Lecture 4

Prosthetic Management

The rehabilitation and prosthetic fitting post-amputation depend on the type and level of the amputation, the patient's needs, and specific goals:

1. **Suspension** Critical for ensuring the prosthesis remains attached during various activities. Options include suction, silicone liners, and cuff straps.
2. **Weight Distribution** Properly designed insoles and prosthetic sockets can distribute weight evenly, minimizing pressure points.
3. **Foot Attachments** Depending on the amputation level, various prosthetic feet might be considered, from simple solid ankle cushion heels (SACH) to dynamic and energy-returning feet.

Common Gait Observations

- **Partial Foot Amputees** May exhibit reduced push-off force and altered stride length. Often, compensatory mechanisms in the hips and knees are observed.
- **Syme Amputees** Generally have a near-normal gait pattern due to the preservation of the knee and most of the lower limb's length. However, they might still experience challenges in the propulsion and initial contact phases.

Prostheses in Rehabilitation

The success of rehabilitation after an amputation largely depends on the prosthetic fit, the individual's motivation, and the quality of the residual limb.

1. **Higher-Level Amputations**

- **Pirogoff and Boyd Amputations** These amputations preserve more of the residual limb. However, when fitted with a prosthetic foot, they cause the prosthetic side to be artificially longer. To balance this, a heel lift on the sound

- limb is typically recommended. This adjustment is crucial to prevent gait imbalances and secondary complications from walking with a limb length discrepancy.

2. **Equinus Deformities**

- Post-amputation, there's a potential for developing equinus deformities, primarily because of a muscular imbalance. The severed dorsiflexors combined with an intact triceps surae (calf muscles) can pull the foot downward, leading to this deformity. Despite this challenge, many with partial foot amputations exhibit impressive functionality. Some even argue they perform better than those with a Syme amputation.

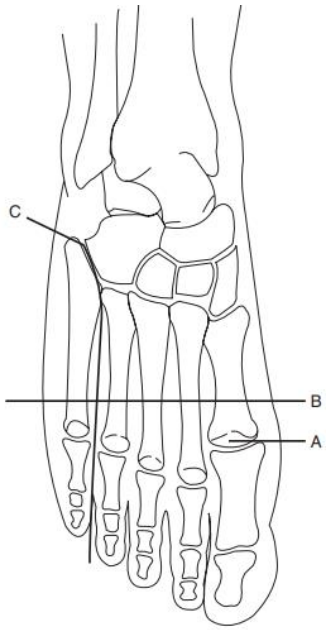
3. **Success Stories**

- Jack Dempsey, a professional football player with a midfoot amputation, is an example of how a well-managed rehabilitation process can lead to high levels of function. With his custom-designed kicking boot, he set multiple all-time field goal records. Such stories highlight the potential for achieving normalcy and even excellence post-amputation.

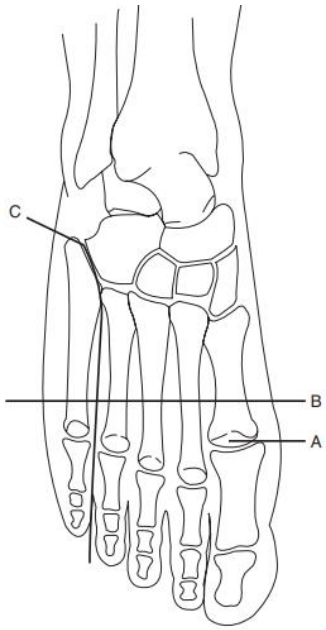
Gait Characteristics

- Individuals with a partial foot amputation, especially those due to vascular insufficiency, typically fall in the age bracket of 60-70. These individuals often exhibit compromised proprioception, sensation, and weak lower limb musculature.
- Post Syme or partial foot amputation, gait modifications are apparent. The common factors influencing these changes include the level and type of amputation, the prosthetic fit, and the individual's overall health and strength.
- **Forefoot Amputations** Examples include phalangeal amputations involving disarticulation at the tarsal–metatarsal joint and more distal digit

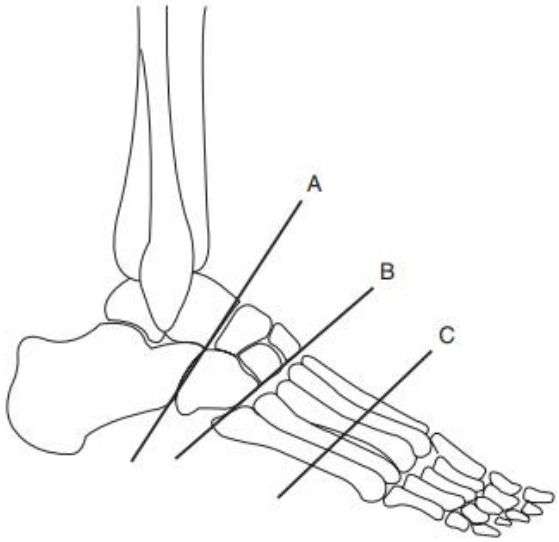
- amputations. Ray resections involve removing one or more metatarsals along with their phalanges (See Figure A).



- **Midfoot Amputations** These include Chopart amputations, involving disarticulation at the talus and calcaneus level, and Lisfranc amputations, where the forefoot gets separated from the midfoot (See Figure B).



- **Syme Amputation** This procedure involves the removal of the lower part of the tibia and fibula, as well as all bone structures distally, but ensures preservation of the natural weight-bearing heel pad. This is demonstrated in Figure A.



Postsurgical Management of Partial Foot and the Syme Amputation

1. Ambulation Challenges Patients who have undergone an amputation might have the ability to walk without the need for a prosthesis. However, this ability comes with challenges:

- Loss of the anterior lever arm during ambulation, leading to a less effective and somewhat dysfunctional walking pattern.
- A notable lack of efficiency in the gait, leading to walking difficulties.

2. Protective Measures *The Neuropathic Walker*: Developed at the Rancho Los Amigos Medical Center, the walker aims to protect the remaining foot by locking the ankle in a custom-molded, foam-lined, thermoplastic ankle-foot orthosis (AFO). Features of this walker include:

- A rocker bottom contoured for smooth rollover, replicating the role of the second and third rockers of the natural gait.
- Offering optimum protection, especially for an insensate residual foot.

Custom Shoe Inserts For those with sufficient protective sensation, custom shoe inserts paired with in-depth or postoperative shoes can often provide the required protection, reducing the chances of tissue breakdown.

3. **Gait Variations in Partial Foot Cases** Studies indicate that the reduction of the forefoot lever arm in partial foot cases leads to alterations in single-limb support time. Such variations can affect force concentration during terminal stance, shortening the single-limb support phase.

4. Effects on the Gait Cycle The intact anterior lever arm in a fully-formed foot helps maintain the elevation of the body's center of mass during the terminal stance. However, partial foot and Syme amputations often result in significant

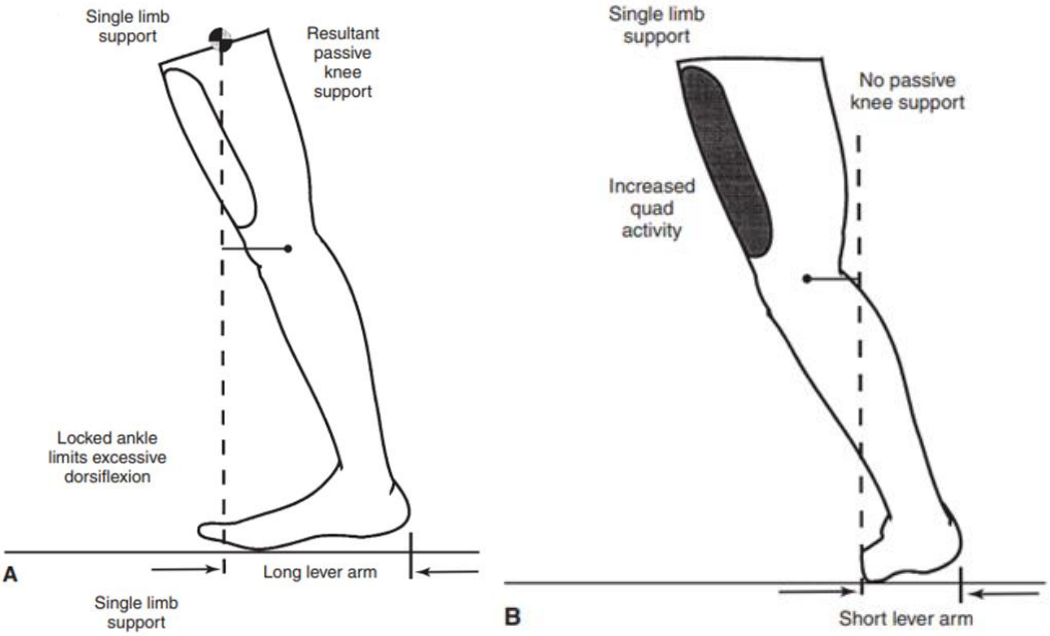
quadriceps weakness, which compromises the knee's control during the early stance.

5. Recent Gait Studies A study observed gait variations in individuals with different types of partial foot amputations. It was found that delays in the forefoot rocker caused all these individuals to walk at a slower velocity compared to those with intact feet. This delay impacts the overall progression of the gait cycle.

6. The Influence of Forefoot Lever Arm on Gait The forefoot lever arm is essential for providing anterior support, ensuring proper terminal stance support time. A reduced lever arm in partial foot amputees leads to premature toe break and forefoot collapse, affecting the step length of the advancing limb.

7. Pressure and Surface Area Dynamics For individuals with partial foot amputation, a decrease in the plantar surface area during the terminal stance increases pressure. The reduced forefoot lever arm further complicates this by creating an abrupt weight transfer, which can reduce step length, stride length, and velocity.

8. Quadriceps Role in Support In a normal foot, the lever arm provides stability during the late stance. However, the reduced lever arm in partial foot amputees demands more work from the quadriceps, leading to higher energy expenditure during walking.



9. Pinzur's Observations Pinzur and his team have noted a functional relationship between gait velocity and amputation level. A shorter residual foot often results in changes in gait characteristics. The reduced length of the forefoot affects the time spent in single-limb support.