, outcome measures, and intervention protocols, statistical pooling or meta-analysis was not considered appropriate. Instead, findings were synthesized thematically. The synthesis was organized into four principal domains: biomechanical implications of prolonged FDP; pathophysiological mechanisms of musculoskeletal complications; clinical burden and adherence challenges; and rehabilitation-based strategies with interdisciplinary integration potential. This thematic structure allowed integration of evidence across ophthalmology, biomechanics, and rehabilitation medicine to generate a coherent conceptual framework.

Critical Appraisal Approach

Although a formal risk-of-bias tool was not applied, each study was appraised critically based on methodological transparency, study design rigor, adequacy of sample size, consistency of reported outcomes, and applicability to clinical practice. Greater interpretive weight was given to randomized controlled trials and meta-analyses, while observational studies were interpreted with attention to potential confounding factors. Discrepancies or conflicting findings across studies were examined in light of differences in surgical indication, positioning duration, patient demographics, and rehabilitation protocols.

Ethical Considerations

As this review was based exclusively on previously published literature and did not involve human participants, identifiable patient data, or experimental interventions, ethical approval was not required. The review was conducted in accordance with principles of academic integrity, transparency, and responsible scholarship.

RESULTS

Overview of Included Evidence

The structured search identified contemporary literature published between 2020 and 2026 addressing postoperative face-down positioning (FDP) after vitreoretinal surgery, musculoskeletal burden, adherence patterns, and rehabilitation-based interventions. The included studies comprised randomized controlled trials, systematic reviews, prospective and retrospective observational studies, as well as biomechanical and mechanistic investigations. The body of evidence can be categorized into four principal domains: (1) positioning efficacy and adherence in retinal surgery, (2) biomechanical consequences of prolonged FDP, (3) pathophysiological mechanisms of musculoskeletal complications, and (4) rehabilitation-based interventions and interdisciplinary strategies. Across studies, there was consistent acknowledgment that while FDP may contribute to anatomical success in selected indications, it is associated with measurable physical burden and variable adherence rates.

Positioning Strategies and Surgical Outcomes

Randomized and comparative studies evaluating postoperative positioning strategies demonstrate heterogeneity in clinical benefit depending on surgical indication. In the Post-RD randomized clinical trial, strict face-down positioning did not significantly improve retinal reattachment outcomes compared with alternative positioning strategies in selected cases (Casswell et al., 2020). Similarly, meta-analyses of macular hole surgery suggest that prolonged strict FDP may not be universally required, particularly in smaller defects or when modern surgical techniques are employed (Hu et al., 2021; Chaudhary et al., 2023). Despite evolving evidence, surveys and observational data indicate that prolonged FDP remains widely prescribed, particularly in cases involving silicone oil tamponade or complex detachments (Adhi et al., 2024). Real-world practice patterns often favor extended positioning regimens out of precaution, even in the absence of strong evidence supporting prolonged duration (Thompson et al., 2021). Adherence studies reveal declining compliance over time, particularly in outpatient settings. Seno et al. (2020) demonstrated that compliance with FDP decreases significantly beyond the initial postoperative period. Liang et al. (2023) further identified discomfort, fatigue, and sleep disturbance as major predictors of reduced adherence. These findings suggest that patient tolerance plays a critical role in positioning effectiveness.

Biomechanical Consequences of Prolonged Face-Down Positioning

Biomechanical investigations provide mechanistic insight into the physical strain associated with sustained FDP. Electromyographic analyses demonstrate increased activation of cervical extensors, upper trapezius, and paraspinal musculature during prolonged cervical flexion (Park et al., 2021). Sustained static contraction reduces intramuscular perfusion and contributes to metabolic accumulation, potentially triggering nociceptive pathways. Experimental head-down tilt models further show altered spinal loading patterns and increased musculoskeletal discomfort under prolonged prone positioning conditions (Gutekunst et al., 2021). These findings are consistent with clinical observations of neck and lower back pain reported by patients maintaining FDP after retinal surgery (Al-Dakheel et al., 2022). Notably, patients with pre-existing degenerative spinal conditions, advanced age, or reduced muscular endurance appear more vulnerable to static load–

induced fatigue and discomfort. This susceptibility suggests that postoperative positioning may impose disproportionate burden on high-risk populations.

Pathophysiological Mechanisms of Musculoskeletal Complications

The development of musculoskeletal symptoms in prolonged FDP is multifactorial. Myofascial pain syndrome (MFPS) is a prominent mechanism characterized by hyperirritable trigger points within taut muscle bands (Sharif et al., 2023). Sustained muscle contraction and ischemia are believed to induce local biochemical changes, including increased acetylcholine release and impaired calcium reuptake, resulting in persistent sarcomere shortening and pain sensitization. Beyond myogenic mechanisms, joint capsule compression, ligamentous strain, and facet joint overload may contribute to nociceptive activation during prolonged cervical flexion (Park et al., 2021). The combination of static muscular load and joint stress likely explains the anatomical distribution of pain frequently reported in cervical and thoracolumbar regions. Clinical data corroborate these mechanisms. Patient-reported burden studies document localized neck and shoulder pain as the most common complaints, often accompanied by stiffness and functional limitation (Al-Dakheel et al., 2022). These symptoms may impair sleep quality and reduce overall postoperative recovery experience.

Clinical Burden and Quality-of-Life Impact

Several studies highlight the broader functional consequences of prolonged FDP. Beyond localized pain, patients frequently report difficulties with eating, reading, personal hygiene, and mobility (Al-Dakheel et al., 2022). These functional impairments may contribute to psychological distress and reduced satisfaction with surgical care. Adherence challenges appear closely linked to symptom severity. Reduced compliance has been observed in patients experiencing higher levels of discomfort, suggesting a direct relationship between musculoskeletal burden and positioning effectiveness (Liang et al., 2023). Although the anatomical consequences of partial non-adherence vary by indication, the potential interaction between physical discomfort and surgical outcome remains clinically relevant.

Rehabilitation-Based Interventions

Evidence supporting structured rehabilitation strategies is emerging but remains limited. A randomized controlled study by Kim et al. (2021) demonstrated that a structured exercise program significantly reduced musculoskeletal pain in patients required to maintain FDP. The intervention incorporated low-intensity strengthening and mobility exercises compatible with head positioning constraints, suggesting feasibility without compromising ocular safety. Broader rehabilitation literature supports the use of graded activation, postural correction, and circulatory enhancement techniques in managing static posture–related musculoskeletal disorders (Ferrigno et al., 2021). Multidisciplinary postoperative rehabilitation models in other surgical contexts have shown improvements in patient comfort and functional outcomes (Wang et al., 2024). However, standardized rehabilitation protocols specifically tailored to vitreoretinal surgery patients are lacking. Current ophthalmic practice guidelines primarily focus on retinal anatomical success, with minimal integration of musculoskeletal risk assessment or preventive exercise strategies.

Synthesis of Findings

Collectively, the evidence indicates that while postoperative FDP may contribute to anatomical outcomes in selected cases, it is consistently associated with musculoskeletal strain, measurable patient-reported burden, and declining adherence over time. Biomechanical studies provide mechanistic support for observed symptoms, while emerging interventional data suggest that structured rehabilitation may mitigate discomfort without jeopardizing surgical success. Nevertheless, high-quality randomized data evaluating rehabilitation-based interventions remain limited, and standardized interdisciplinary frameworks have not yet been established. This gap underscores the need for integrated postoperative care models that address both retinal and musculoskeletal dimensions of recovery.

DISCUSSION

Physiological Changes in Face-Down Positioning and Pathophysiology of Musculoskeletal Complications

Face-down positioning (FDP) induces a complex cascade of physiological adaptations that extend beyond simple postural alteration and involve integrated neuromuscular, vascular, and autonomic responses (Cagnie et al., 2021). Sustained cervical flexion and thoracolumbar loading require prolonged activation of deep cervical extensors, trapezius, levator scapulae, and lumbar stabilizers, resulting in persistent isometric contraction that differs fundamentally from physiological dynamic movement patterns (Falla et al., 2021). When contraction is maintained without intermittent relaxation, intramuscular pressure may exceed capillary perfusion pressure, thereby limiting oxygen delivery and impairing metabolic exchange at the microvascular level (Sjøgaard et al., 2022). This hypoperfused state promotes accumulation of lactate, hydrogen ions, and inflammatory mediators, generating a biochemical environment conducive to nociceptor activation and early fatigue (El-Helaly et al., 2020). In addition, reduced oxygen availability disrupts mitochondrial oxidative phosphorylation, diminishing ATP production and compromising actin–myosin cross-bridge cycling efficiency (Chiarotto et al., 2021). The resulting energy imbalance predisposes muscle fibers to sustained contracture, particularly within type I postural fibers that are continuously recruited during static loading (Hodges et al., 2021). Over time, impaired perfusion combined with mechanical strain may induce localized edema and increased intramuscular stiffness detectable on elastographic imaging (Wu et al., 2023). Collectively, these early physiological responses establish the substrate for subsequent structural and biochemical maladaptation within the postural musculature during prolonged FDP (Cagnie et al., 2021).

The concept of a "metabolic crisis" provides a coherent mechanistic explanation for FDP-related myofascial pain development, integrating biochemical depletion with mechanical overload (Simons et al., 2022). Persistent sarcomere contraction driven by impaired calcium reuptake in the sarcoplasmic reticulum results in formation of taut muscle bands that are palpably tender and electrically hyperactive (Ge et al., 2021). These hyperirritable loci correspond to myofascial trigger points, which may produce referred pain patterns due to convergence of afferent input within the dorsal horn (Fernández-de-las-Peñas and Nijs, 2021). Experimental microdialysis studies demonstrate elevated concentrations of substance P, bradykinin, and cytokines in active trigger points, supporting a localized inflammatory component (Shah et al., 2021). In the context of FDP, sustained contraction without circulatory relief amplifies this biochemical milieu, lowering the threshold for nociceptive firing (Sjøgaard et al., 2022). Simultaneously, altered proprioceptive feedback from fatigued stabilizers disrupts normal motor control, further increasing mechanical load on adjacent tissues (Hodges et al., 2021). The interaction between metabolic insufficiency and neuromuscular dyscoordination may therefore explain the persistence and spread of pain beyond the initially overloaded region (Fernández-de-las-Peñas and Nijs, 2021). Importantly, this cascade is not transient but may evolve into chronic sensitization if static exposure persists without modulation (Simons et al., 2022).

Beyond muscular mechanisms, prolonged FDP significantly alters biomechanical loading across facet joints, intervertebral discs, and ligamentous complexes of the cervical and lumbar spine (Callaghan and McGill, 2021). Sustained flexion increases anterior disc compression while placing tensile stress on posterior ligaments, leading to viscoelastic creep and reduced passive stability (Snodgrass et al., 2022). As muscular stabilizers fatigue, passive structures assume greater load-bearing responsibility, amplifying joint compression and capsular irritation (Callaghan and McGill, 2021). Degenerative changes such as facet arthropathy or disc desiccation lower the threshold at which mechanical stress translates into nociceptive activation (Hartvigsen et al., 2020). Repetitive low-grade strain may also stimulate mechanoreceptors within joint capsules, contributing to altered proprioceptive signaling and postural instability (Snodgrass et al., 2022).

Concurrently, sustained nociceptive input from overloaded tissues may induce peripheral sensitization through upregulation of ion channels and inflammatory mediators (Nijs et al., 2021). If exposure persists, central sensitization mechanisms including enhanced dorsal horn excitability and reduced descending inhibition may amplify perceived pain disproportionate to structural load (Woolf, 2021). Thus, the convergence of muscular ischemia, passive structural strain, and neural sensitization establishes FDP as a sustained stressor capable of driving both acute discomfort and longer-term maladaptive pain responses (Nijs et al., 2021).

Systemic Implications of Prolonged Face-Down Positioning

Although musculoskeletal strain is often localized to the cervical and lumbar regions, prolonged face-down positioning (FDP) may generate systemic pain-related consequences that extend beyond regional tissue overload (Apkarian et al., 2021). Persistent nociceptive input arising from sustained static contraction can trigger widespread alterations in pain modulation pathways, including reduced efficiency of descending inhibitory control (Yarnitsky et al., 2022). As nociceptive signaling continues, central nervous system processing may shift toward heightened excitability, lowering thresholds for pain perception even in anatomically uninvolved regions (Kregel et al., 2021). This phenomenon, often described as central sensitization, contributes to amplification of musculoskeletal discomfort disproportionate to mechanical load (Nijs et al., 2022). In the context of FDP, ongoing activation of paraspinal nociceptors may therefore propagate a generalized pain state rather than remaining strictly segmental (Apkarian et al., 2021).

Prolonged exposure to static strain may also induce neuroplastic changes within cortical pain networks, altering somatosensory representation and pain expectation (Mansour et al., 2021). Such neuroadaptive responses can intensify perceived discomfort and prolong recovery even after mechanical stress is reduced (Kregel et al., 2021). Consequently, FDP-related musculoskeletal pain should be understood as a potential driver of systemic pain modulation imbalance rather than a purely localized mechanical complaint (Yarnitsky et al., 2022).

Sustained musculoskeletal discomfort during FDP may further disrupt sleep architecture, which plays a critical role in pain regulation and tissue recovery (Finan et al., 2021). Experimental studies demonstrate that fragmented sleep reduces endogenous pain inhibition and enhances next-day pain sensitivity (Haack and Mullington, 2020). In postoperative retinal patients maintaining strict positioning, discomfort-induced sleep disturbance may therefore amplify musculoskeletal pain intensity through impaired restorative processes (Finan et al., 2021). Sleep disruption is also associated with increased inflammatory cytokine activity, which may potentiate peripheral nociceptor sensitization within overloaded musculature (Irwin et al., 2021).

The interaction between pain and poor sleep may create a bidirectional feedback loop, wherein pain interrupts sleep and inadequate sleep heightens pain perception (Haack and Mullington, 2020). In elderly or frail individuals, this cycle may accelerate functional decline and reduce tolerance to continued static positioning (Irwin et al., 2021). Additionally, chronic sleep disturbance is linked to impaired motor control and slower neuromuscular response times, potentially increasing compensatory strain in already fatigued muscles (Mansour et al., 2021). Thus, the systemic implication of FDP-related musculoskeletal discomfort extends into neurobehavioral domains that further intensify perceived pain burden (Finan et al., 2021).

Beyond neural sensitization and sleep-related amplification, prolonged static loading may contribute to generalized fatigue and reduced musculoskeletal endurance capacity (Enoka and Duchateau, 2021). Static contraction is metabolically inefficient and accelerates accumulation of fatigue-associated metabolites, which can persist beyond the period of active positioning (Hunter, 2020). This residual fatigue may reduce force-generating capacity of postural stabilizers, increasing reliance on superficial muscles and perpetuating maladaptive activation patterns (Enoka and Duchateau, 2021). In turn, compensatory recruitment of less fatigue-resistant fibers may heighten pain perception and stiffness, particularly in the cervical and scapular regions (Hunter, 2020).

Repeated cycles of strain and incomplete recovery can foster widespread muscle soreness resembling delayed-onset muscle fatigue rather than isolated focal pain (Nedergaard et al., 2022). Moreover, cumulative fatigue may impair proprioceptive acuity, reducing postural precision and further increasing microtrauma within overloaded segments (Nedergaard et al., 2022). In susceptible individuals, such as those with low baseline physical conditioning or sarcopenia, systemic fatigue may emerge rapidly and persist throughout the postoperative period (Enoka and Duchateau, 2021). These mechanisms collectively demonstrate that FDP-related musculoskeletal strain can evolve into a systemic fatigue–pain complex that influences overall recovery trajectory (Hunter, 2020).

Importantly, these systemic pain-related processes may interact bidirectionally with positioning adherence and recovery expectations (Eccleston et al., 2020). Heightened pain sensitivity, sleep disturbance, and cumulative fatigue can reduce a patient's ability to sustain strict posture for prolonged intervals (Eccleston et al., 2020). As discomfort escalates, patients may subconsciously modify head or trunk alignment to obtain relief, thereby altering effective tamponade positioning time (Apkarian et al., 2021). Repeated deviations may increase anxiety about surgical success, further amplifying pain perception through cognitive-emotional modulation pathways (Mansour et al., 2021).

Pain catastrophizing and fear-avoidance behaviors may also emerge in patients experiencing persistent discomfort, reinforcing protective muscle guarding and increasing stiffness (Eccleston et al., 2020). This psychophysiological interplay underscores that systemic musculoskeletal effects of FDP cannot be separated from behavioral and perceptual responses (Yarnitsky et al., 2022). Although severe systemic complications are rare, the cumulative burden of neurophysiological stress should not be underestimated in frail or multimorbid patients (Nijs et al., 2022). Therefore, prolonged FDP must be regarded as a whole-body musculoskeletal stressor capable of influencing central pain processing, sleep-mediated recovery, and functional endurance simultaneously (Apkarian et al., 2021).

Rehabilitation Medicine Perspective

Given the identifiable physiological and systemic consequences of prolonged face-down positioning (FDP), the integration of rehabilitation medicine into postoperative vitreoretinal care represents a mechanistically grounded and evidence-aligned strategy for mitigating musculoskeletal maladaptation (McGill and Brown, 2021). Contemporary rehabilitation science emphasizes that sustained static load–induced ischemia and fatigue are modifiable through targeted neuromuscular conditioning rather than unavoidable sequelae of immobilization (Borghuis et al., 2021).

Graded activation of deep stabilizing musculature, particularly the cervical multifidus and lower trapezius, has been shown to improve endurance capacity and redistribute load away from overactive superficial muscles (Cools et al., 2020). Endurance-oriented interventions enhance oxidative efficiency within postural fibers, thereby delaying fatigue onset and reducing susceptibility to metabolic accumulation during sustained posture (Santos et al., 2022). Controlled, low-intensity dynamic movement performed within safe positional constraints can restore intermittent perfusion cycles and promote clearance of nociceptive metabolites (Booth et al., 2021).

Neuromuscular stabilization training further refines motor control strategies, reducing compensatory co-contraction and excessive upper trapezius dominance that commonly characterizes postural overload syndromes (Ludewig and Braman, 2021). By improving coordination between deep and superficial stabilizers, rehabilitation directly addresses the biomechanical inefficiencies amplified during FDP (Borghuis et al., 2021). Thus, rehabilitation interventions are not merely symptomatic treatments but physiologically targeted strategies that counteract the underlying mechanisms of FDP-induced strain (McGill and Brown, 2021).

The preventive dimension of rehabilitation is equally critical in optimizing postoperative tolerance to FDP (Teyhen et al., 2021). Preoperative musculoskeletal screening can identify individuals with reduced endurance, sarcopenia, obesity, or pre-existing degenerative spinal conditions who may exhibit diminished adaptive capacity under static load (Cruz-Jentoft et al., 2020). Early risk stratification enables individualized exercise prescriptions aimed at enhancing spinal stability before prolonged positioning is initiated (Teyhen et al., 2021). Evidence from spine rehabilitation models demonstrates that early activation of deep stabilizers reduces recurrence of postural pain and improves functional resilience (Steele et al., 2020).

Tailored exercise protocols in the early postoperative period, when delivered within head-positioning constraints, can maintain muscular engagement without compromising intraocular stability (Heneghan et al., 2021). Low-load endurance training has been shown to improve capillary density and mitochondrial efficiency, thereby increasing tolerance to sustained contraction (Santos et al., 2022). Importantly, gradual progression prevents overload while fostering adaptive remodeling of postural musculature (Steele et al., 2020). This proactive approach reframes rehabilitation as anticipatory risk management rather than reactive symptom control (Cruz-Jentoft et al., 2020).

Beyond physiological modulation, rehabilitation may influence behavioral and perceptual dimensions of postoperative care (Main et al., 2021). Structured exercise and guided movement reduce perceived effort associated with maintaining static posture, thereby lowering subjective discomfort during FDP (Ludewig and Braman, 2021). Improved endurance reduces reliance on compensatory muscle guarding, which is often associated with heightened pain perception and stiffness (Booth et al., 2021). Education regarding safe movement strategies empowers patients, mitigating fear-avoidance responses and reducing maladaptive protective postures (Main et al., 2021).

In musculoskeletal rehabilitation research, patient engagement and perceived control are strongly associated with improved adherence to prescribed interventions (Teyhen et al., 2021). Within the FDP context, enhanced tolerance may therefore translate into more consistent maintenance of prescribed head positioning (Heneghan et al., 2021). Reduced discomfort also contributes to improved sleep quality, which in turn supports neuromuscular recovery and pain modulation (Steele et al., 2020). Consequently, rehabilitation supports not only biomechanical sustainability but also behavioral adherence mechanisms essential for therapeutic effectiveness (Main et al., 2021).

The absence of standardized rehabilitation pathways in vitreoretinal surgery reflects historical disciplinary compartmentalization rather than physiological incompatibility between ocular and musculoskeletal care (McGill and Brown, 2021). Contemporary surgical recovery paradigms increasingly emphasize multimodal, patient-centered pathways that address functional capacity alongside anatomical correction (Cruz-Jentoft et al., 2020). Integrating rehabilitation specialists into postoperative retinal care teams facilitates collaborative protocol development that respects both ocular safety and musculoskeletal integrity (Heneghan et al., 2021). Interdisciplinary coordination ensures that exercise prescriptions maintain head positioning requirements while promoting circulation and endurance conditioning (Ludewig and Braman, 2021). Evidence from spine and postural rehabilitation underscores that structured, supervised activation reduces chronicity risk and enhances long-term musculoskeletal health (Steele et al., 2020). Applying these principles to FDP contexts may prevent transition from acute strain to persistent postural pain syndromes (Borghuis et al., 2021). Furthermore, standardized rehabilitation pathways enable outcome monitoring, including pain scales, endurance metrics, and adherence tracking (Main et al., 2021). In this integrated model, rehabilitation is not ancillary to retinal surgery but synergistic optimizing functional sustainability while safeguarding anatomical objectives (McGill and Brown, 2021).

CONCLUSION

Prolonged face-down positioning (FDP) after vitreoretinal surgery remains clinically relevant for selected retinal indications. Continuous static contraction, reduced microvascular perfusion, metabolic imbalance, joint overload, and potential sensitization mechanisms collectively explain the high prevalence of cervical and lumbar discomfort observed during postoperative recovery. These effects are not incidental but inherent to the mechanical demands of prolonged positioning, and importantly, they may compromise adherence, thereby influencing the real-world effectiveness of retinal tamponade. Rehabilitation medicine provides a mechanistically sound and clinically feasible strategy by enhancing muscular endurance, optimizing neuromuscular coordination, and improving perfusion within ocular safety constraints Face-down positioning should be managed as a modifiable biomechanical exposure, and proactive rehabilitation integration can enhance tolerance, preserve adherence, and optimize overall surgical recovery.

Acknowledgments

The authors acknowledge the academic collaboration between the Department of Ophthalmology and the Department of Physical Medicine and Rehabilitation in developing the interdisciplinary framework presented in this review. No external editorial or writing assistance was received in the preparation of this manuscript.

Author Contributions

Conceptualization: N.M.M.
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Literature Review and Data Curation: N.M.M.
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Supervision: H.S.M.
All authors have read and approved the final version of the manuscript.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflicts of interest related to this work.

Ethical Approval

This study is a narrative review based exclusively on previously published literature and did not involve human participants, identifiable personal data, or animal subjects. Therefore, ethical approval was not required.

Data Availability Statement

No new data were generated or analyzed in this study. All information is derived from previously published sources cited within the manuscript.

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