in the sit-to-stand five times test in patients who used the IDEO. However, most of the patients who initially desired a late amputation reversed their decision based on improvement in function associated with use of the IDEO.

Summary

Treatment and rehabilitation of patients with severe trauma to the lower extremities is challenging. Patient expectations are high, and failure to meet these expectations is associated with poor outcomes. Although some significant advances in the rehabilitation of these high-energy, lower extremity injuries have been made during the current conflict, the reproducibility of this intervention remains in question. Small case series have reported improvement in function with use of the Return to Run clinical pathway in patients with severe trauma to the lower extremity; however, large-scale studies are warranted.

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to the persistent functional challenges experienced by limb salvage patients. The pathway consists of use of the Intrepid Dynamic Exoskeletal Orthosis (IDEO) and high-intensity physical therapy. Because limb salvage patients experience residual weakness and limited range of motion following lower extremity reconstruction, development of an energy-storing ankle-foot orthosis was needed to restore wounded warriors to their desired level of function and participation in meaningful life activities.[11]

The IDEO is similar to a prosthetic running foot in that the shape and carbon fiber material of the orthosis store and deliver energy that simulates plantar flexion power (Figure 1). The proximal cuff of the orthosis helps offload the extremity, and the footplate limits extremes of ankle motion. These two factors help minimize the mechanical pain that limb-salvage patients typically experience with high-level activity.

The high-intensity physical therapy of the clinical pathway is based on a sports medicine approach to recovery, with running being the common goal.[12] Patient cohorting promotes peer motivation and mentoring as the warriors work through a series of progressions to achieve the goal of running. These progressions have a heavy emphasis on strength training, plyometrics, and agility.[13] For service members who desire to return to duty, occupation-specific rehabilitation is included.

A recent case series reported early results of the integrated orthotic and rehabilitation intervention in 10 patients who underwent limb-salvage procedures.[12] Patients who underwent hindfoot fusion and those with diagnoses such as nerve injury, volumetric muscle loss, and posttraumatic arthritis regained high-level function after completing the clinical pathway.

Figure 1

Photograph of a patient wearing an Intrepid Dynamic Exoskeletal Orthosis.

Standardization of Lower Extremity Testing Measures

Objective, quantitative assessments of surgical and rehabilitative intervention are lacking in persons who must carry out the high-level physical demands required of active military personnel.[14] The Military Performance Laboratory at the Center for the Intrepid has worked to establish normative data for several physical performance measures, including the four-square step test and the timed stair ascent. Further testing of these measures demonstrated that they are reliable and remain stable between testing days.[15]

Select physical performance measures are now used routinely for assessment of wounded warriors with severe lower limb trauma. These measures include self-selected walking speed on both level and rocky terrain, timed stair ascent, the sit-to-stand five times test, and the four-square step test. Self-selected walking speed on level and rocky terrain is used to assess gait efficiency and stability on different surfaces. Timed stair ascent and the sit-to-stand five times test are used to assess strength and mobility, whereas the four-square step test is a measure of dynamic balance and mobility.

IDEO Functional Measures

Objective testing of improvement in physical performance with use of the IDEO was conducted.[16] In addition, the ability to complete a 40-yard dash was assessed because this measure is familiar to patients. Performance was compared with the use of an IDEO, a noncustom commercial carbon fiber orthosis, a posterior leaf spring orthosis, and no brace. Substantial improvement in performance was seen with use of the IDEO in almost all of the physical performance measures as well as the 40-yard dash. No improvement was reported

Challenges in Severe Lower Limb Injury Rehabilitation

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Abstract

Restoration of lower limb function following severe injury is a challenge. Rehabilitation must take into account psychosocial factors and patient self-efficacy as well as functional goals. The Return to Run clinical pathway, an integrated orthotic and rehabilitation initiative, is an example of goal-oriented rehabilitation with periodic assessment aimed at restoring wounded warriors to high-level performance following severe lower extremity trauma. Objective assessment measures of surgical and rehabilitation interventions are lacking for persons with high-level performance demands, such as those required by service members. Thus, the Military Performance Laboratory at the Center for the Intrepid has established normative data for several physical performance measures, some of which are now routinely used to assess service members with severe lower extremity trauma. Patient expectations of treatment and rehabilitation are high and must be met to avoid poor outcomes attributed to nonanatomic factors.

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Anatomic reconstruction of the lower limb following severe trauma has long been the focus of attempts to restore function; however, recent data suggest that nonanatomic factors (eg, depression, anxiety, pain) may have the greatest influence on outcome.[1] Reports of functional outcome and ability to participate in meaningful life activities following high-energy lower extremity trauma have been alarmingly poor.[1,2] Level of depression, anxiety, pain, and psychosocial resources have a significant influence on these outcomes.[3]

In addition to the focus on reconstruction techniques, we must advance rehabilitation strategies to restore function and patient self-efficacy. A multidisciplinary approach to rehabilitation of the total patient is needed. The Trauma Collaborative Care Intervention is a multimodal intervention designed to address current gaps in rehabilitation, particularly in regard to psychosocial factors, during the transition from acute care.[4]

Rehabilitation Following Limb Salvage

Combat-related lower extremity injuries have resulted in significant disability in wounded warriors,[5] with low rates of return to duty.[6,7] Although advances in reconstruction have improved surgical outcomes,[8] disability persists due to pain, nerve injury, volumetric muscle loss, and joint stiffness. Because of these persistent challenges, some patients request late amputation to improve function.[9,10]

In the current military conflict, running has become a patient-driven symbol of a return to high-level function. The Return to Run clinical pathway was developed in response