

PART THREE

**ACTIVITIES
FOR
FITNESS AND SKILL**



NEWSDAY/ J. CONRAD WILLIAMS, JR.

INTRODUCTION

Stretching, weight resistance, and aerobic exercises will develop and maintain physical fitness if done regularly. However, exercise routines are repetitious and may be tedious. Sports, on the other hand, are fun. Certain sports can also help participants to maintain fitness and improve overall strength and endurance. Active sports provide aerobic conditioning—the most important health benefit of exercise.

A balanced combination of flexibility exercises, weight resistance workouts, and active participation in sports builds aerobic endurance and strength in all major muscle groups, and creates proper muscle balance. While many sports require cardiovascular endurance, to excel in certain sports one should concentrate on exercises that focus on particular parts of the body. For example, in running, aerobic dance, or soccer, it is essential to develop strength in the legs and lower body; in rowing, emphasis is placed on strength and flexibility in the upper body, arms, and shoulders.

People who do not get enough regular exercise are not in adequate physical condition to participate in active sports without some preliminary aerobic conditioning. A person who is “out of shape” is not going to last very long on a cross-country ski trail, for example, nor will the experience be particularly enjoyable.

In the past, it was generally thought that a person with lower limb amputation could expect a greater amount of cardiovascular strain when engaging in active movements than would someone with

two sound legs, because an artificial limb could not function as efficiently as a sound limb. Now, however, prosthetic adjustments or adaptive components can make artificial limbs quite responsive to athletic needs.

PROSTHETIC OPTIONS

Most exercises can be performed with or without the use of a prosthesis. In order to enjoy and successfully participate in sports, however, it is essential that one have a comfortable artificial limb that is suited to the activity. Activities such as walking, bicycling, and rowing often do not require any modifications or special adaptations to standard artificial limb components. However, runners usually require energy-storing feet and other prosthetic adaptations in order to improve performance and protect the residual limb; avid swimmers often use special waterproof prostheses. For any activity requiring lower limb movement, prosthetic units that provide knee stability and/or ankle mobility will be useful.

A general discussion of prosthetic components is presented below. Special adaptations for and modifications to these prosthetic components for particular activities are discussed in the chapters that follow. Most prosthetic components described here are explained in the Glossary.

The major components of a lower limb prosthesis are the socket, foot, ankle unit, and, for

above-knee prostheses, the knee unit. The choice of components, materials, and design varies with the needs of each individual.

The Socket

The socket is the most critical component of any prosthesis because it comes in contact with the residual limb. It should be both comfortable and functional. The residual limb must fit so that it is properly supported in the socket. The prosthesis must also be suspended on the body properly. If suspension is not adequate, pistoning can occur between the socket and limb interface, resulting in skin irritation that can lead to debilitating conditions and make it painful to even walk.

For those with BK amputations, the conventional patellar tendon-bearing (PTB) socket is generally not adequate for evenly distributed absorption of the force of impact that is generated during active sport participation. It is uncomfortable to run on a prominent patellar bar. A total surface-bearing socket provides for full contact and distributes the impact load over the greatest surface area. Side joints and a thigh lacer further reduce forces on the residual limb by transferring some weight to the thigh. This is especially helpful for individuals with very short or scarred residual limbs.

The ActivSleeve™ and Michigan Sleeve are latex rubber suspension sleeves that provide suction-type suspension and help reduce pistoning for the person with BK amputation. They may be used without additional support. A waistbelt attached to a cuff suspension socket can provide additional suspension within the socket to prevent pistoning. Suspension sleeves of neoprene are also useful in providing atmospheric suspension. The 3S (Silicone-Suction-Socket) provides excellent suspension and a socket interface that reduces shear forces and, for some individuals, can eliminate the need for straps or sleeves. The 3S suspension can also be used on AK and upper-extremity prostheses.

For those with AK amputation, the ischemia containment socket (also known as the Narrow M/L socket) design provides alignment stability and control of the femur. The Narrow M/L or Normal Shape Normal Alignment (NSNA) designed socket is also referred to as CAT-CAM (Contoured Adducted Trochanteric-Contained Alignment Method). A Silesian belt or Neoprene T.E.S. belt can provide

auxiliary suspension to the AK suction socket, if needed. Many individuals find that it is more comfortable to run on a NSNA-style socket than on a quadrilateral socket because weight on impact is not placed on the ischial tuberosity. The flexible brim above-knee socket is also helpful in reducing stress on the residual limb.

Prosthetic Feet

The development of energy-storing feet is the greatest advance in prosthetic adaptations pertaining to running and any other sport requiring agility. With the aid of energy-storing feet, people with lower limb amputation are able to move quickly and run in the foot-over-foot gait. This is made possible by the presence of a flexible keel, which provides a spring action that simulates the push-off phase of running.

The SAFE (stationary attachment flexible endoskeletal) Foot, introduced in 1980, is considered to be the first modern energy-storing design. The VA Seattle Foot, developed in the early 1980s, was first made commercially available in 1985. The Flex Foot was also first released in 1985. Since then, a number of other energy-storing feet have been introduced. These include the STEN Foot, Carbon Copy II and III Foot, Quantum Foot, DAS Foot, Springlite Foot, and the Sabolich Foot.

A recent version of the SAFE Foot has a lightweight design using a totally flexible keel which offers a unique dynamic elastic response that functions well on uneven terrain. The Flex Foot and the Springlite Foot are made of lightweight graphite to create a strong push at toe-off. Because of this extra



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strong push-off capability, they are referred to as “super”-dynamic elastic response feet. However, proper alignment of the Flex Foot is critical in order for the leg to roll smoothly from heel-strike to toe-off. Most new wearers will need some time to adjust their gait to the spring action of this foot, but will find it excellent for fast-paced walking on even terrain.

For some activities, an energy-storing foot is not essential. A single-axis prosthetic foot (SACH) provides both plantarflexion after heel-strike and a smooth transition to mid-stance, thus increasing knee stability, particularly for the walker with AK amputation. For this reason, a single-axis unit can also be useful to a person with a short residual limb below the knee or with a knee with flexion contracture.

In addition to plantarflexion at heel-strike, a multi-axis foot provides motion in dorsiflexion, inversion, and eversion. These features help the walker deal with uneven terrain. A multi-axis foot can also make walking on even terrain more comfortable because the foot conforms well to the ground surface. The current versions of the SAFE Foot, Greissinger Foot, Dynamic Foot, Endolite, Quantum, IPOS 6-way Foot DAS, and DAW feet provide excellent multi-axis function. The SAFE Foot, DAS Foot, and Quantum Foot also offer energy-storing capabilities. The energy-storing keel of the SAFE Foot is also flexible, giving it dynamic elastic response. One of the newest multi-axis foot systems is called the Carbon Copy System III, which combines an energy-storing foot and combined rotational pylon unit.

Ankle Units

Newly developed ankle components, such as the Seattle Ankle, MARS Unit, Multiflex Endolite Ankle, or SwePro Ankle, can provide for a wide range of motion and increased flexibility. An energy-storing foot that does not have a multi-axis function can be coupled with an ankle to acquire range of motion. Most new ankle units can be adapted to the Seattle Foot, Sten Foot, Carbon Copy II, Flex Walk Foot, or other prosthetic feet that are similar in design. The ankle is mounted inside the foot in a position that closely resembles the anatomy of a real foot.

Knee Units

The knee joint of an AK prosthesis should allow for stable and safe operation and ease of extension, and should be lightweight. Hydraulic knees, such as the Mauch SNS Knee Unit, provide for stance and swing control, which enables stability on single limb support, particularly when running. The redesigned Otto Bock hydraulic unit also provides excellent swing and stance control and is lightweight. The Endolite Stabilized StanceFlex (Bouncy) Knee is another knee unit that is excellent for use in active sports. This knee unit can be combined with other prosthetic systems to improve mobility, and is discussed in further detail in the chapter on running.

SKIN CARE

Proper skin care is absolutely necessary for active individuals. Blisters and other irritations to the residual limb can be prevented by regular use of products that reduce shear forces and cushion vulnerable areas.

Practicing good hygiene of the residual limb and socket will help prevent skin problems. Socks should be changed when they become wet. Determining the right number of socks to wear is important: too few or too many can result in skin irritations and blisters. If blisters occur, vitamin E oil or *Aloe vera* are excellent aids for healing the skin. Spenco™ 2nd Skin™, Spenco™ Skin Care Pads, DuoDerm from Squibb, and Johnson & Johnson Bioclusive® Pads are also helpful. The Hood Socket Cleaning Kit is useful in making the job of socket care easier. If sweat is a problem, the Drionic device from General Medical can be useful.

SELECTION OF ACTIVITIES

The activities presented in this section can be categorized as follows:

1. Individual sports that produce vertical impact on the residual limb (i.e., walking for exercise, running, and aerobic dance). Usually, no previous skill is needed to participate. High-level strength and endurance are not essential for beginner participation and aerobic benefit.

2. Individual sports that are relatively nontraumatizing to the residual limb (i.e., swimming, cycling, rowing, and cross-country skiing). For adequate aerobic benefit, good skills in swimming, cycling, and rowing are needed. High-level skill, strength, and endurance are needed to achieve adequate aerobic benefit in cross-country skiing.
3. Game sports, which usually involve vertical

impact and stresses to the residual limb (i.e., handball, racquetball, tennis, squash, basketball, soccer, hockey, and lacrosse). These and most other game sports will require a moderate skill level for adequate aerobic benefit. Game sports are often considered supplemental options rather than integral parts of the total physical fitness program.



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Jeff Keith arrives in Los Angeles after completing a 3-month run across the United States.