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Prehabilitation for Patients Undergoing Elective Foot and Ankle Surgery: A Contemporary Review

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Introduction

Disorders of the foot and ankle, as well as their treatment, can be temporarily disabling and affect both mobility and independence. With an increase in the understanding of foot and ankle conditions and improved surgical techniques, more patients are undergoing elective foot and ankle surgery.[8,36, 44,83] From a rehabilitation perspective, it is known that postoperative rehabilitation plays an important role in helping orthopaedic patients return to their baseline functional status.[30,72,104] With regard to prehabilitation, modifiable factors such as strength, baseline function, mental health, and education have been shown to be predictive factors for orthopaedic outcomes.[5,9,23] Varying outcomes with prehabilitation have been reported in both hip and knee arthroplasty.[30,72,104] However, the impact of prehabilitation in foot and ankle surgery remains largely unknown. Thus, the purpose of this review was to explore existing prehabilitation programs in other regions of the lower extremity and the theoretical benefits of prehabilitation for elective foot and ankle surgery.

Background: Prehabilitation in Orthopaedic Surgery

Prehabilitation has been described in the literature as early as the 1940s.[71] In orthopaedic surgery, a widely cited review published in 2002 laid a conceptual framework for prehabilitation and defined it as "the process of enhancing functional capacity of the individual to enable to them to withstand the stressor of inactivity."[21] The authors first outlined negative consequences of physical inactivity on the musculoskeletal system as well as on the cardiovascular system, which may be expected following orthopaedic surgery. Then, the authors proposed general prehabilitation principles including patient education regarding upcoming procedures, cardiovascular training, resistance training, flexibility exercises, and functional task training. Without much supporting evidence, however, the authors proposed that patients undergoing prehabilitation would theoretically have a higher level of functional capacity to better withstand the stress of surgery.

Over the past 2 decades, this argument has been substantiated by numerous clinical trials investigating the effect of

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prehabilitation on postoperative outcomes in orthopaedic surgeries. Prehabilitation prior to total knee arthroplasty (TKA)[6,11,15,16,18,22,26,32,40-42,47,56,58,59,76,77,79,86,89,93,97,99,101,107] has been most commonly studied, but studies have also been completed in total hip arthroplasty (THA),[13,25,28, 35,39,68] lumbar spine surgery,[49,51,55,65,78] anterior cruciate ligament reconstruction (ACLR),[46,82] and femoroacetabular impingement (FAI) syndrome.[31] Several systematic reviews[17,30,72,103,104] have synthesized these studies and demonstrated that prehabilitation is associated with improvement in specific outcomes for patients undergoing orthopaedic surgery.

For patients undergoing TKA, prehabilitation programs range from 3 days to 12 weeks and focus on lower extremity strengthening and general mobility.[30] One systematic review found low to very low certainty of evidence that prehabilitation resulted in superior knee function preoperatively and up to 3 months postoperatively.[30] Another systematic review reported moderate certainty that prehabilitation results in superior outcomes in knee function, knee flexion strength, and 6 Minute Walk Test (6MWT) prior to surgery. However, the authors concluded there was low certainty of postoperative improvement in knee function, range of motion, strength, quality of life, Timed Up and Go (TUG) test at 6 weeks, and in knee function, Health-Related Quality of Life (HRQOL), and stairs test at 3 months.[72]

Prehabilitation protocols for THA typically involve up to 12 weeks of sensorimotor training, strengthening, cardiovascular exercises, and/or education.[104] One systematic review concluded that exercise-based prehabilitation resulted in significant improvement in the 6MWT, TUG test, chair-rise test, and stair climbing.[104] A meta-analysis by Punnoose et al[72] demonstrated moderate certainty of evidence that prehabilitation promotes superior outcomes in HRQOL and hip abductor strength and low certainty of improvement in preoperative pain and function. Additionally, there was low certainty of improvement in hip function at 3 and 12 months postoperatively.

For patients undergoing lumbar spine surgery, prehabilitation has consisted of up to 2 months of exercise, nutrition, and cognitive-behavioral therapy.[49,51,55,65,78] Punnoose et al[72] showed that there was high certainty of evidence that prehabilitation leads to better outcomes in back pain, moderate certainty in improvement in HRQOL, and low certainty of benefit in preoperative function. Postoperatively, there was low certainty of evidence in better outcomes for back pain at 3 months and moderate certainty of evidence in functional improvement at 6 months.

There are fewer RCTs exploring prehabilitation for ACLR and hip arthroscopy for FAI. However, for ACLR, one RCT studied a 6-week prehabilitation exercise program that consisted of supervised resistance exercises and balance training. The authors showed improved knee function preoperatively based on the single-legged hop test and the modified Cincinnati score that lasted at least 12 weeks postoperatively.[82] Another RCT demonstrated that a 4-week prehabilitation exercise program including strengthening, functional balance, muscle control, and cocontraction resulted in significantly greater improvements in knee extension strength and single hop distance test at 12 weeks postoperatively.[46] One systematic review synthesizing RCTs and cohort studies concluded that prehabilitation prior to ACLR may improve neuromuscular and self-reported knee function as well as return to sports.[27] For patients undergoing hip arthroscopy for FAI, a pilot RCT that consisted of an 8-week home exercise prehabilitation program focusing on hip muscles demonstrated better knee extension strength and hip flexion strength at 3 months postoperatively.[31] Thus, there are varying levels of supporting evidence for prehabilitation programs prior to orthopaedic surgery, and further research is necessary to understand how to optimize patients' preoperative strength, range of motion, and overall health.

Unfortunately, there is limited evidence to support the concept of prehabilitation in foot and ankle surgery. A recent systematic review identified 4 studies that demonstrated positive results with various preoperative education before elective foot and ankle surgery.[100] One study from the United Kingdom found that the use of preoperative patient information packets on procedure details, recovery timeline, risks, and potential complications of surgery was well received by patients.[91] Another study from Germany evaluated the effect of a 2½-hour preoperative multidisciplinary training course that included education on the procedure, perioperative expectations, and postoperative protocols followed by an opportunity to practice ambulating with assistive devices.[80] Following intervention, they reported significant improvement in patient knowledge and satisfaction, but no effect on preoperative anxiety.[80] An additional 2 studies from the United Kingdom found that preoperative educational interventions led to significantly reduced length of hospital stay.[81,95] Selvan et al[81] set up a single course 3 weeks before surgery led by a nurse who provided education on the procedure and postoperative course and a physical therapist who reviewed postoperative weightbearing restriction, evaluated mobility, and instructed on stair navigation and safe use of crutches. In the study by Thomas et al,[95] patients were invited to join a "foot school" group session within 2 weeks of surgery led by (1) a nurse who provided education on postoperative care and (2) physical and occupational therapists who trained patients on ambulation with crutches or postoperative footwear, stair navigation, and exercise practice. Although these studies demonstrate that prehabilitation efforts may improve patient knowledge and reduce postoperative length of stay, they do not report on patient-reported outcome measures, functional outcomes, performance measures, and other important outcomes such as falls.

Presentation: Common Physical Impairments and Psychological Symptoms Seen in Patients Undergoing Elective Foot and Ankle Surgery

Patients undergoing elective foot and ankle surgery may have deficits in foot and ankle strength, function, range of motion (ROM), and proprioception. For example, for patients with ankle osteoarthritis, a systematic review demonstrated significantly less range of motion and strength in ankle dorsiflexion and plantarflexion in addition to reduced calf circumference.[4] Hindfoot mobility as measured by ankle inversion and eversion in the frontal plane may also be reduced.[98] Additionally, one study using magnetic resonance imaging revealed smaller cross-sectional areas of the gastrocnemius-soleus complex of the affected extremity,[105] whereas in another study electrodiagnostic testing demonstrated reduced electromyography amplitudes of the gastrocnemius and decreased frequencies of the tibialis anterior, gastrocnemius, and peroneus longus muscles.[98] These findings are potentially concerning because muscular impairments may lead to limited mobility as well as overcompensation of the unaffected limb or proximal muscles of the affected limb during ambulation, which can cause further muscular imbalance and instability following ankle arthroplasty or arthrodesis.

Patients undergo elective foot and ankle surgery for a variety of conditions, and may benefit from prehabilitation to improve preoperative function and strength. In patients with chronic ankle instability, decreased proprioception and evertor muscle weakness have been reported.[45,90,106] Additionally, it is postulated that functional shortening of the peroneus brevis in progressive collapsing foot deformity (PCFD) could be a factor in prolonging recovery even though hindfoot alignment is restored.[43] Prehabilitation-related peroneal tendon strengthening could have a crucial role in restoring foot function after surgery.[43,54] In regard to talocalcaneal coalition, especially when associated with hindfoot deformity, limited hindfoot inversion and eversion may result in imbalanced function of the tibialis posterior tendon and the peroneal tendons. Efforts to improve the tendon and muscle function have been postulated to help with recovery if done as part of prehabilitation before coalition excision or arthrodesis.

For patients with plantar fasciitis, weakness in ankle plantarflexion, dorsiflexion, inversion, and eversion has been observed[75] as well as limited ankle active and passive dorsiflexion secondary to a tightened gastroc-soleus complex.[38] For patients with tibialis posterior tendinopathy, decreased subtalar inversion and foot inversion strength, impaired ability to achieve normal push-off secondary to weak deep compartment muscle strength, and poor unipedal standing balance were seen.[74]

Following lower extremity orthopaedic surgery, patients are at higher risk of falling due to imbalance, impaired gait, and pain associated with their pathology, in addition to postoperative weightbearing restrictions. Postoperative falls may lead to complications such as fracture, revision surgeries, hospital readmissions, unnecessary emergency department visits, or health care provider evalautions.[53,73,102] The incidence of falls in the first year following discharge for total knee or hip arthroplasty has been reported to be as high as 43%.[50] A more recent study on foot and ankle surgery reported a 29% incidence of falls in the first 6 weeks after discharge.[7] Although the authors of this study found that antidepressant use and higher postoperative pain scores were associated with increased risk of falling,[7] it is also important to note that all patients also had postoperative weightbearing restrictions and used assistive devices for ambulation. The location of surgery (forefoot, midfoot, hindfoot, or ankle) was not a significant variable influencing fall risk in this study.[7]

Following foot and ankle surgery, many patients have partial or nonweightbearing restrictions for up to 12 weeks and require assistive devices for ambulation. Orthopaedic knee scooters have gained popularity among foot and ankle surgery patients as they require less energy than crutches or walkers and allow for faster mobility than other conventional ambulatory aids while adhering to weightbearing restrictions. Unfortunately, knee scooters are a significant risk factor associated with postoperative falls, and falls can lead to complications and prolonged recovery. Three studies have reported that the prevalence of postoperative knee scooter–related falls ranges from 25 to 44%.[102,108,111] The prevalence of knee scooter–related injuries in a prospective cohort study was found to be 15%, and on average these injuries prolonged recovery by 7 weeks.[102] Injuries in another study included a rotator cuff tear requiring surgery, wound dehiscence, knee and hand lacerations, bruised ribs, and severe fright.[108] In a survey of American Orthopaedic Foot & Ankle Society surgeons, the prevalence of postoperative knee scooter–related injuries was estimated to be 2.5%, and 34% of those injuries were treated operatively.[73] Despite the apparent risk associated with knee scooter use, patients report very high satisfaction scores and continue to prefer knee scooters over conventional ambulatory aids.[88,102,111] There have been no studies investigating the effect of preoperative physical therapy, ambulatory aid training, patient education or other preventative strategies on fall risk after foot and ankle surgery. To this end, most patients in one study reported receiving no instruction or education on the proper use of knee scooters.[111]

Beyond physical impairment, patients with foot and ankle disorders tend to have higher proportion of depression and anxiety than patients in general practice settings[96] and possibly other orthopaedic patients.[12,34,109] In foot and ankle patients, the prevalence of anxiety and depression has

been reported to be 30% and 27%, respectively.[64] The presence of depression and anxiety was negatively associated with pain and impaired quality of life,[64] and pain-related fear contributed to self-reported disability in patients with foot and ankle pathology.[48] Furthermore, preoperative anxiety predicted worse pain and function during early postoperative follow-up in patients undergoing elective foot and ankle surgery.[66] Preoperative antidepressant use has also been associated with increased risk of postoperative falls.[7] Despite the lack of evidence to support an argument that preoperative treatment of psychological symptoms can improve outcomes for foot and ankle patients, it may be prudent to screen patients for these symptoms prior to surgery[84] and referred to the appropriate clinicians to optimize their recovery given limited evidence from other orthopaedic studies.[24,69]

Given that there is often a waiting period or delay prior to elective foot and ankle surgeries, there is a window of opportunity for prehabilitation to improve not only physical impairments associated with foot and ankle disorders but also psychological distress which may affect postoperative outcomes.

Treatment: Prehabilitation for Patients Undergoing Elective Foot and Ankle Surgery

Currently, there are limited studies investigating the effect of prehabilitation on the outcomes of elective foot and ankle surgery. However, patients undergoing foot and ankle surgery have substantial physical impairments, high rates of psychological distress, and high postoperative fall rates. We suggest a multimodal prehabilitation program consisting of patient education, health optimization, exercise, and ambulatory device training (Table 1). The goals of this program are aligned with those of prehabilitation in general, specifically to prepare the body to withstand a stressful event such as an orthopaedic procedure, to optimize safety, and to minimize the duration of dependent functioning.[21]

Table 1. Preoperative Checklist for Patients Undergoing Elective Foot and Ankle Surgery.

Medical optimization	Comanagement and optimization of medical conditions as well as risk stratification is done in consultation with primary care practitioner. ☐ Optimization of anemia, diabetes, hypertension, sleep apnea and other comorbidities ☐ Bone health screen ○ Vitamin D supplementation ☐ Nutritional assessment ☐ Weight management
Behavioral health optimization	☐ Anxiety screen: GAD-7 ☐ Depression screen: PHQ-9 ☐ Alcohol consumption and substance use screening
Educational topics	☐ Procedure, anesthesia, risks and complications ☐ Clinical outcomes and recovery timeline ☐ Postoperative pain and wound care ☐ Weightbearing precautions
Prehabilitation assessment	☐ Activity level, function, gait, mobility and cognition ☐ Strength, range of motion, sensation, and proprioception ☐ Home environment
Prehabilitation interventions	☐ Training with appropriate ambulatory aid, durable medical equipment and/or other assistive devices ○ Transfers, ambulation, stair navigation, and activities of daily living ☐ Physical therapy–guided exercise program

Patient Education

At the preoperative visit, the surgeon should discuss and provide a printed or electronically available guide to review the procedure, expectations, and the postoperative protocol. The details of the surgical technique, anesthetic plan, associated risks and complications, as well as postoperative pain management and wound care instructions should be discussed. The patient should have a clear understanding of likely clinical outcomes, recovery timeline, weightbearing precautions, and the need for home modifications or durable medical equipment such as ambulatory aids. It is crucial to set realistic expectations for patients given that 66.3% of patients undergoing foot and ankle surgery were found to have higher expectations than surgeons did.[52]

Following foot and ankle surgery, patients are at high risk of falling, which may lead to complications and prolonged recovery. It is important to consider that depending on the type of surgery, patients may have weightbearing restrictions for up to 12 weeks and may require assistive devices for ambulation. Noncompliance rate with postoperative weightbearing restrictions has been reported to be 27.5%,[19] which may lead to suboptimal recovery and possible complications.[102,111] Knee scooters are associated with reported prevalence of falls and associated injury as high as 44%[111] and 15%,[102] respectively, and knee scooter–related injuries prolong recovery by an average of 7 weeks.[102] Gait training using ambulatory aids, such as canes, crutches,

walkers, knee scooters, hands-free walking crutches, and other assistive devices should be included as a part of preoperative patient education for those with anticipated weightbearing restrictions.

Medical Optimization

Prior to elective surgery, routine screening of surgical risk factors should be performed in consultation with primary care practitioners. Providers can counsel patients with nonmodifiable risk factors[1,2,20,33,70] regarding their increased risk of perioperative complications and comprehensively evaluate for modifiable risk factors[14,29,61,62,87,92,94] so that the appropriate interventions can be prescribed. Nonmodifiable risk factors include older age, chronic medical conditions, heart disease, lung disease, vascular disease, neuropathy, and kidney disease. Modifiable risk factors include substance use (tobacco, alcohol, or narcotics), obesity, diabetes, osteoporosis, hypertension, anemia, sleep apnea, poor nutrition, depression, and anxiety. Primary care providers should assist in modifiable risk factor reduction. Although nonmodifiable risk factors may not be eliminated, these conditions can be stabilized, and medications can be optimized prior to surgery.

Potential wound issues after surgery can be minimized by maintaining better diabetic control with routine HbA_{1c} and perioperative blood glucose monitoring in addition to qualified nutrition advice. Various HbA_{1c} cutoff values from 7.0% to 8.0% have been suggested to minimize potential complications of elective surgery in diabetic patients; however, no consensus has been reached on the optimal level.[57,85] The perioperative blood glucose target recommended by the American Diabetes Association is 80 to 180 mg/dL as values greater than 200 mg/dL are associated with increased risk of surgical site infection.[57] Additionally, offering guidance about the signs and symptoms of infection or wound issues can aid in management.[3]

Nutrition and Weight Management

It is important to evaluate dietary habits, protein intake, vitamin deficiency, and body mass index as these factors can compromise healing and increase risk of complication. An emphasis on high-quality carbohydrates, adequate protein intake, possibly in conjunction with dietary supplementation starting 7-10 days prior to surgery can optimize nutrition and healing.[37] Given that only 1 in 6 patients undergoing foot and ankle surgery had a normal vitamin D level whereas 1 in 5 patients were deficient, it may also be beneficial to measure a vitamin D level preoperatively, especially in patients undergoing bony procedures.[10] It has been reported that a higher prevalence of nonunion following elective foot and ankle surgery was associated with vitamin D deficiency and insufficiency.[60] Vitamin D–deficient patients should receive supplementation with 50 000 IU/weekly for 12 weeks and may have a level repeated prior to surgery to ensure adequate repletion.

Behavioral Health Optimization

Surgeons should consider screening for any psychological symptoms indicative of depression, anxiety, and kinesiophobia, given the potential association of these diagnoses with suboptimal postoperative outcomes. Screening tools such as the general anxiety disorder-7 (GAD-7), patient health questionnaire (PHQ-9), or hospital anxiety and depression scale (HADS) can be used during preoperative assessment, and positive screens or poorly controlled symptoms may benefit from referral for further evaluation, counseling, and/or pharmacologic management to optimize mental health prior to surgery.[14,48,84] Behavioral health interventions and counseling resources should also be offered for alcohol, tobacco, and substance use, as these may increase the risk of surgical complications, impaired healing, and prolonged surgical recovery.

Preoperative Rehabilitation Assessment and Interventions

Patients with foot and ankle pathology demonstrate limitations in ankle ROM, weakness in supporting and proximal muscles, and diminished proprioception. Prehabilitation programs should be designed to address specific deficits and functional impairments seen with each pathology. In general, exercise programs can include strengthening and stretching of the musculature involved in ankle and hindfoot motion in order to improve gait biomechanics, ankle mobility, stability, and balance. Upper limb muscle strength is essential to facilitate mobility using ambulatory aids. In order to be partial or nonweightbearing, patients are required to flex the knee or limit the amount of weight placed on one portion of the foot. From a prehabilitation standpoint, strengthening the quadriceps as well as the brachioradialis and deltoid muscles in the upper extremities may aid in controlling and using ambulatory devices even after foot and ankle surgery.[110]

The strength and stability of the knee and hip on the affected side, in addition to that of the unaffected lower extremity, lumbopelvic region, and upper extremities should be also optimized to prepare for nonweightbearing status and ambulatory aid use, thus protecting the operative site and reducing the risk of falls (Table 2).

Navigating transportation and the home environment in addition to performing activities of daily living can also pose substantial challenges postoperatively. As such, patients may benefit from learning techniques to safely navigate activities of daily living, transfers, ambulation, and climbing stairs. These activities often entail the appropriate

Table 2. Sample Prehabilitation Exercise Program for Patients Undergoing Foot and Ankle Surgeries.[a]

Exercise	Purpose	Sample Instructions
Gastrocnemius-soleus (GS) stretching	Improve dorsiflexion range of motion for gait function	Hold for 30 s in each leg, repeat 3 sets per session, and 2 sessions a day
Ankle pumps	Improve range of motion and stability of ankle joints; stretch and strengthen the GS complex and tibialis anterior muscle	10 repetitions, twice a day
4-way ankle exercises	Strengthen GS complex, tibialis anterior, tibialis posterior, and peroneal muscles	10 repetitions in each dorsiflexion, plantarflexion, inversion, and eversion, twice a day
Gluteal squeezes Hooklying bridges	Strengthen gluteal muscle; improve trunk stability, gait, and posture Patient may progress to hooklying bridges if gluteal squeezes are not challenging enough	10 repetitions, twice a day
Quad sets Seated knee extension	Strengthen quadriceps; improve knee biomechanics and lumbopelvic stability Patient may progress to seated knee extension if quad sets are not challenging enough	10 repetitions, twice a day.
Supine heel slides	Strengthen quadriceps, hamstrings, hip flexor, and gluteal muscle	10 repetitions on each side (one side at a time), twice a day.
Straight leg raises	Strengthen hip flexors, quadriceps, and abdominal muscles; improve stability and biomechanics of hip and spine	10 repetitions on each side (one side at a time), twice a day.
Side-lying leg raises	Strengthen hip abductors, lumbopelvic region, and lower back	10 repetitions on each side (one side at a time), twice a day
Seated ankle circles	Increase range of motion and stability of ankle joints; stretch and strengthen the GS complex, tibialis anterior, tibialis posterior and peroneal muscles	10 repetitions, twice a day
Deep knee bends	Maintain ankle dorsiflexion; strengthen GS complex, tibialis anterior, quadriceps, hamstrings, and gluteal muscles; improve balance, stability, and proprioception	10 repetitions, twice a day
Calf raises	Strengthen GS complex and tibialis posterior muscle	10 repetitions, twice a day
Single leg balance	Improve ankle, knee, and hip stability and proprioception, balance, and coordination	Hold for up to 1 min on each side, twice a day. May progress to eyes closed when not challenging enough
	If patients demonstrate positive Romberg test, patients may practice balancing with their 2 feet on the ground and eyes closed.	
Seated push up	Strengthen triceps, pectoral, and shoulder muscles	10 repetitions, twice a day

[a]Potential manual work with in-person PT would include talocrural distraction to decrease pain and globally increase motion as well as calcaneal glides to assist with subtalar joint and hind foot mobility.

and competent use of durable medical equipment including commodes, tub benches, crutches, wheelchairs, walkers, knee scooters, or other devices. Assessing the home environment and living situation for accessibility, stairs, and rugs can help guide home modifications and identify safety concerns or challenges.

Complications, Contraindications, and Considerations

Prehabilitation is a relatively benign intervention that can be implemented prior to foot and ankle surgery. However, it may not be appropriate for all patients. Patients who sustain acute trauma or require emergent surgery may not be candidates for prehabilitation. Other acute medical conditions and concomitant orthopaedic conditions that would limit patients from participating in exercise would also be potential contraindications for prehabilitation.

Adherence to prehabilitation programs poses another challenge to patients although >70% adherence rate has been reported in clinical trials.[72] Although exercises described in the previous section can be performed at home, patients with low baseline function, cognitive impairment, or decreased motivation may be directed to a more structured course of therapy to optimize results. Special attention should be given to patients with inflammatory arthritis[63] and increased frailty[67] as these diagnoses may exhibit poor baseline function and require more rigorous prehabilitation.

Conclusion

Patients planning to undergo elective foot and ankle surgery often suffer from unique issues with mobility, proprioception, and mental health. Prehabilitation provides patients with exercise programs to optimize strength and range of motion while also increasing patient knowledge of and exposure to interventions that they will receive after surgery. There is limited literature to support the concept of prehabilitation for foot and ankle surgeries, although 2 small case series have demonstrated that prehabilitation primarily in the form of a preoperative educational session may reduce length of stay and improve discharge readiness. Given the benefits reported in other orthopaedic subspecialties, further research is now needed to evaluate the benefits of prehabilitation in foot and ankle surgery using validated patient-reported outcome measures, functional outcomes, and other important events such as postoperative falls and injuries.

Ethical approval

Ethical approval was not sought for the present study because this was a review article.

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