



# Partial Foot Amputation: Sometimes Less Means More

*"Begin challenging your assumptions. Your assumptions are your windows on the world. Scrub them off every once in awhile or the light won't come in."*

*- Actor Alan Alda*

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Amputation surgery is both an art and a science. When considering such a surgery, we should ask, "How can we provide this individual with as much function and independence as possible?" and "How can we create a new limb that will best work with current and future prosthetic technology?" The success of each amputation surgery depends upon the balance between removal and reconstruction of the remaining limb. After the diseased, damaged or dysfunctional part of the limb is removed, reconstruction must promote wound healing, as well as create an amputation site with the most optimal sensory and motor function. Surgeons, prosthetists and rehabilitation specialists want everyone with limb loss to resume as active a life as possible after amputation.

Partial foot amputations are performed much more frequently today than in past decades. We understand the surgery and healing process better, and we realize that a partial foot amputation can result in improved transfers, strength and walking. Unfortunately, partial foot amputations can also result in pain, deformities and the recurrence of ulcers and infections. In this column, I discuss the partial foot amputation and the difficulty in striking a balance between bone, muscle, skin and nerves. Amputations involve every one of these bodily tissues, and each is important. There is no insignificant structure

in the process of reconstruction, but orthopaedic surgeons sometimes focus too closely on preserving as much bone length as possible. And it can be a mistake to do so.

Bone is the hardest of human structures. We fixate on it because of its importance in skeletal architecture and because we can see it on x-rays. As an orthopaedic surgeon, it took me years to figure out that bone isn't always the most important thing. When the quest to save as much bone as possible deprives the residual limb of adequate padding to protect it from the stress, strains and bumps of life, then the person with limb loss has been done no favors; rather, we can make the ultimate result much worse.

The desire to save as much of everything as possible, including bone, is natural. Surgeons reason that "more is better." But bone clearly is not the most important thing. We see that the other tissues are even more important when creating a new residual limb to best interact with the world. It is vital to balance the soft tissues and the skeleton. We strive to fashion them to

work together in a way that is perhaps unnatural, but that will provide maximal benefits to the person with limb loss.

A well-padded shorter residual limb can make for a more expeditious recovery and return to activities. If there is inadequate padding and the end of the residual limb is not durable enough to withstand the forces of walking even with the best prosthesis, pain, ulceration and infection can result. Many midfoot amputations end up with poor padding and with the ends of the metatarsal bones just under the skin. By shortening the metatarsal bones more dramatically, we can better use soft tissue to promote healing and a more durable limb. Saving a little extra bone simply for the sake of saving it is not a success when the person later has pain, ulcers, infections or other problems because there is not enough padding to protect the limb end. In this context, when it comes to skeletal length, less means more.

Level selection and decision-making in amputation surgery are not easy. We try to balance the chance of successful



healing with preserving function. We know that higher-level amputations have a better chance of healing, but we also know that rehabilitation is more difficult and that function is less. Whenever possible, we do everything we can to preserve a joint, especially the elbow or the knee. Joints are vitally important for motion, power and leverage. There are major differences when a person undergoes a transtibial (below-knee) amputation, a knee disarticulation or a transfemoral (above-knee) amputation, but the difference between a medium and a short transtibial procedure is not necessarily so dramatic. Occasionally the longer transtibial amputation might have less function. At these times, clinical and biomechanical evidence suggest that we should be as concerned about the optimal use of soft tissue as we are about skeletal length.

### A Delicate Balance

The foot is a unique structure with strength, durability and balance. The normal foot has a long mechanical lever arm and many muscles that work in an integrated fashion. The large calf muscles hook onto the heel close to the center of the ankle. The smaller muscles hook farther forward on the foot to gain more leverage. Both the surgeon and patient face a big challenge in a partial foot amputation, because when a person loses the front part of the foot, he or she often loses the attachments of these muscles, as well as mechanical leverage and muscle balance. Rebalancing requires reattaching these muscles on the front and also possibly weakening the muscles in the back to achieve a new balance. Without rebalancing, deformity and loss of function can result.

### Relearning Old Lessons

From time to time, researchers reconfirm or “rediscover” that muscle, skin and nerves have a much bigger impact on the outcome than bone length. While we have a powerful intuitive

sense to preserve as much bone as possible, scientific research shows that our intuition may be wrong. A study published in the January 1964 issue of the *Canadian Journal of Surgery* followed 41 patients who had undergone partial foot amputations. Only 22 patients had outcomes that were characterized as “good”; the rest ranged from fair to poor. The study’s authors said, “contrary to our expectations,” there was a higher incidence of failure when surgeons tried to preserve as much bone length as possible.

Twenty-four years later, a study published in the March 1988

issue of *The Journal of Bone and Joint Surgery (British)* followed 260 people with limb loss, including 113 partial-foot amputees. Thirty-eight percent had only fair functional end results, and 19 percent had poor results. Higher-level amputations that allowed for more padding provided better results than those performed at midfoot (transmetatarsal) levels, where less padding was available for protection. The length of the residual bone did not matter nearly as much for patient benefit as did the quality of the tissue over the end of the amputation. We still struggle with this same problem today. When surgeons strive to save an extra length of bone – a midfoot amputation as opposed to a hindfoot procedure – and the patient is left with thin padding or damaged tissue, the outcome can be worse than if more bone had been removed. Partial foot amputations can yield good results, but they must be performed carefully with strong attention to the soft tissues.



Maybe a good way to illustrate this is to think about your buttocks. Imagine how uncomfortable it would be to sit if you didn’t have that tissue “padding.” You wouldn’t stay seated for long if the only thing protecting your bones against the seat was a thin layer of skin or scar tissue. It would feel awful. The person with limb loss deals with a similar experience when there is inadequate padding to protect bone and nerves from the end of a prosthesis. After a while, it hurts. And if the pressure on this thin tissue is exerted long enough, the tissue will break down, sores will develop and infection can easily set in.

Each generation of surgeons must relearn this lesson and fight the instinct to save the most bone possible. There are times when we learn this lesson, but we’re not good enough about teaching it to the next generation. They’re forced to learn it on their own. And, unfortunately, surgeons who haven’t done amputations or don’t follow

amputee patients closely never really learn it. They mean well, but fall into the same trap again and again throughout their careers, because it's never been stressed to them that muscle, skin and nerves have a much greater impact on the outcome than bone length.

### Gait Styles With Partial Foot Amputation

Amputation and rehabilitation involve much more than just surgery and a prosthetic device. Physical therapy and gait training are vital parts of the process. For generations, we've endeavored to teach only one walking pattern, a symmetric heel-toe gait. We've assumed that this method with all the muscles working in unison is the most efficient way of walking and that this is how everyone should walk. But recent research into gait styles suggests that partial-foot amputees might well choose more than one walking pattern, and use them at different times. Can it be good to have different styles? If people are choosing to do it, there may be some benefit that we don't understand. For example, individuals with partial foot amputations may periodically need a rest from the wear and tear of constantly striving for a symmetric heel-toe gait and may get relief by occasionally using a recovery pattern of heel walking that uses the muscles and residual foot differently. This could give other parts of the body a rest as well.

Try this yourself: Spend 10 minutes heel walking on one foot. Feel how the leg and buttock muscles work differently than they do in a heel-toe gait. Feel the impact on the heel, but also notice the relief to the forefoot. These two walking patterns are very different, and they can provide some intermittent rest or relief to an area that is sore or tender.

The human body is such a wonderfully designed machine that normally these periods of rest and recovery are rarely needed. But though they're rare, they may be useful. For example, when



we overdo it and start getting a blister on the front of the foot, we start heel walking. Or, if we have a minor injury, we'll walk on the inside or the outside of the foot to protect the injured area and give it a chance to heal. While individuals with partial foot amputations primarily walk with a normal heel-toe progression as the muscles in the buttocks, thighs and calves were designed to do and as they were trained to do by their therapists, at times they may need a change.

It's always been believed that the heel-toe pattern with a symmetric gait is the most energy-efficient way of walking and the one that is the least traumatic to the rest of the body. But if that's so, why do people fall into other walking patterns? Maybe for some individuals, using different gait patterns provides them with these needed periods of rest and recovery. Again, what seems obvious isn't always so.

Challenging assumptions isn't always easy. Bone is important, but it is not the single most important aspect of amputation surgery. Bone length must be balanced with skin, muscle and nerves to all work together. Individuals with partial foot amputations may need several different gait styles, not just one. Challenging assumptions can mean rejecting what we and all those around us have long held to be true and opening our minds to new ideas and new paths. This journey of discovery can lead to improvement if we keep our minds open and continue to learn. ■