

Ten Exercises to Maximize the Performance of Your Prosthetic Feet

by Robert S. Gailey, PhD, PT
Illustrations by Frank Angulo

The design of prosthetic feet and knee components has flourished, in part through traditional research and development, but also through the input of prosthetic users themselves. As a result, manufacturers now offer lighter, more-durable prosthetic components fabricated from exceptionally dynamic materials that have the capacity to better mimic human walking. Unfortunately, people with first-rate prosthetic components often don't take full advantage of the functional capabilities their prosthesis has to offer. This article, therefore, will discuss various ways to enhance prosthetic performance to maximize functional ability.

Some simple exercises designed to improve balance and promote weight bearing over the prosthetic limb will help give you confidence in your prosthesis and enable you to take equal-length steps without putting unnecessary stress on the lower back. Understanding where your balance point or center of mass (COM) is located in relation to your feet, or base of support (BOS), is the foundation for balance with all prosthetic feet from the very basic designs to the most dynamic.

Prosthetic Feet

SACH (Solid Ankle Cushioned Heel) foot designs, considered the most basic of prosthetic feet, consist of a simple block keel encased in a molded rubber cover with no

ankle motion. This type of foot is designed for amputees who do a limited amount of walking with little variation in speed.

Single- and multiple-axis ankle designs typically use rubber bumpers to control the speed and amount of motion permitted at the ankle. The greatest benefit of movable ankles occurs constantly during standing, but is rarely observed. In standing, we all sway a little, and, as we age, sway increases. If motion is permitted in the ankle, then it has been suggested that less muscular effort is required at the knee or hip, therefore reducing the possibility of fatigue during standing. To take advantage of this benefit, equal weight bearing between both the prosthetic and sound limb must occur in standing, and the COM over the BOS must be controlled.

As activity increases, the value of a movable ankle becomes more apparent and is especially observed on ramps, hills and uneven terrain, which are easier to negotiate with the additional motion provided at the ankle. However, as you learn to balance over the prosthetic foot (displacement of COM over BOS), greater muscular control is required within the socket, as well as at the hip, knee and trunk. It is the speed and efficiency of the muscular effort, however, not the brute strength, that assist with prosthetic control.

Dynamic-response feet can be more responsive and allow

the amputee to walk faster with greater ease. They are typically designed for amputees who have the ability to vary their walking speed, change directions quickly, or walk long distances. The advantages of dynamic-response feet are realized only if the transition of weight over the foot is of the magnitude and duration to permit the deflector system to work as designed. In other words, to take full advantage of a dynamic foot, you must allow your full body weight to pass over the foot long enough for the deflector plate to fully bend and then release the stored energy. If higher-level activities such as sports are performed, time should be spent learning how to properly land, load and change direction with the foot to maximize performance. A wide variety of dynamic feet are available today to meet everyone's activity levels.

Some prosthetic feet offer both movable ankles and dynamic response.

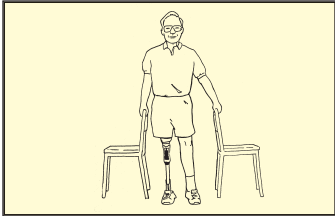
The single-axis ankle system provides the advantages of a movable ankle and the deflector plate offers the benefits of a dynamic-response foot. Because of the mobility at the ankle, it is believed that the "energy release" generated in dynamic-response feet with movable ankles is decreased; however, for the person who walks on hills or uneven terrain and is able to vary walking speed, this type of foot would

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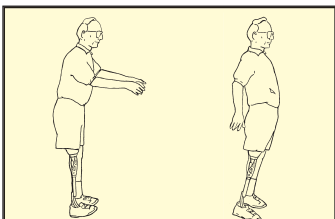
still be a strong consideration.

Exercises

Side-to-Side Balance: Stand



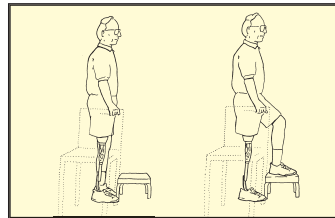
between two chairs, if possible facing a full-length mirror. Place one hand on the back of each chair. Your feet should be approximately two to four inches apart. Shift your body weight from right to left. Note how the pressure changes on your residual limb within the prosthetic socket when you put weight on it and become familiar with the movements throughout your legs. Work toward maintaining your balance using the muscles within the socket, and, eventually eliminate the use of the hand supports.



Forward and Backward Balance: The same exercise can be performed shifting your body weight forward and backward, beginning with small movements and progressing slowly to larger movements. You should continue to be aware of the pressure changes on your residual limb within the socket as you move, and use your muscles as previously described. If you shift your weight too

far backward (over the heels) simply raise both arms forward and bend forward at the hips. If you shift your weight too far forward (over the toes), simply stretch both arms behind you and arch your back.

Exercise 2.



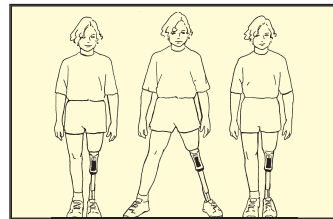
Single-Limb Balance: As you become comfortable with maintaining your balance and sharing the weight between both legs when standing on two feet, you must begin to get comfortable standing on the prosthesis alone. Stand between the two chairs, with a small step stool placed in front of your unaffected or sound limb. Place both hands on the backs of the chairs and step onto the stool with your unaffected limb as slowly as possible. Repeat this movement several times until you feel comfortable with it. Then, remove your unaffected-side hand from the chair. Again, slowly step onto the stool with your unaffected limb. Once you can perform this movement slowly, remove both your hands from the chairs, and continue stepping onto the stool in a slow and controlled manner.

Exercise 3.

At first, you will have difficulty stepping with your unaffected limb in a slow, controlled manner and maintaining your balance over the prosthesis during this exercise. This

is largely due to the lack of strength and coordination in the hip of your residual limb. Concentrate on controlling your prosthetic limb, rather than simply moving your unaffected limb slowly. Focus on the following three items when you are stepping up:

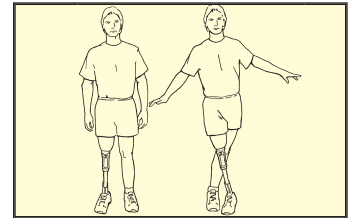
1. Control your hip on the prosthetic side by tightening your hip muscles.
2. Increase the weight bearing into the socket by allowing your full body weight to be placed down into the socket.
3. Visualize controlling the movement of the prosthetic foot.



Side Stepping: Stand at one end of a kitchen counter or at a long sturdy table. Face the counter and place both hands on it for support. Begin by sidestepping to your unaffected side. Try to concentrate on keeping your hips even with each other and not leaning way over your prosthetic limb as you move your unaffected limb.

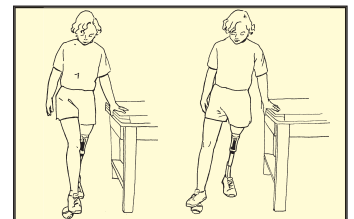
Exercise 4.

Braiding: From the standing position with your feet comfortably apart, cross your prosthetic limb in front of your unaffected limb, then bring your unaffected limb from behind to return to your original standing position. From the standing position, cross your prosthetic limb behind your unaffected



limb, then bring your unaffected limb across your prosthetic limb, returning to your original standing position. Repeat, alternating each step as you move sideways. Use your arms and rotate your trunk to assist you with your balance. As you become comfortable with these maneuvers, increase your speed.

Exercise 5.

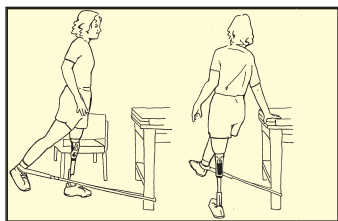


Ball Rolling: Stand with a tennis ball in front of your unaffected limb. Place your unaffected foot on top of the ball. Keep your foot flat on the ball and roll it forward, backward, side-to-side or in circles. Feel the muscles working in the prosthetic-side hip as your weight shifts with the movements of your unaffected foot.

Exercise 6.

Resisted Elastic Kicks: You will need a sturdy, immovable table or sofa leg and some rubber tubing. Secure one end of the rubber tubing to a sturdy table leg and place the other end around the ankle of your unaffected leg. Holding on to a chair, move far enough away

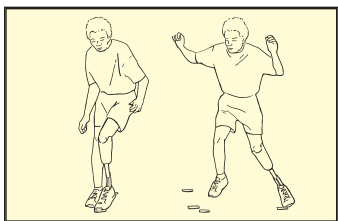
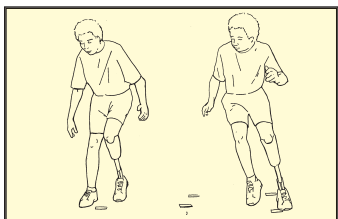
Ten Exercises to Maximize the Performance of Your Prosthetic Feet



from the table to slightly stretch the rubber tubing. Then do the following exercises:

1. Kick your leg back, while facing the table.
2. Kick across the prosthetic limb.
3. Kick away from the prosthetic limb.
4. Kick forwards with your back to the table, holding on to the table for balance.
5. Kick your unaffected limb back so the rubber tubing is stretched out.

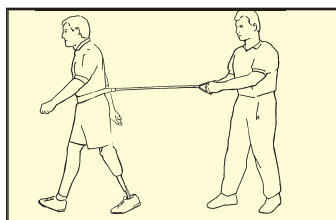
Exercise 7.



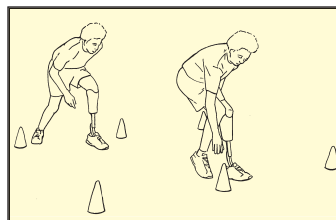
Toe Box Jumps: Place four pieces of tape two feet apart, forming a square. Standing with both feet together, jump diagonally to the opposite mark landing on the toe of the prosthetic foot, using your unaffected limb for balance. As your body weight loads the prosthetic foot, quickly push

off using your thigh muscles, aiming for the mark just to the side. Again landing on the toe of the prosthetic limb and balancing with the unaffected limb, push off diagonally to the last remaining mark.

Exercise 8.



Resisted Walking: A partner is required to assist with this exercise. Place a belt around your waist with an elastic cord looped through the belt. Walk along a flat surface, as your partner offers resistance with the cord. As you walk, feel your muscles working in the socket, your body weight passing over the prosthetic foot, the deflection of the prosthetic foot lever as your body weight moves over the toe, and the spring effect of your prosthetic limb as it leaves the ground and begins to advance forward. Exercise 9.



Agility Drills: Line up four to six cones or cups in two rows approximately six feet apart. Quickly move from one cone to another squatting down to touch each cone as you zigzag through them. The key to this

exercise is maintaining speed by staying on the toe of the prosthetic foot and using the thigh or hip muscle to rapidly extend the prosthetic limb as you turn or come up from the squatting position.

Exercise 10.

There are many more exercises that can be incorporated into your training program and improve prosthetic performance. The essential elements to maximize the performance of your prosthesis are:

- Develop a good sense of balance over both your feet.
- Maintain equal weight bearing through both lower limbs.
- Learn to use your muscles in the socket, your knee and your hip quickly and efficiently because timing is everything.
- Continue to keep your body weight over your prosthetic limb long enough to fully deflect the prosthetic foot for maximum “energy release.”
- Develop agility by practicing moving in multiple directions with your prosthesis and, therefore, using your muscles in a variety of situations.

Getting the most out of your prosthesis means putting some time into practicing these skills initially. However, the rewards of learning how to let your prosthesis work for you instead of against you can make life much more rewarding.

Note: Always check with your doctor before starting an exercise program, and when you first attempt any of these exercises have someone assist you. Then, slowly progress to

practicing the exercises independently.

About the Author:

Robert Gailey, PhD, PT, and Kurt Collier CPO, will be instructing a workshop titled Maximizing Your Prosthetic Foot/Ankle Performance at the 2001 ACA Annual Educational Conference and Exposition in Kansas City, Missouri.

This workshop will assess the participants ability to take full advantage of their prosthetic foot/ankle during normal walking, or recreation activities; provide a straightforward overview of the design and functional differences of the prosthetic foot/ankle components worn by the participants; teach a series of simple exercises to promote improved prosthetic performance; teach participants how to maximize use of the prosthetic foot/ankle during selected recreational activities, and reassess any changes that may have occurred during the session.