POSNA

The Core Curriculum

# Prosthetics and orthotics

**Objectives**

1. Discuss the timing of prosthetic fitting for congenital deficiencies of the upper and lower limb
2. Describe four types of prosthetic knees
3. Describe 2 type of prosthetic feet
4. Discuss the advantages of myoelectric upper limb prostheses over the conventional voluntary-opening hook terminal device upper limb prostheses, and the advantages of the conventional prostheses over the myoelectric
5. Define orthotic
6. Describe the nomenclature of lower limb orthotics
7. Discuss the limitations of spinal orthoses
8. Describe prerequisites for orthotic prescriptions
9. Discuss use of orthotics for prevention of ankle sprains

**Discussion point**

1. What is CAD-CAM?

**Discussion**

The timing of prosthetic fitting of upper and lower limb prostheses is timed to correlate with the normal developmental milestones of the child. Thus, children with lower limb deficiencies are fitted with a prosthesis at about the time they would be pulling to standing, roughly 8-12 months. The first prosthesis would have a nonarticulated knee for greater stability. For the upper limb, a passive prosthesis is fitted at about age 6 months, when the child is performing bimanual activity. Prosthetic fitting of the upper limb is more complex than the lower due to the importance of sensation in the upper limb. The shoulder powered conventional voluntary opening hook terminal device is the standard for upper limb prosthetic fitting. Many clinics are now prescribing myoelectric hands at age 1-2. These eliminate the need for a harness about the shoulders. The first prosthesis usually uses only one electrode which opens the hand. Later, a two-electrode prosthesis that opens and closes the hand can be prescribed. Myoelectric hands are heavier, more expensive, require more training, and have more repair time. Their appearance and function are superior to conventional terminal devices which can either close or open with shoulder power, but not both. Young children may be physically incapable of handling body-powered prostheses. Rejection rates of both body powered and myoelectric upper limb prosthesis remain high. Sensory considerations obviously are an important component of the high rejection rate.

By age 3, the above knee or knee disarticulation lower extremity juvenile amputee is fitted with a prosthetic knee. There are four types of knees. The first knee is generally a single-axis manual locking knee. A constant friction knee also is a single axis knee using constant friction to control the knee during swing phase. This can provide a smooth gait, but only at one speed. These are often used in older children. The stance control or weight activated knee is an adjustable braking mechanism in the first 20 degrees of knee flexion to prevent stumbling. These are applicable for very short below knee amputees, but a true pediatric version of this knee is not available. Polycentric knees provide a moving center of rotation and can more closely simulate normal gait. The most common variety is the four bar linkage. Hydraulic knees can most closely simulate a normal gait pattern. These have swing phase control with a stance phase braking mechanism. These are functionally ideal, but are heavier and require more maintenance. The SACH (solid ankle cushion heel) foot is a standard for children. Dynamic response feet with a flexible keel are excellent for older children and adolescents as they improve running ability and athletic performance. Lower limb prostheses generally function well in children.

An orthotic is used to control body movement. For optimum control, limb alignment should be reasonably normal to eliminate uncomfortable pressure from the orthosis. It is futile to prescribe an orthotic for a contracted joint; for example, fitting an articulate AFO across an ankle with an equinus contracture will result in an unstable gait. Orthotics are designated by the joints they span. An ankle foot orthosis (AFO) controls foot and ankle motion. A KAFO (knee-ankle-foot orthosis) controls knee motion in addition to that controlled by the AFO. A HKAFO controls hip motion. Most orthoses are now constructed from thermoplastic material applied to a mold made from a cast of the patient's limb or trunk. Orthotic control is most feasible for flexible components. Mobile foot deformities can be casted in a corrected position, and a stable, comfortable orthosis can then be fabricated. Control of knee position is possible with solid ankle AFOs, slight plantarflexion with an anterior tibial shell will promote knee extension (floor reaction brace). Attempting to apply a KAFO over a knee with marked genu varum or valgum will fail functionally and be uncomfortable in addition. The same principles apply to spinal orthoses. Weight considerations play a large role in the applicability of spinal orthoses, especially for scoliosis. If adequate pelvic fixation is not possible, the orthosis cannot be effective.

Our knowledge base in orthotic management of a number of pediatric orthopaedic conditions is unsettled. The effectiveness of bracing for scoliosis has been challenged, and the effect of bracing on possibly worsening sagittal plane deformity (thoracic lordosis) accompanying scoliosis is a concern to many. The value of bracing for neuromuscular spinal deformities is presently questionable, but newer materials that make it possible to brace the spine without a deleterious effect on pulmonary function may yet find a place. The effects of ankle bracing is being actively investigated; it appears that no orthotic support is as effective as strong ankle evertors. More sophisticated analyses of the effect of orthotics on energy expenditure and motion control by motion analysis will aid decision making in the future. Follow-up studies of extensive bracing, such as the RGO (reciprocating gait orthosis) used for high level myelodysplasia will help in decision making in the future. Seemingly mundane topics such as the effect of applying a rigid cervical collar in a head injured patient is not so simple; negative effects on intracranial pressure have been reported. This field is an active one; not only orthopaedists, but podiatrists physical therapists, and physiatrists are involved in orthotic care. The complete orthopaedist must keep abreast of current developments in orthotic management, there are many orthotics prescribed based on anecdotal information only.

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