3. K3 Functional Level Feet

The K3 functional level pertains to prosthetics suitable for individuals with the ability to engage in daily activities and walk with variable cadence. This category has seen a vast array of designs and developments, thanks to advancements in materials and technology.

1. Manufacturers and Their Offerings Several manufacturers lead the industry in prosthetic feet design:

- **Carbon fiber composite feet** which provide energy-storing dynamic response:
  - Ossur Flex-Foot
  - Otto Bock
  - Freedom Innovations
  - Ohio Willow Wood
  - Endolite
- **Microprocessor feet** with advanced technological capabilities:
  - Ossur
  - Endolite
  - Fillauer
  - iWalk

2. Key Features of K3 Feet

- **Material:** These feet are fabricated from carbon fiber, a lightweight, flexible, and durable material.
- **Energy Efficiency:** They surpass the SACH foot in reducing energy consumption, enhancing ankle movement, and offering energy storage and return.

- **Design Diversity:** Almost 100 different designs exist, with each varying based on carbon fiber shape and additional materials that absorb shock and rotational forces.

3. Integrated Pylon Foot This foot is remarkably light. Made from a continuous carbon fiber composite, it provides significant plantarflexion and dorsiflexion. Some designs even provide inversion, eversion, and rotation. However, its alignment capabilities are somewhat limited.

4. Energy-storing feet without Integrated Pylon These offer the same advantages as the integrated ones but also permit the prosthetist to perform alignment adjustments at the ankle, giving more alignment flexibility but slightly more weight.

5. The Role of the Ankle Joint in Prosthetics Ankle joints can be matched with prosthetic feet to provide natural plantarflexion and eversion movements. Moreover, users can even adjust heel height seamlessly to switch between different shoes.

- **Shock and Torsion Absorption** This feature, designed into the foot or added in the pylon, is crucial for high-activity individuals, greatly reducing forces transmitted to the residual limb.

- **Microprocessor Feet** This recent innovation actively responds to environmental changes. For instance, when walking uphill, the foot automatically provides dorsiflexion. It reacts in real-time to changes in speed and terrain. A leading example is the BiOM foot, which has shown promising results in providing near-normalized gait for persons with transtibial amputation.

I. Design

1. Material Composition

- **Carbon Fiber** Many advanced prosthetic feet use carbon fiber because of its strength-to-weight ratio. Carbon fiber allows for the foot to be both durable and lightweight. Its flexibility also aids in the energy return function, as it can store energy upon weight-bearing and release it during push-off.
- **Silicone or Polyurethane Coverings**: These materials can be used to provide a more natural appearance and feel. Additionally, they offer protection for the internal components against dirt, debris, and moisture.

2. Modular Construction

- **Ankle Unit** This contains the primary actuators and sensors which enable dorsiflexion and plantarflexion. It's crucial for adapting to different terrains and activities.

- **Footplate** This is the main body of the prosthetic foot, and its design can vary depending on the specific activities it's optimized for (e.g., walking, running, or specialized activities like swimming).

3. Connectivity

- **Wired or Wireless Interfaces**: Some advanced prosthetics come with the ability to connect to external devices for calibration, diagnostics, or software updates. This could be done through USB ports, Bluetooth, or other wireless technologies.

4. Bionic Features

- **Powered Ankle Joint** Unlike passive prosthetics, a design like the BiOM foot has a powered ankle joint, allowing for active movement, which closely resembles a natural gait cycle.
- **Responsive Damping System** This system helps in absorbing shocks when walking on uneven terrains, ensuring comfort and stability for the wearer.

5. Energy Source

- **Battery Design** The placement, weight, and capacity of the battery are critical. It needs to be lightweight and compact to not interfere with natural movement but also potent enough to power the prosthetic for a reasonable duration. Advanced designs may also focus on fast-charging capabilities.

6. Ergonomics and Customization

- **Socket Interface** This is where the prosthetic connects to the wearer's residual limb. It's vital that this interface is comfortable, adjustable, and provides a secure fit. The design usually involves a combination of hard materials for stability and soft materials (like silicone liners) for comfort.
- **Adjustable Heel Heights** Some designs allow users to adjust the effective heel height, permitting wearers to switch between different shoe types while maintaining comfort.
- **Footshell** This covers the footplate and provides a more anatomical and natural appearance. The design may offer various aesthetic choices, including different skin tones or even custom patterns.

II. Functionality

1. **Adaptive Response**: The BiOM foot adjusts in real-time based on the information it receives from its sensors. If the wearer starts running, the foot can recognize this change in activity and adapt accordingly.
2. **Terrain Adaptability**: Whether the user is walking on flat ground, uphill, or downhill, the foot can detect these changes in terrain and adjust its angle and stiffness to provide the most natural and supportive movement possible.
3. **Energy Return**: One unique feature of advanced prosthetics like the BiOM foot is their ability to provide energy return. This means that, unlike passive prosthetics, which merely absorb energy, the BiOM foot can actively push off the ground, similar to how a biological foot uses the calf muscles to propel the body forward. This makes walking more efficient and less tiring for the user.
4. **Personalization**: Given that every amputee might have different needs and walking patterns, the microprocessor can often be calibrated or programmed to suit individual requirements, ensuring optimal functionality for each user.

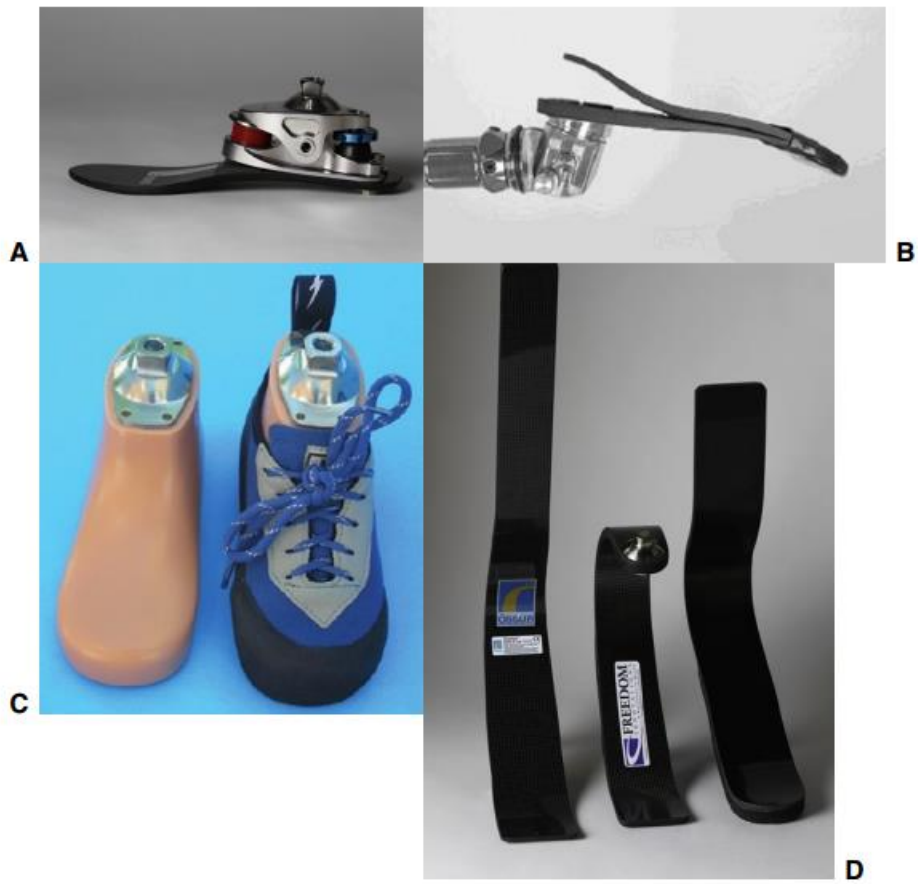
4. High Activity (K-4 Feet)

For athletes and runners, specialized feet are designed for activities like sprinting and distance running. Sprinting feet, designed for short, intense races, differ from those made for marathons. These feet are not recommended for daily wear but prove invaluable in sporting contexts.

Specialized Activity Feet

There are designs specifically for golfers, swimmers, and even rock climbers, catering to their unique requirements.

Choosing the right prosthetic foot is a complex yet crucial process. With myriad choices available, the collaboration between the patient, their family, caregivers, and medical professionals is paramount. The advances in energy-storing materials and microprocessor technology have paved the way for improved daily functioning and high-activity performance in sports for persons with lower-extremity amputation.

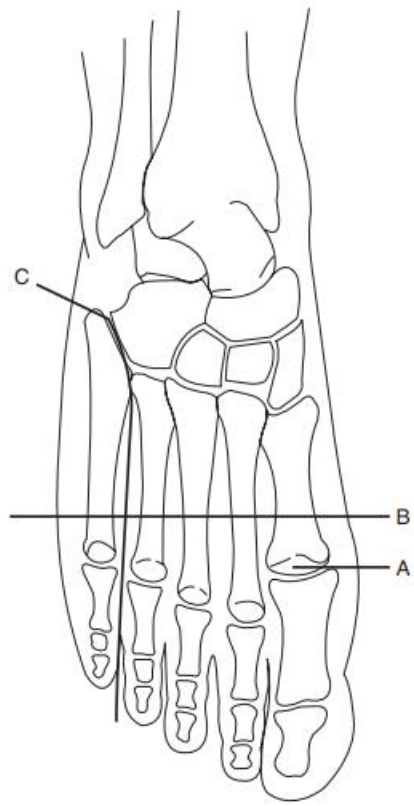


Postsurgical Management of Partial Foot and the Syme Amputation

1. **Partial Foot Amputations**

- **Ray Resections** Removal of a toe and part or all of its metatarsal bone. This procedure is often due to infection or gangrene. The goal is to preserve as much foot length as possible while ensuring a viable stump for weight-bearing.

- **Digit Amputations** Solely involve the removal of one or more toes. This procedure often arises from traumatic injuries or infection.



- **Chopart Disarticulation** In a Chopart amputation **(A)** there is disarticulation of the midfoot from the forefoot at the level of the talus and calcaneus.
- **Lisfranc Disarticulation** In a Lisfranc amputation (B) there is disarticulation of the forefoot (metatarsals) from the midfoot (tarsals).
- **Transmetatarsal amputation**(C) , there is transaction through the length of one or more metatarsals, usuall just proximal to the metatarsal heads.

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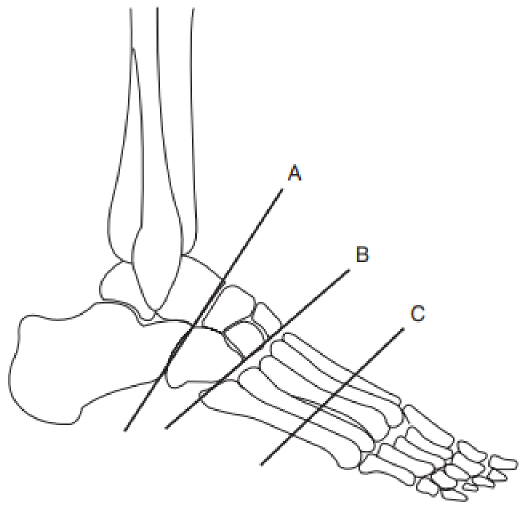

- **Pirogoff** A complex procedure involving a fusion of the heel bone to the end of the tibia, providing a weight-bearing stump. Although less common, it can be advantageous for specific patients, especially those requiring high-end mobility.
- **Boyd** This is similar to the Pirogoff but preserves more of the heel bone. It's especially beneficial for pediatric patients with congenital limb deficiencies because it offers a more natural foot length relative to the unaffected limb.
- **Syme** This involves an amputation at the ankle joint, removing the foot but preserving the heel pad. It provides a weight-bearing end, making it one of the most functional levels of lower limb amputation when fitted with a prosthesis.