

Gait training for the below-knee amputee*

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Introduction

Statistics show that the real incidence of amputation occurs between 60 and 75 years (Kay & Newman, 1975). Hence most of the time the therapist is dealing with older patients who have a poor vascular condition which is often accompanied by other complications such as diabetes, hypertension or cerebro-vascular accidents. The level of amputation is highly dependable on tissue viability (Murdoch 1977). In the older amputee, preservation of the knee joint makes a great difference to his rehabilitation prospects and his ability to walk greater distances without expending even more energy. The intensity of treatment has to be carefully adjusted to each individual patient.

Pre-operative treatment

In this phase attention is directed to muscle reinforcement and the maintenance of full joint range movement of all extremities; the patient is taught to balance on one foot and how to transfer from bed to chair and vice versa, as far as his condition allows.

Post-operative care

As soon as the condition of the patient permits bed exercises are started for muscle strengthening; special attention is paid to preventing contractive deformities, especially of the preserved knee joint. Exercises are carefully and gradually increased in intensity.

If a rigid dressing has not been applied the patient is taught to touch and exert slight pressure with his hands on his stump. This not only prepares him to tolerate his prosthesis but also teaches him to accept his stump as part of his body on which he has to rely for walking.

Gait training

As soon as possible, standing exercises in the parallel bars are started, with or without the prosthesis.

Once the patient has been fitted he learns to flex and extend his knee to work the stump comfortably in the socket. He is taught to bring his weight over the prosthesis and gradually reduce the support provided by the parallel bars.

It is very important that the patient learns to bring his full weight over the prosthesis before he starts walking and learns to have confidence in his new leg.

It is helpful to do these exercises in front of a mirror so that the patient can correct his posture with his weight evenly distributed over both legs.

Once the patient can accomplish the balance exercises properly, with only slight support from the parallel bars, walking training can be started between the bars which, at this stage, are only for security and to give the patient more confidence.

Initial walking exercises

Firstly, the patient is taught to raise each knee alternately and to try to take weight on his limb as much as possible. Secondly, with the prosthetic foot five to ten centimetres ahead of the sound foot, he is asked to flex his knee with progressively more weight on it until the prosthetic foot is flat on the floor (Fig. 1, left). He is then asked to do the reverse and extend the knee fully, at the same time bringing the weight back to the sound leg. This teaches the patient that he can use and trust the knee of his limb. Thirdly, he brings the prosthetic foot forward again as described previously, then steps forward with the normal foot at the same time extending the knee on the amputated side while keeping the foot flat on the floor. This is repeated with

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the sound foot in front. When he has mastered these exercises, free walking in the parallel bars is undertaken. It is very important that the patient learns to use his knee right from the start, as once a bad habit is established it is very difficult to correct the fault.

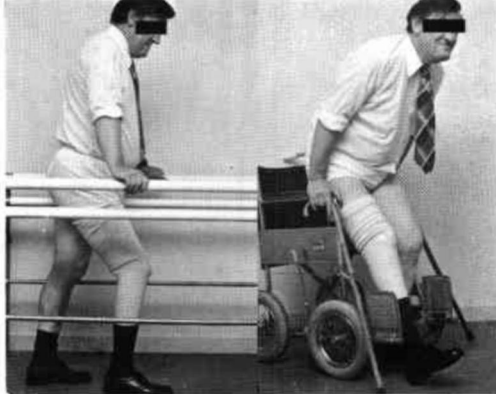


Fig. 1. Left, one stage in initial walking training. The prosthetic foot is advanced and the knee flexed, progressively more weight is applied until the foot is flat on the floor (see text). Right, demonstration of standing up from a wheelchair. The wheelchair brakes should be applied before the patient attempts to stand.

Advanced walking exercises

Once the patient walks well in the parallel bars and feels confident, walking with crutches or walking sticks can be started; first with one crutch and supported by one parallel bar, then with two crutches or walking sticks but still inside the parallel bars for security. The patient is taught to walk with a four point gait. Once the patient feels confident with his sticks, walking outside the parallel bars can be started. Psychologically this is an important point in his treatment and the patient will take time to adjust to the greater space around him where people might pass by closely.

The patient is taught how to stand up from his wheelchair while holding his sticks (Fig. 1, right) and how to stand up from a chair without arm supports (Fig. 2).

Gradually the walking exercises are extended to out-doors, to walking with one stick, stepping over obstacles, ascending and descending inclines and ascending and descending stairs.

Dependent on age and ability, the patient is taught to ascend and descend stairs by using the prosthetic leg and sound leg alternately. Young patients are taught to run, jump and practice some equilibrium exercises on a beam.



Fig. 2. Standing up from a chair without arm supports. The patient leans forward until his weight is above the feet then pushes up into the standing position.

Gait deviations

To give correct walking training the therapist should be able to recognize gait deviations and their causes. Firstly, let us look at the components of a desired gait:

1. Foot flat on the ground during midstance
2. Lateral stability of the knee
3. Controlled knee use
4. Smooth movements
5. Minimal lateral bending of the trunk
6. Even step length, timing and arm swing.

The aim of the therapist is to achieve a gait pattern for the patient which corresponds as closely as possible to the desired gait. The degree of success which is attained is dependent upon the condition and motivation of the patient and the input of the therapist.

Deviations during stance phase

Between heelstrike and midstance—excessive or insufficient knee flexion.

Excessive knee flexion can be caused by:

1. Excessive dorsiflexion of the prosthetic foot or excessive anterior tilt of the socket.
2. Excessive anterior placement of the socket with respect to the foot.
3. Too stiff plantarflexion bumper or heel cushion.
4. Posterior displacement of cuff suspension points.

(This deviation can also be caused by a flexion contracture of the knee).

During normal locomotion, the knee is in approximately full extension at heelstrike; following this, the knee begins to flex and continues until foot flat (approx. 15–20 degrees).

Insufficient knee flexion can be caused by:

1. Excessive plantarflexion of prosthetic foot or insufficient anterior tilt of the socket.
2. Excessive posterior placement of the socket with respect to the foot.
3. Too soft plantarflexion bumper or heel cushion.
4. Anterodistal socket pain

(When the quadriceps contracts, pressure between the anterodistal surfaces of the stump and the socket increases considerably. This may cause stump discomfort at heelstrike.)

5. Weakness of quadriceps muscles. The patient compensates automatically by shortening the prosthetic step length, or by digging the heel into the ground with increased hip extension resulting in a lumbar lordosis, or with anterior bending of the body or with a combination of these.
6. Habit pattern; sometimes caused when the patient goes over from a BK prosthesis with a thigh corset to a PTB prosthesis or when during initial walking training there was not enough emphasis on using and trusting his knee.

During mid-stance there is sometimes an excessive *lateral thrust* of the prosthesis, this derives from the tendency of the prosthesis to rotate around the stump; when this occurs the medial brim presses against the stump while the lateral brim tends to gap. The patient sometimes compensates by bending the trunk laterally to reduce the pressure on the medial brim.

Between midstance and toe off, the centre of gravity passes over the MP joints. If this occurs too soon it results in insufficient anterior support and allows *premature knee flexion* or "drop off". This can be caused by:

1. Excessive anterior placement of the socket with respect to the foot.
2. Posterior displacement of the toe-break or keel.
3. Excessive dorsiflexion of the prosthetic foot or excessive anterior tilt of the socket.
4. Excessively soft dorsiflexion bumper.

If the bodyweight is carried over the MP joints late the reverse occurs causing *delayed knee flexion*; the amputee experiences the sensation of walking uphill. This can be caused by:

1. Excessive posterior placement of the socket with respect to the foot.
2. Anterior displacement of toebreak or keel.

3. Excessive plantarflexion of the prosthetic foot or excessive posterior tilt of the socket.
4. Excessively hard dorsiflexion bumper.

Certain deviations may be observed during the swing phase of gait, such as:

1. Piston action due to improper suspension or poor socket fit.
2. Circumduction, when the patient does not sufficiently flex his knee out of habit, or when the prosthesis is too long.
3. Toe stubbing, due again to a too long prosthesis or insufficient knee flexion.

When a therapist recognises deviations which may be corrected by alterations to the limb alignment she should contact the prosthetist so that any necessary adjustments can be made. If a prosthesis is not well aligned the patient can suffer pressure sores and will develop bad walking habits. It is therefore of prime importance that the therapist and the prosthetist communicate with each other as members of the clinic team for the benefit of the patient.

Good walking training which is adjusted to the capability and age of the patient will enable an optimum gait to be achieved which might make all the difference between the individual staying at home bound to a chair, or leading a relatively normal existence.

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