

# Unilateral Transtibial Amputation Rehabilitation Guidelines

**Approved by:**

**Physical Therapy Department**  
BAMC CFI  
NMCS D C5  
WRNMMC MATC

**James H. Flint, MD, FAAOS**  
CDR, MC, USN  
Head, Musculoskeletal Oncology  
NMCS D C5

**Sarah N. Pierrie, MD**  
Maj, MC, USAF  
Director, Surgical Services  
BAMC CFI

**B. Kyle Potter, MD, FACS**  
COL, MC, USA  
Director, Surgical Services  
WRNMMC MATC

**Created with support from:**



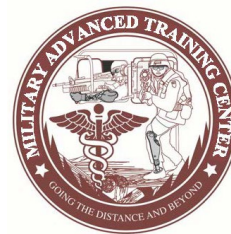
Brooke Army Medical Center  
Center for the Intrepid



Extremity Trauma and Amputation  
Center of Excellence



Naval Medical Center San Diego  
Comprehensive Combat and Complex Casualty Care (5)  
Program



Walter Reed National Military Medical Center  
Military Advanced Training Center

**Note:** This document serves as a guideline for post-operative rehabilitation and should be executed in combination with sound clinical judgment and reasoning to ensure patient safety and optimize long term function. If any concerns and/or complications arise regarding the progress of any patient, Physical Therapy and Prosthetics providers must contact the attending Orthopedic Surgeon and/or Physical Medicine & Rehabilitation specialists assigned to the patient's case. Progression to the next phase along the course of rehabilitation care should be determined by the surgical and rehabilitation team's guidance with continual evaluation of clinical criteria to include but not limited to: bone/soft tissue healing status, achievement of functional milestones, pain levels, and/or concurrent medical conditions.

### **Types of TTA and Secondary Procedures**

- Standard Burgess / Suture Bridge no bony bridge used, closed with long posterior myocutaneous flap
- Ertl/Modified Ertl – Tightrope, screw or suture used to stabilize a piece of fibula or alternate bone graft source to form bony bridge between tibia and fibula
- AMI (Agonist antagonist Myoneural Interface) - Comprises a surgical construct and neural control architecture designed to serve as a bidirectional interface
- Common closures – posterior flap, long posterior flap which provides more padding to the anterior distal end, skew flap, sagittal flap, medial flap and fish mouth flap
- TMR (Targeted Muscle Reinnervation) - Severed motor nerves are surgically transferred to the motor points of denervated *target* muscles, which, after reinnervation, contract in response to neural control signals for the missing limb
- RPNI (Regenerative Peripheral Nerve Interfaces) - constructed by excising the nerve and wrapping the proximal nerve end with a small free muscle graft

### **Suggested Outcomes Metrics**

- Amputee Mobility Predictor (AMPnoPRO or AMP-Bilateral)
- Timed Up and Go or Component Timed Up and Go
- L-Test
- 2 Minute Walk Test or 6 Minute Walk Test
- Four Square Step Test
- Timed Stair Accent
- Comprehensive High-Level Activity Mobility Predictor
- Prosthetic Limb Users Survey of Mobility
- Trinity Amputation and Prosthesis Experience Scale

### **Pre-Operative Guidelines**

- Strengthening exercises to improve muscle tone and function
- Strive for full/functional residual limb active/passive range of motion values
- Improve cardiovascular fitness
- Optimize medical management of any existing concurrent medical conditions
- Optimize unilateral balance/proprioceptive training
- Promote wellness, proper nutrition, tobacco cessation, and an optimal body weight
- Educate patient on post-operative rehabilitation requirements to ensure an optimal functional outcome
- Validate behavioral health and family support program is in place
- Facilitate identification of any necessary assistive devices and/or durable medical equipment for procurement, use, and training if clinically indicated prior to surgery
- Implement Vitamin D and Calcium supplementation, as per surgeon's recommendation

### **Goals:**

- Achieve maximal hip and knee ROM with emphasis on hip and knee extension
- Begin core/LE strength training with emphasis on quad/ hip extension/ hip abd strength

### **Protective Healing (Week 1-2)**

- Non weight bearing status of residual limb x 4-6 weeks post-op
- It is important to maintain knee extension while seated, use of limb support device or wheelchair residual limb attachment can assist in maintaining full knee extension
- Physician may prescribe a residual limb protector postoperatively, to maintain knee extension and protect the limb (may or may not be worn during physical therapy session)
- Avoid shear stress and protect incision site
- Per physicians recommendation, patient can be fit with a shrinker or use figure 8 wrapping for swelling management and shaping of the residual limb (timeline and wear schedule may vary per physician)
- Range of motion as tolerated
- Bed mobility
- Transfer and appropriate assistive device training
- Gait training (non-weight bearing on operative side)
- Wheelchair mobility training
- Aerobic conditioning (ex: arm ergometer/rower)
- Core and limb strengthening (ex: mat therapy exercises to include CKC bolster)
- Neuromuscular re-education (ex: seated and standing balance activities)
- Begin desensitization and mirror therapy for phantom limb and neuropathic pain
- Monitor symptom responses for 24-48 hours after each exercise session. Pain should settle quickly post exercise with no significant increase in symptoms the next day (see pain monitoring model below)

### **Goals:**

- Pain control, functional mobility
  - Protection of residual limb
  - Achieve knee extension to 0 degrees and hip extension to 10 degree
- 

### **Pre-prosthetic Training (Weeks 2-8)**

- Wound monitoring and assist with dressing changes as needed
- Maintain/improve hip and knee ROM
- Continue appropriate previous exercises with increased resistance and/or difficulty
- Core strengthening exercises
- Gait training on even and uneven surfaces with appropriate assisted device maintaining non-weight bearing status on amputee limb
- Suture removal depending on wound healing and surgeon preference (typically 2 weeks post op)
- Liner fitting once cleared by Orthopedics, establish wear schedule (i.e. liner during the day and shrinker at night)
- Once incision site is fully healed begin scar mobilization

### **Milestone:**

- Tolerate liner wear 8 hours a day without skin issues
- Maintain knee extension and quadriceps activation
- Ambulate at a modified independence level with appropriate assisted device

### **Prosthetic Training**

- Socket fit typically occurs around 4-6 weeks post op to allow for adequate tissue healing
- Educate on prosthetic wearing schedule, skin inspection, management of limb volume changes, use of different ply socks, prosthetic fit, and hygiene instructions

- Gradually increase prosthesis wear time starting at 15 min interval and increasing as tolerated with frequent skin checks
- Balance activities (ex: step up, playing catch, rebounder with a weight ball, compliant surfaces, balance beam, etc.)
- Gait activities (ex: weight shifts, step ups, hurdles, level surfaces, ramps, curbs, stairs, grass, car transfers, etc.) focusing on equalizing step length, stance time, upright posture, equal reciprocal arm swing
- Fall recovery training

**Milestones:**

- Wear prosthesis around 8 hours a day without any skin issues
- Full hip/knee ROM
- 5/5 MMT strength for hip and knee
- Score of ~30 on single leg bridge test (with 8 inch towel roll)
- Demonstrate fall recovery procedures training and floor to stand transfers
- Ambulate with modified independence with zero to minimal gait deviations on level and uneven surfaces over 1000ft
- Ascend and descend 4 steps with least restrictive device and modified independence
- AMPPRO scores (normative values, see CPG): K0/K1 25±7; K2 35±7; K3 41±4; K4 45±2
- 2 MWT or 6 MWT consistent with age rated normative values

**Recommended criteria for return to run programing**

- No earlier than 4-6 months post amputation
- DEXA scan at the discretion of the physician
- Wear prosthesis throughout the day without skin break down
- Walk a mile without an assistive device
- Score of ~40 on single leg bridge test (with 8 inch towel roll)
- Single leg stance greater than 5-10 seconds on prosthesis and up to 30 seconds on residual limb
- Single leg step up on residual limb x10 on 6 inch step without UE support

MONITORING PAIN AND  
LOAD RESPONSE



Adapted from Thommeé (1997) and Silbernagel (2007)

Monitor symptoms response for 24-48 hours post exercise.  
Pain should settle quickly post exercise with no increase in symptoms the next day

## References

1. Barbin, J., Seetha, V., Casillas, J. M., Paysant, J., & Perennou, D. (2016). The effects of mirror therapy on pain and motor control of phantom limb in amputees: A systematic review. *Annals of Physical and Rehabilitation Medicine*, 59(4), 270-275.
2. Clites, T. R., Herr, H. M., Srinivasan, S. S., et al. (2018). The Ewing amputation - the first human implementation of the agonist-antagonist myoneural interface. *Plastic and Reconstructive Surgery*, 6(11), 1997.
3. Department of Veterans Affairs and the Department of Defense (2017). *VA/DoD clinical practice guidelines, rehabilitation of lower limb amputation*. Retrieved from <https://healthquality.va.gov/guidelines/rehab/amp>.
4. Flint, J. H., Wade, A. M., Stocker, D. J., Pasquina, P. F., Howard, R. S., & Potter, B. K. (2014). Bone mineral density loss after combat-related lower extremity amputation. *Journal of orthopaedic trauma*, 28(4), 238–244.
5. Kahle, J. T., Highsmith, M. J., Kenney J., et al. (2017). The effectiveness of the bone bridge transtibial amputation technique: A systematic review of high-quality evidence. *Prosthetics and Orthotics International*, 41(3), 219-226.
6. Keeling, J. J., Shawen, S. B., Forsberg, J. A., Kirk, K. L., Hsu, J. R., Gwinn, D. E., & Potter, B. K. (2013). Comparison of functional outcomes following bridge synostosis with non-bone-bridging transtibial combat-related amputations. *Journal of Bone Joint Surgery*, 15;95(10), 888-93.
7. Kuiken, T. A., Barlow, A. K., Hargrove, L., & Dumanian, G. A. (2017). Targeted muscle reinnervation for the upper and lower extremity. *Techniques in Orthopaedics*, 32(2), 109–116.
8. Plucknette, B. F., Krueger, C. A. Rivera, J. C., et al. (2015). Combat-related bridge synostosis versus traditional transtibial amputation: comparison of military-specific outcomes. *Strategies in Trauma and Limb Reconstruction*, 11(1), 5-11.
9. Powers, C. M., Boyd, L.A., Fontaine, C.A., & Perry, J. (1996). The influence of lower-extremity muscle force on gait characterizes in individuals with below-knee amputations secondary to vascular disease. *Physical Therapy*, 76(4), 369-385.
10. Raya, M. A., Gailey, R. S., Fiebert, I. M., & Roach, K. E., (2010). Impairment variables predicting activity limitation in individuals with lower limb amputation. *Prosthetics and Orthotics International*, 34(1), 73-84.
11. Sanders, J. E. & Eatone, S. (2011). Residual limb volume change: systematic review of measurement and management. *Journal of Rehabilitation Res Dev* 48(8): 949-986.
12. Woo, S. L., Kung, T. A., Brown, D. L., Leonard, J. A., Kelly, B. M., & Cederna, P. S. (2016). Regenerative peripheral nerve interfaces for the treatment of post amputation neuroma pain: A pilot study. *Plastic and Reconstructive Surgery*, 4(12), 1038.