Kayaking is one of many activities to receive attention with regard to the recreation and rehabilitation of persons with an amputation. From a rehabilitation perspective, kayaking is utilized at such places as the Walter Reed Army Medical Center through the all-volunteer Team River Runner program. From a recreational perspective, the O&P Extremity Games (2006 and 2007) have included kayaking as both a demonstration and a competitive event. For persons with lower extremity amputation, this predominantly upper extremity activity is feasible with considerations including; bolstering and padding of the residual limb, a reasonable quantity of training in the areas of balance, conditioning, stroke technique and others. This is not the case for individuals with amputation of the upper extremity. Because kayaking is dependant upon upper extremity function, the terminal device is crucial to not merely participation but also to success and satisfaction as well.

Kayaking is often very cyclic and repetitive, much like gait can be. Also like gait, kayaking can change and become dynamic and non-cyclic. Kayaking demands consideration of numerous factors including efficiency, motor planning, motor control, balance and others. Presently, there is only one terminal device commercially available that is specific to kayaking, the TRS Hammerhead. This device was released to the commercial market at approximately the same time researchers from the University of South Florida developed the USF kayak hand.

A study was conducted to compare gross upper extremity kinematics from non-amputee expert kayakists under three conditions: no device, prosthetic simulator with TRS hand and prosthetic simulator with USF hand. These data were further compared to that of two persons with upper extremity amputation (one with long transradial and one with short transhumeral amputations) under the two terminal device conditions: TRS and USF hands. The TRS hand permitted a repeatable quantity of trunk rotation where use of the USF hand resulted in a more variable quantity of trunk rotation. With regard to shoulder motion in the sagittal plane, use of either terminal device did not make as much difference as level of amputation. Non-amputees retained similar quantities of shoulder flexion/extension whereas the transradial amputee presented less flexion and moved closer to shoulder extension and the transhumeral amputee actually moved into shoulder extension with the least quantity of shoulder flexion of all four subjects. Frontal plane shoulder motion was largely unchanged in all conditions except in the transhumeral amputee who presented an average peak shoulder abduction angle of 79° versus an average peak shoulder abduction angle of 44° in the other three subjects. At the elbow, the largest range of motion was seen in the non-amputee group under the no-prosthesis.
condition with a range of 15-58 degrees. Elbow motion with the USF hand was within the range of the non-amputee group, no-prosthesis condition range, but was much narrower at 22˚ (averaged). Elbow range of motion was not quite as narrow with the TRS hand at 29˚ (averaged) but it fell outside the range of the no-prosthesis condition (increased flexion). Elbow range with the transhumeral subject was negligible as the elbow joint was locked at 40 degrees of flexion. Mediolateral sliding of the terminal device along the long axis of the paddle was the largest difference between the hands. The TRS hand moved an average of 44mm along the length of the paddle whereas the USF hand moved an average of 13mm.

Both prosthetic hands resulted in amputee participants’ successful ability to kayak on a slow moving river. There were specific benefits and drawbacks associated with each device. The TRS Hammerhead hand was found to migrate along the shaft of the paddle under laboratory conditions but much more so ‘on the water’. Subjects reported that the sound hand seemed to work harder to maintain paddle position with the TRS hand due to this migration. Subjects further reported that the TRS hand was forgiving of form errors. The TRS hand is a one piece construction terminal device that is commercially available. The USF Kayak hand, in its original version, was fabricated from mild steel. Obvious drawbacks were corrosion and mass. Furthermore, the device had a rigid, preset wrist angle that led to complaints of stiffness. Other limitations are the fact that there are two pieces to the hand and the fact that it must be custom fabricated by the prosthodontist. Non-amputee experts using the prosthetic simulator reported that the USF hand maintained form more consistently with their preference. Objectively however, the most obvious kinematic difference was in mediolateral sliding which is markedly less with the USF hand.

Authors believe either terminal device is appropriate for facilitating a return to or continuation of kayaking in persons with a unilateral amputation of the upper extremity. Clinicians assisting athletes with selecting and training of a device for kayaking should be familiar with benefits and drawbacks associated with the available devices in addition to having a basic understanding of the movement patterns associated with the performance of kayaking.

REFERENCES

SUPPLIERS
1. TRS. 3090 Sterling Circle, Suite A. 80301. Boulder, CO. USA.