Swim and Ski Prosthesis

Any lower limb amputee will find it less physically demanding to swim with a fully plantar flexed prosthesis. Whether the individual is trying to set new speed records or just casually swimming, wearing a swimming prosthesis will reduce the amount of energy expended to move through the water. The single amputee becomes bilaterally symmetrical. Each arm stroke will be the same whether or not he or she is kicking for power. For the bilateral amputee, the legs will act like the keel of a boat. They will keep the bilateral going in a straight line and will stop the torso from gyrating with each stroke, thus reducing energy expended.

My name is Michael Ross, and I am the inventor of the Activankle. I am a bilateral BK who grew up in Southern California. Surfing, sailing, scuba diving, swimming competitively and water polo were major parts of my life. After my accident, it was important to me to be able to resume my water activities. Thus the Activankle was developed. I make no claim that this is the perfect device for swimming or other water activities, but it does the task it is intended to do. However, what you attach to the Activankle will make a noticeable difference in the performance of the swim prosthesis. Even for the amputee not interested in performance, the following information is useful for making a prosthesis that will hold up to the rigors of water and salt.

After several prototypes, I found that the swim leg that works best is a hollow exoskeletal leg with a Symes foot. The advantage of exoskeletal over endoskeletal (without foam) is increased hydrodynamic efficiency. The exoskeletal allows the water to flow undisturbed along the length of the leg and onto the foot. This could be accomplished with a foam covered endoskeletal leg but foam has a distinct tendency to absorb water and even if the foam is waterproofed, it will create too much positive buoyancy. By drilling two holes in the hollow section of the exoskeletal leg and allowing water to fill this cavity, excess positive buoyancy is eliminated. When a foam-covered foot is attached to the hollow exoskeletal swim leg, ideal positive buoyancy is attained. A Symes foot is another major factor for increasing hydrodynamic efficiency. When the Activankle is bolted to a Symes foot, the Activankle pivots from a point closely resembling the natural ankle joint. When these two are attached to the exoskeletal leg and fully plantar flexed, the top of the Symes foot will line up evenly with the anterior of the leg. Water flowing undisturbed along the leg and directly onto the top surface of the foot is what allows the foot to generate power.

Suspension is very important. In the water, the prosthesis should feel as if it were bearing weight. If not, each kick will allow the residual limb to wobble inside of the socket, creating friction, which everyone knows is not good, and the energy will not be fully transferred to the foot. Silicone, urethane and latex suspension sleeves, work very well. They also keep water out. The addition of an auto expulsion valve creates superior suspension. For those using a pin suspension liner such as Iceross, Alps or Alpha Liner, the only shuttle locks I have recently seen two that appear to be water, salt and contamination proof are Fillauer's Gator Grip Lock and Coyote Design's Air-Lock. Whether you build endoskeletal or exoskeletal, the components used should be waterproof and corrosion resistant to salt. Kingsley's Steplite is Rampro's choice of foot. Water will not damage this foot. It has a graphite keel, the foam does not absorb water, and it can be ordered in several heel heights including flat. A flatty is ideal for use around the water where barefoot is usually the norm. Ohio Willow Woods Carbon Copy II Symes and Campbell-Childs waterproof Symes will also work well. A lightweight aqua shoe with no heel such as Nike's "Reefwalker" will protect the prosthetic foot and the real foot.

If you decide to build a hollow exoskeletal, you can laminate a pyramid into the distal end of the leg. Two that work very well are Ohio Willow Woods's Composite laminating Pyramid Adapter (FND-994000) and USMC's all titanium Cup Connector Kit (15113/large or 15143/regular). If the leg will also be used for snow skiing a low profile rotatable pyramid adapter should be used. Snow skiing typically requires the foot to be toed out 4 to 8 degrees. Rampro has stainless steel pyramid adjustment set screws in metric or SAE. Titanium is the best material for the pyramid and pyramid adapter. Some manufacturers' stainless steel parts use a lot of iron and these parts will continually leech a red oxide after use in water and even more so after use in salt water.

The hollow exoskeletal leg with a pyramid interface also makes an ideal ski leg. The unlocked Activankle mounted to a Symes foot flexes from the same place as the human ankle and the ski boot manufacturers do know where the human ankle flexes. The hard exoskeletal leg solidly transfers energy to the tongue of the ski boot. The pyramid system easily allows for proper alignment and the rotatable adapter allows the toe to be set correctly. The only optional modification for a ski leg would be the addition of a threaded stainless steel plate (approx.1"x1"x1/8") laminated into the leg. Placement of the plate depends on the brace used. (e.g. For a Townsend brace, approximately 3" or 8cm below the patella.) This will allow a hard knee brace to be securely attached to the prosthesis. A matching hole needs to be drilled in the brace to accommodate the bolt or set screw protruding from the threaded plate. I use a partially threaded 1/4-20 bolt with 1/8" of threads. Cut off the bolt head so that the end of the non-threaded (smooth) bolt section is flush with the surface of the brace. A screwdriver slot can be cut into the end of the bolt with a hacksaw for easy install and removal of the bolt. With the easy to take on and off brace on top of my suspension sleeve, I have great suspension, extra stability and added safety.

If you decide not to fabricate the Hollow Exoskeletal leg yourself, Rampro can have your Hollow Exoskeletal leg fabricated for you from a walking alignment. Call Rampro for details, or email **Darren Vincent.** I hope this will answer a lot of questions. I do not consider this the only way to make a swim or ski prosthesis, but it works well for me as you can see in these video clips .Any comments or responses will be gladly accepted.

Sincerely

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