# The Transtibial Amputation

**Site of Previous Surgeries:**
Amputation indication: four unsuccessful previous surgeries. Patient experiences chronic pain and disfunction along with a limited range of motion.

**Bone Cut Level:**
One very critical decision is where exactly to cut the tibia and fibula for this particular individual. Several factors must be taken into consideration when choosing where to cut the bone.

1. Historically, many surgeons recommended a tibial bone cut that was always one hand's breadth distal to the tibial tubercle. This gives a tibial length of between 10 and 15 cm depending on the size of the surgeon's hand.
2. Recently it has been recognized that additional tibial length may have some value up to a certain level.
3. It is almost always recommended to avoid amputation in the distal 1/3 to 1/4 of the tibia, as there is very little muscular tissue for padding in the distal most portion of the lower limb.
4. Calves vary dramatically in their anterior to posterior diameter, so ideally the tibia would be divided at a point where the distal edge of the appropriate length posterior flap would occur at the junction of the soleus muscle and the Achilles tendon.
5. When the transtibial amputee is standing up, the distance between the ground and the end of the residual limb allows adequate space for the liner, socket, proximal connector, pylon, distal connector, and foot.
    1. 4 to 6 inches of space allows for the use of most standard prosthetic feet and a pin lock suspension system.
    2. 6 to 8 inches allows for the addition of a shock absorbing component to the above standard prosthetic system.
    3. 8 to 10 inches is required for the use of most integrated high-impact foot/pylon/shock absorbing systems.
6. Practically, the tibial bone cut is planned to keep one third to one half of the length of the tibia. The exact location is based most commonly on the quality of the soft tissue envelope, the shape and size of the calf muscle, the overall height of the individual, and the location of scars, ulcerations or soft tissue defects.

**Measure Limb Diameter:**
Measure the anterior to posterior diameter of the limb, at the level of the tibial bone cut. The skin of the flap needs to rotate all the way from the posterior aspect of the limb up and over the distal end, to join the anterior skin in a tension free closure. This flap has an axis of rotation that is just posterior to the limb, not at the mid-limb as is still shown in some older texts. Therefore, the length of the flap needs to be equal to the AP diameter of the limb, plus an additional cm to allow for the curvature of the tissue around the end of the limb.

**Draw Incision Lines:**
The skin incisions are drawn out based on the proposed level of the tibial bone cut.

1. The **medial** and **lateral** extensions are straight distally, and do not drift posteriorly. The length of the extensions is equal to the AP diameter of the limb at the proposed level of the tibial bone cut, plus one additional cm.
2. **Anterior** incision – down approx half diameter of limb. Medially this extends down to an inflection at the edge of gastrocnemius muscle. Laterally, this extends down to the posterior edge of fibula. The incisions curve very slightly from distal to proximal as it moves from anterior to posterior.
3. **Posterior** incision is drawn straight around the back of the leg, connecting the ends of the medial and lateral incisions.

**Aesanguinate leg before applying the tourniquet.**

**Incisions:**
Incisions should be made in a decisive fashion to provide a clean and pure incision through skin, subcutaneous tissue, down to and through the fascia. One should avoid feathered or beveled edges, and avoid irregularly cut surfaces that can lead to devitalized tissue which may be a focus for non-healing or infection.

**Saphenous Vein and Nerve:**
Find the saphenous vein, the nerve is usually just lateral to the vein. Separate vein and nerve, drawn down nerve and cut, no need to suture ligate this nerve. Ligate the saphenous vein with absorbable suture.

**Cut Lateral Fascia**

**Expose and Ligate Superficial Peroneal Nerve:**

In the lateral compartment, the course of the superficial peroneal nerve changes dramatically from proximal to distal. Proximally, it is found between the peroneus longus and peroneus brevis muscle. Distally, it can pierce the fascia and change from the lateral to the anterior compartment. Find the nerve, drawn down and ligate. No need to suture ligate this nerve.

**Dissect Lateral Edge of Tibia**

## Transect Anterior and Lateral Compartment Muscles:

Disect down lateral edge of tibia and along the syndesmotic membrane over to the fibula. Pass the clamp under the anterior and lateral compartment muscles. Transect the muscles.

1. Anterior compartment
    1. Anterior Tibialis (AT), Extensor Hallucis Longus (EHL), and Extensor Digitorum Longus (EDL)
    2. The anterior compartment muscles are transected at the level of the tibial bone cut early in the operation. The anterior tibial vessels and the deep peroneal nerve are located at the depth of the anterior compartment, just anterior to the syndesmotic membrane.
2. Lateral Compartment
    1. Peroneus Longus (PL) and Peroneal Brevis (PB).
    2. These muscles are transected at the same level as the anterior compartment muscles, at the level of the tibial bone cut.

**Anterior Tibial Vessels and the Deep Peroneal Nerve:**

Identify and separate the vessels and the nerve. Pull deep peroneal nerve distal and divide. Dissect the anterior tibial vessels, clamp them, and double ligate first with a stick tie, then with a free tie (proximal to first tie).

The Anterior tibial vessels are located within the anterior muscle compartment, at the deepest or most posterior surface, just anterior to the syndesmotic membrane. They are most easily visualized after transecting the anterior muscles and finding the transected vessels at the posterior aspect of the anterior compartment.

**Dissect Tibial Periosteum:**

In the traditional amputation, as described by Burgess, the periosteum is divided at the level of bone transection, as far proximal resection or elevation of periosteum can decrease the vascular supply to the bone. Also, leaving extra periosteum distal to the bone cut can leave tissue that may calcify and develop new bone formation.

**Divide the Tibia:**

Tibia – the tibia is typically divided at the level of the anterior skin incision. The tibia is initially transected perpendicular to its long axis. Just before closure, the tibia is shaped with an anterior bevel to better accommodate prosthetic fitting.

**Expose the Fibula:**

Dissect out the fibula, remove periosteum and soft tissue. Place retractors to protect the soft tissue.

**Divide the Fibula:**

A. Fibula– the fibula is typically divided between 1 and 2 cm proximal to the level of the divided tibia. It is typically cut perpendicular to its long axis. If the fibula is long or at the same level as the tibia, it frequently feels long to the patient and prosthetists and can create a bone prominence that can cause increased pressure, pain, and skin breakdown.

1. There are exceptions to this traditional fibular bone cut level of 1 to 2 cm shorter than the tibia.
2. First – if bone bridging techniques are used, most surgeons recommend having the tibia and fibula at either equal levels, or with the fibula a very slight amount shorter than the tibia (appr. .5 to 1cm shorter than the tibia).
3. Second – in the ultra short transtibial amputation, the fibula is quite frequently removed by careful dissection on the fibular side of the proximal tibia/fibula joint to preserve the capsule of the joint in the tibial side. The fibular collateral ligament and the biceps femoralis tendon (often confluent) which attach to the proximal tip of the fibula are carefully dissected off the fibula and then reattached with suture to the tibia via the tibia/fibula joint capsule.
4. In trauma situations, the surgeon has to be aware that the zone of injury may extend proximally and the syndesmotic membrane and even the proximal tibia/fibula joint may be disrupted. If this is the case, then the joint needs to be reduced and the fibula stabilized to the tibia proximally, distally, or in both locations.
5. The fibula also needs to be shaped to smooth the anterior corner, the outer or lateral edge. Care also needs to be taken to look for a posterior spike of bone of periosteum that can lead to development of a small bone spur.

B. Bone bridging reconstruction is not performed in the traditional reconstructive posterior flap transtibial amputation as described by Burgess.

**Place hook in fibula and dissect along back of bones.**

**Incise distal end of flap.**

**Lift deep posterior compartment off soleus, preserve soleus fascia.**
Deep Posterior Compartment: Posterior Tibialis (PT), Flexor Hallucis Longus (FHL), and Flexor Digitorum Longus (FDL).

After dissecting down the back of the tibia and fibula to remove the foot, the deep posterior compartment is carefully lifted off of the soleus. Care is taken to keep the muscular investing fascia with the soleus.

**Clamp Perforating Vessels to Tie:**
Care is also taken to find and clamp the small perforating vessels that go from the posterior tibial and peroneal vessels down into the soleus, so that these perforating vessels do not retract down below the fascia and cause bleeding that may be difficult to control.

**Tibial Nerve and Posterior Tibial Vessels:**
Dissect out the posterior tibial vessels and the tibial nerve.

1. The Posterior tibial Vessels are located within the fascia of the deep posterior muscle compartment. They are easily visualized after gently lifting the deep posterior compartment off of the superficial compartment by manually separating the fascial plane between the soleus and deep compartment, starting on the medial edge, at the proximal portion of the flap. If the interval between the soleus and gastrocnemius is entered inadvertently, this becomes obvious when the plantaris tendon comes into view.
2. The Tibial nerve runs throughout its course with the posterior tibial vessels. It is the largest nerve in the lower leg. Separate form the posterior tibial vessels by opening the perineurium and physically pulling away from the vessels. Clamp the posterior tibial vessels to exclude the nerve. Draw the nerve down and divide. Ligation of this nerve to prevent bleeding from the nerve is controversial. I rarely ligate the nerve, and only do so if I visibly see small vessels that may bleed.

**Isolate the posterior tibial vessels, clamp and cut.**

**Pull the tibial nerve distally and transect.**

**Isolate and transect residual lateral compartment muscle.**

**Isolate Peroneal Vessels:**
The Peroneal vessels are also within the deep posterior muscle compartment, but are not as obviously identified as the posterior tibial vessels. They lie lateral to the posterior tibial vessels, and are between the FHL muscle and the PT muscle, very close to the deep edge of the fibula. The large veins are occasionally torn during the transection of the fibula, and occasionally bleeding that appears to be coming from the fibula, is actually coming from the peroneal veins. If this is the case, placing a bone hook into the fibula, and lifting the limb by the fibula allows the peroneal vessels to fall away from the bone so they can be clamped more proximally and ligated at the site of bleeding under direct visualization.

**Remove residual deep posterior compartment muscles.**
After separating out the posterior tibial vessels, the tibial nerve, and the peroneal vessels, the PT, FHL, and FDL are transected at or just distal to the level of the tibial bone cut.

**Double Ligate Peroneal Vessels**

**Double Ligate Posterior Tibial Vessels**

**Ligate Perforating Vessels**

**Locate Small Saphenous Vein and Sural Nerve:**
Sural nerve – This superficial nerve runs in the posterior flap, and is located between the skin and the superficial fascia. It runs just lateral to the small saphenous vein. The vein is isolated and ligated. The Sural nerve needs to be shortened dramatically so as to position the nerve ending not just away from the incision, but well up posteriorly and not in the tissue covering the distal end of the amputation.

**Pull the sural nerve distally and transect.**

**Tie the small saphenous vein.**

**Test the flap, notice the need to bevel the tibia.**

**Bevel Tibia:**

1. The tibia is triangular in shape, and the anterior corner can be quite sharp and lead to a painful bone prominence at the distal and anterior aspect of the amputation site.
2. A tibial bevel is created to re-shape the tibia and remove the anterior 1/3 of the tibia. I prefer to cut from the transected surface of the bone, starting just anterior to the medullary canal and beveling up at 45º to a point approximately one cm proximal to the original cut. The edges of the tibia are then smoothed and shaped with either the saw blade, a rasp, or the rounger.

**Bevel Fibula:**
The fibula also needs to be shaped to smooth the anterior corner, the outer or lateral edge. Care also needs to be taken to look for a posterior spike of bone of periosteum that can lead to development of a small bone spur.

**Let the tourniquet down.**

**Hemostasis**

**Bone Wax:**
Use a very small amount of bone wax to stop intraosseus bleeding.

**Irrigate to Remove Debris:**
Irrigate to clean, remove bone dust, and old blood.

**Insert Drain:**
Bring drain out laterally in the muscular area. A medial exit can cause painful scarring. Cut drain between holes

**Trim achilles tendon if needed.**

**Myodesis of the Fascia:**
Muscular Closure:

- The muscular closure should be considered as reconstruction. In the transtibial amputation the fascia of the superficial muscular compartment is advanced up and over the end of the tibia to the sewn into the periosteum of the tibia and to the fascia of the anterior compartment. Since this muscular fascia is sewn to the bone via its periosteum, this is a myodesis. Some surgeons prefer to drill holes in the edges of the tibia just medial and lateral to its crest. I personally have found that I am better able to advance the muscle proximally up and over the tibia by sewing to periosteum, and am not able to advance the muscle as well using the drill hole technique. In the extended posterior flap technique, the fascia is advanced several cm proximal to the cut edge of the tibia.
- To accurately secure this myodesis, typically three or four sutures are carefully placed under direct vision in the periosteum and in the deep and superficial layers of the fascia. The sutures do not grab muscle tissue. They may secure the edge of the Achilles tendon in the longer transtibial amputation. The sutures are all placed and clamped, and only tied after placing all three or four myodesis sutures. If the first suture is tied, it is more difficult to see the layers and accurately place the subsequent myodesis sutures.
- The myodesis is typically performed with an absorbable suture of moderate strength such as number 1 or O suture material.

**Close Lateral Fascia:**
The fascial closure needs to be secure. It is typically performed with an absorbable suture of moderate strength such as O suture material.

**Trim the Flap:**
Anterior lateral corner

**Close the fascial layer.**

**Trim the Flap:**
Anterior medial corner

**Trim the Flap**:
Posterior medial corner

**Trim the Flap:**
Posterior lateral corner

**Subcutaneous Tissue Closure:**
Skin healing in an amputation surgery can take longer than in other surgical procedures. A subcutaneous closure can help re-enforce the approximation of the skin edges and minimize wound dehiscence. The subcutaneous closure is typically performed with an absorbable suture of light strength such as 2-O suture material.

**Nylon Skin Sutures:**
Skin healing in amputation surgery can take longer than in other surgical procedures. A suture technique that minimizes trauma to the skin edge is needed. I typically use 3-O nylon suture and prefer it over staples as I can leave the nylon in longer with less irritation. It is not uncommon to leave sutures in 4 or 5 weeks. I have found that skin staples tend to show irritation and redness sooner than nylon suture.

**Prepare the Skin for Tape:**
The skin closure is typically re-enforced with skin tapes to help take tension off of the sutures.

**Apply skin tape.**

**Apply non-stick gauze.**

**Apply open 4x4 gauze**.
Then 4x4 gauze is opened up and carefully layered over the amputation site so as not to not form a large single mass of bandages that could potentially shift in position and cause a pressure point inside the cast.

**Apply fluff gauze.**

**Roll on amputation sock.**
The sock helps to shape the limb and minimize the post-operative edema. Cotton cast padding is then applied over the amputation sock to further pad the amputation site.

**Place reticulated foam end-pad.**

**Place patellar pad.**
The patellar pad is placed over the patella to identify the location for the patellar cut as the last step in the final casting procedure.

**Tibial crest pad placement**
Tibial crest pads are placed over the anterior-medial and anterior-lateral tibial flare regions. These two regions are loaded in a traditional transtibial prosthetic socket. Padding helps to protect the tibial crest and push the tibia back away from the cast to protect the skin over the distal end of the tibia. The narrow pad goes on the lateral side to avoid pressure on the peroneal nerve.

**Two rolls of elastic gauze plaster are applied.**
Two rolls of plaster with elastic gauze are used for the initial layers of the cast to both mold the amputation site and to compress the reticulated foam distal end-pad. Care must be taken to not wrap circumferentially as to avoid constricting the limb.

**Apply a 5-ply plaster splint.**
A 5 ply plaster splint is added to strengthen both the medial side of the knee area and the distal end of the cast.

**Two additional regular cast material rolls applied.**

**Create 3-5 degrees of flexion.**
The limb is laid onto a pillow to create 3 to 5 degrees of knee flexion, avoiding hyperextension of the knee and facilitating cast molding.

**Supra-condylar Mold**
A supra-condylar mold is applied to contour the cast above the femoral condyle to control rotation and prevent the cast from falling off the patient. The larger the patient, the larger the supra-condylar mold.

**Cut out patellar pad.**
The patellar area of the cast is cut out to provide a landmark to assure the nurses, therapists, and physicians that the cast is indeed located properly and has not rotated or moved distally.