Fitting and Training Children with Swivel Walkers[1]

W. M. Motloch[2] AND
Jane Elliott[3]

Mobility can be provided fairly successfully for the bilateral hip-disarticulation patient when his arms can be used in connection with crutches and canes, but when the patient cannot use crutches a most difficult problem is presented to the clinic team. The most effective means of treating patients who have complete or essentially complete absence of all four limbs has been to provide them with a socket encasing the pelvic region mounted on a three- or four-wheeled platform (Fig. i), or to provide them with motorized carts with special controls. The unpowered vehicles permit the patient to be upright but generally they must be moved from place to place by an attendant, and the motorized carts are expensive.

Experiments at the Child Amputee Prosthetics Project, University of California, Los Angeles, with pylons mounted on rockers, and hinged at a point anterior to the anatomical hip joint, proved to be very disappointing mainly because the effort required in their use exceeded the functional gain (Fig. ii) (1).

To overcome some of the deficiencies presented by previous approaches, Richard E. Spielrein (3), Senior Engineer, Repatriation Department, Commonwealth of Australia, suggested a pylon arrangement to capitalize on side-to-side oscillations of the man-machine combination (Fig. iii) and built a prototype, based on mathematical computations, which was used successfully by a 16-year-old girl.

The Ontario Crippled Children's Centre, Toronto, Canada, has successfully utilized the principles set forth by Spielrein and presents herewith instructions for fabrication and use of the so-called swivel walker (Fig. iv).

Experience has been limited to young children, but the walker should prove successful with older persons. It has been suggested that the principle of the swivel walker might also be applied in the case of paraplegia.

A. Bennett Wilson, Jr.[4]

Fig. i. Three-wheeled cart built by Child Amputee Prosthetics Project, University of California, Los Angeles, for patient with congenital bilateral above-elbow amputations and bilateral lower-extremity amelias. From Blakeslee, Berton, *The Limb-Deficient Child (1).*

[1] The device described in this article was developed by the Prosthetic Research and Training Unit, Ontario Crippled Children's Centre, under a grant from the Department of National Health and Welfare, Project No. 605-7-304.

[2] Prosthetist, Prosthetic Research and Training Unit, Ontario Crippled Children's Centre, 350 Rumsey Rd., Toronto 17, Canada.

[3] Physiotherapist, Prosthetic Research and Training Unit, Ontario Crippled Children's Centre, 350 Rumsey Rd., Toronto 17, Canada.

[4] Executive Director, Committee on Prosthetics Research and Development, National Academy of Sciences—National Research Council, 2101 Constitution Ave., Washington, D. C. 20418.

Fig. ii. Same child who appears in Figure i shown on pylons mounted on rockers and hinged at a point anterior to the anatomical hip joint. Although the child learned to ambulate with this device, her progress was slow and the energy expenditure extremely high. From Blakeslee, Berton, *The Limb-Deficient Child (1).*

The swivel walker in its simplest form (Fig. 1) consists of two pylons attached in a vertical position to a pelvic socket, and two foot pieces which are attached to the pylons so that each may rotate about the vertical axis of the appropriate pylon. Stops are provided to limit rotation of the feet in each direction, and a spring returns the feet to a neutral position when no force is applied.

The soles of the feet are canted in relation to the floor, and the pylons are positioned with their center lines falling posterior to the center of gravity of the patient and prosthesis

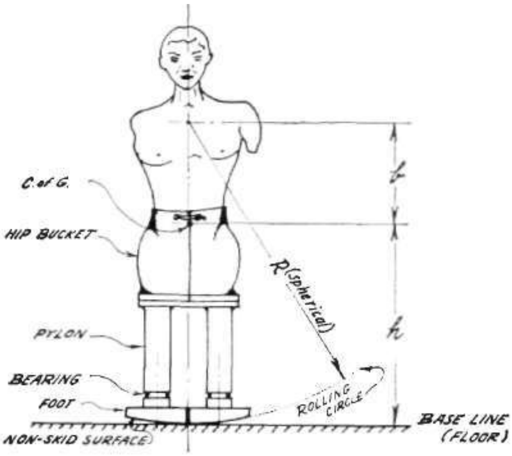

Fig. iii. Swivel walker developed by Richard E. Spielrein, Senior Engineer, Repatriation Department, Commonwealth of Australia. From Spielrein, R. E., *A Simple Walking Aid for Legless People (3).*

so that tilting of the body on one side will cause rotation of the socket about the long axis of the pylon on the tilting side. The contralateral pylon is raised initially and swings forward due to gravity until it strikes the floor ahead. Backward motion can be obtained by tilting sideways and leaning backward so that the center of gravity falls posterior to the center lines of the pylons. Of course, to manipulate the swivel walker, the patient must have a mobile trunk.

The type of walker suggested for initial use is shown in Figure 2. Later, a more cosmetic device can be used.

The socket is essentially the same as that for a conventional bilateral hip-disarticulation prosthesis *(2)* and is mounted on a platform which, in turn, is mounted on two aluminum tubes. In the bottom end of each pylon is mounted an ankle joint, or rotation unit, which in turn is attached to a foot piece mounted so that the inner edge rests on the floor when the appliance is at rest (Fig. 2). The foot pieces should have rubber soles to prevent slipping.

MEASUREMENTS

Measurements that need to be recorded (Fig. 3) are:

Crown-rump length
Waist width

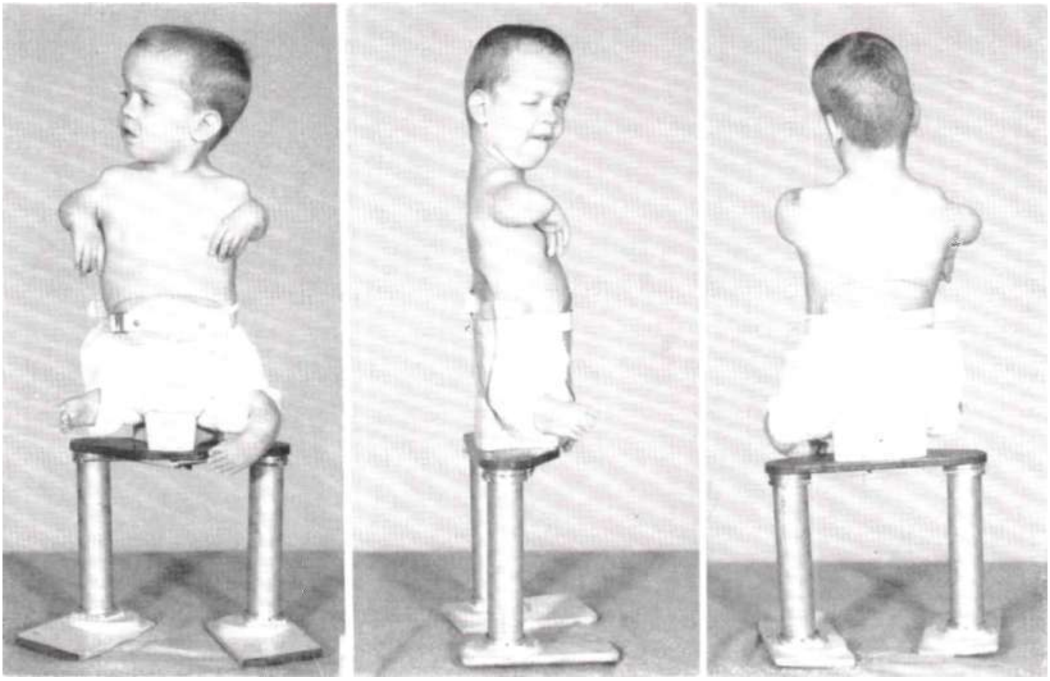

Fig. iv. Swivel walker developed by the Ontario Crippled Children's Centre, Toronto, Canada.

Crest of ilium to ischial tuberosities
Distance between ischial tuberosities
Maximum distance across pelvis

The "normal" height of the child with pylons on can be estimated by multiplying the crown-rump length by two or a little less.

TAKING THE CAST

Taking the cast usually requires the services of two people. A length of large-diameter stockinette is sewn closed at one end, with openings for existing limbs if present. Straps or webbing are used to suspend the stockinette from an overhead hook. This arrangement ensures firm contours and supports the child. The lower trunk, excluding the limbs, is then wrapped with plaster bandages up to the rib cage.

If the child is not toilet trained, the cast is made over the diapers. If diapers are not worn, the ischial tuberosity, pubic tubercle, crests and anterior spine of the ilium, and the rib cage are marked as shown in Figure 4. For use in alignment, vertical lines indicating the lateral and sagittal planes are drawn on the cast before it is removed from the patient.

FABRICATION

SOCKET

The original socket is usually made so that it extends a little higher than the waist, both front and back, for early training. As ability to balance improves and proficiency increases, the height can be reduced to approximately waist level. It is important that forward, backward, and side-to-side motions of the torso are not restricted.

The original socket fabricated for testing the first model of the swivel walker was heat-formed out of acrylic sheet, but all later models have been of polyester laminate. Two complete layers of Dacron felt, two partial layers of Dacron felt, and two partial layers of glass cloth are used, as shown in Figure 5. The lay-up is completed with four layers of nylon stockinette before impregnation with a mixture of 70 per cent rigid and 30 per cent flexible polyester resin. The laminate should be formed under a vacuum in order to prevent unnecessary bulk.

After curing and removal from the plaster cast, the socket is trimmed approximately

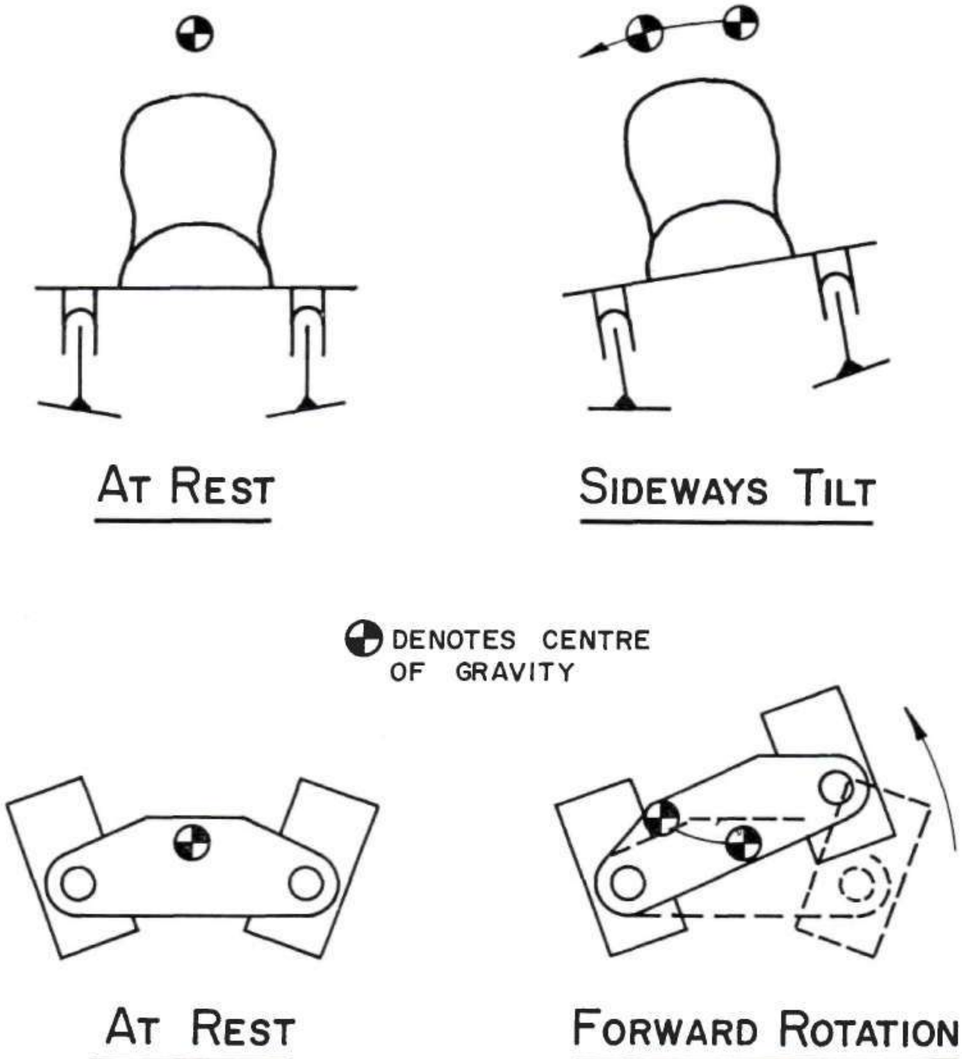

Fig. 1. Principle of the swivel walker. The child can transfer his weight to one foot by leaning sideways and then swivel forward about this foot, using only the force of gravity. Stops are provided to limit forward or backward swing, with springs returning the foot to the neutral position when it has been returned to the floor.

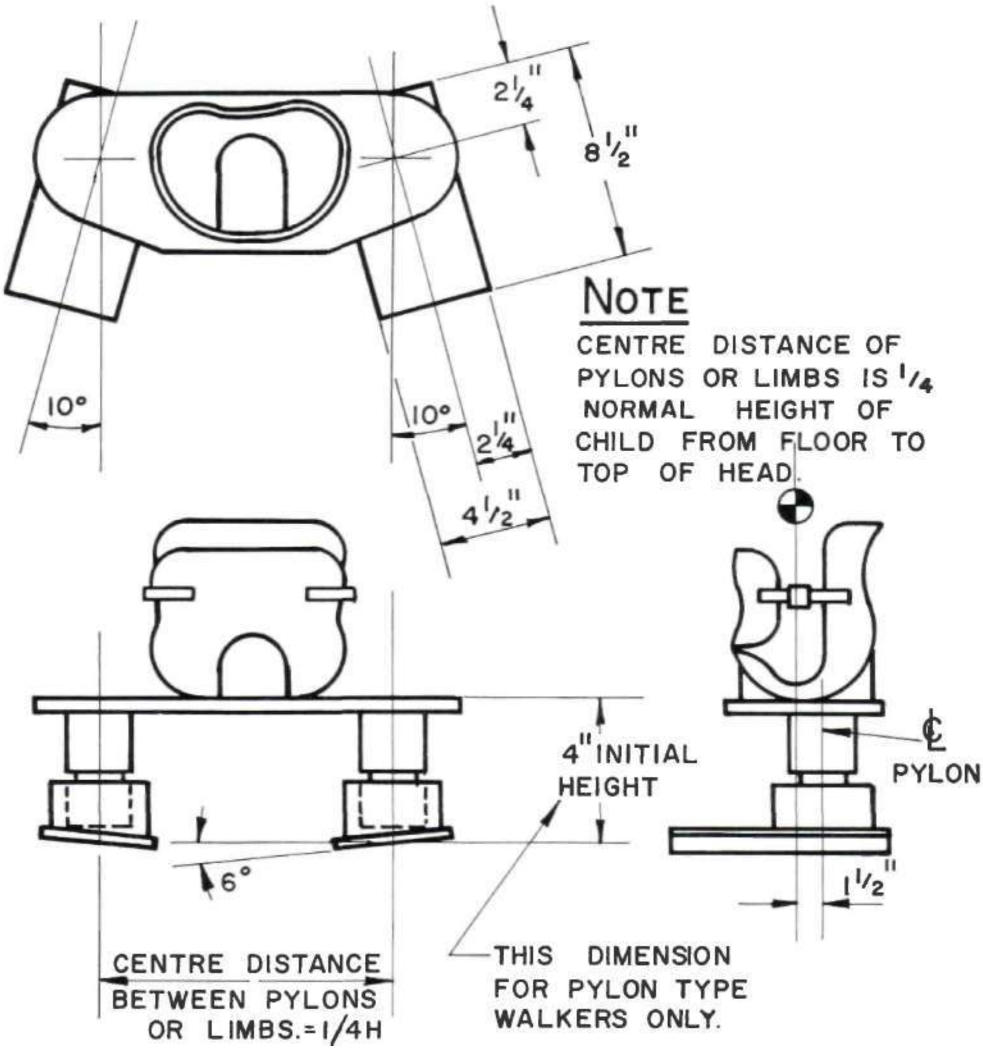

Fig. 2. Basic dimensions of the swivel walker.

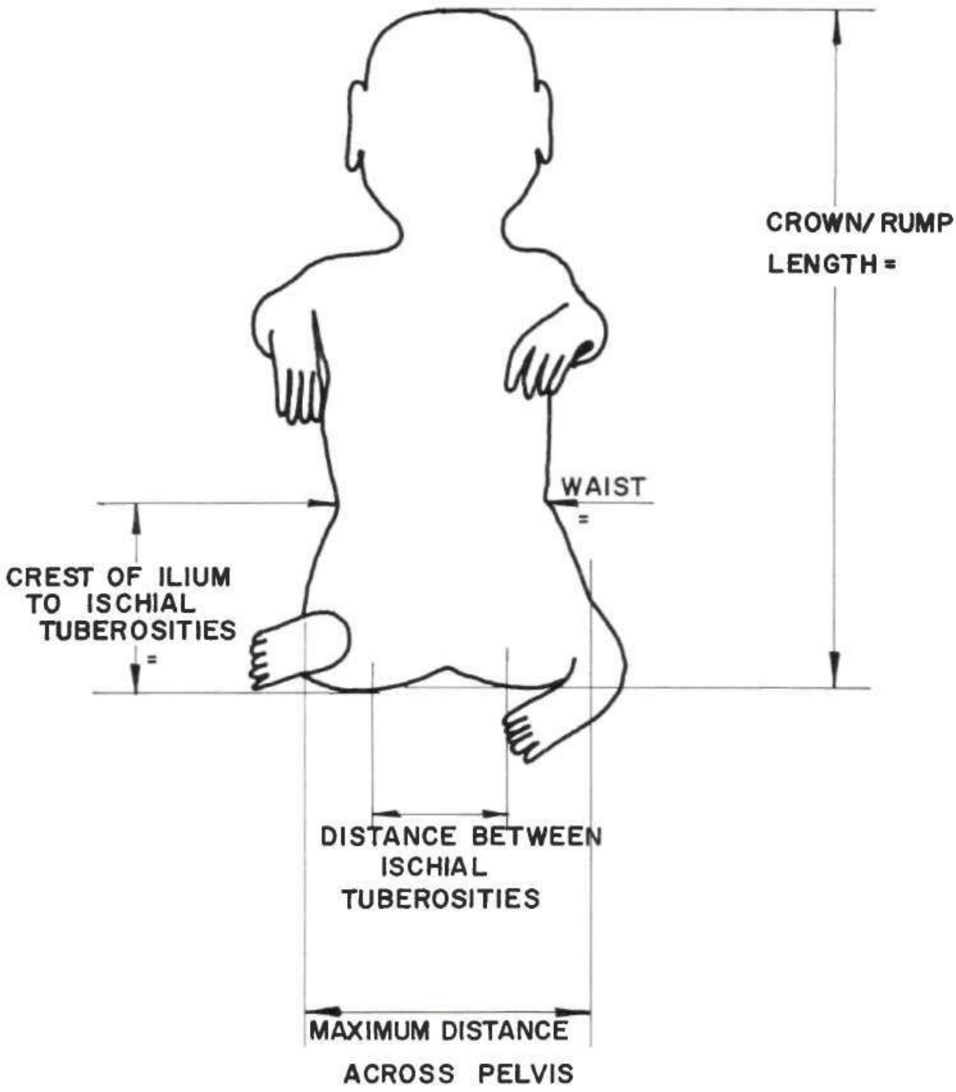

Fig. 3. Measurements required for fabrication of the swivel walker.

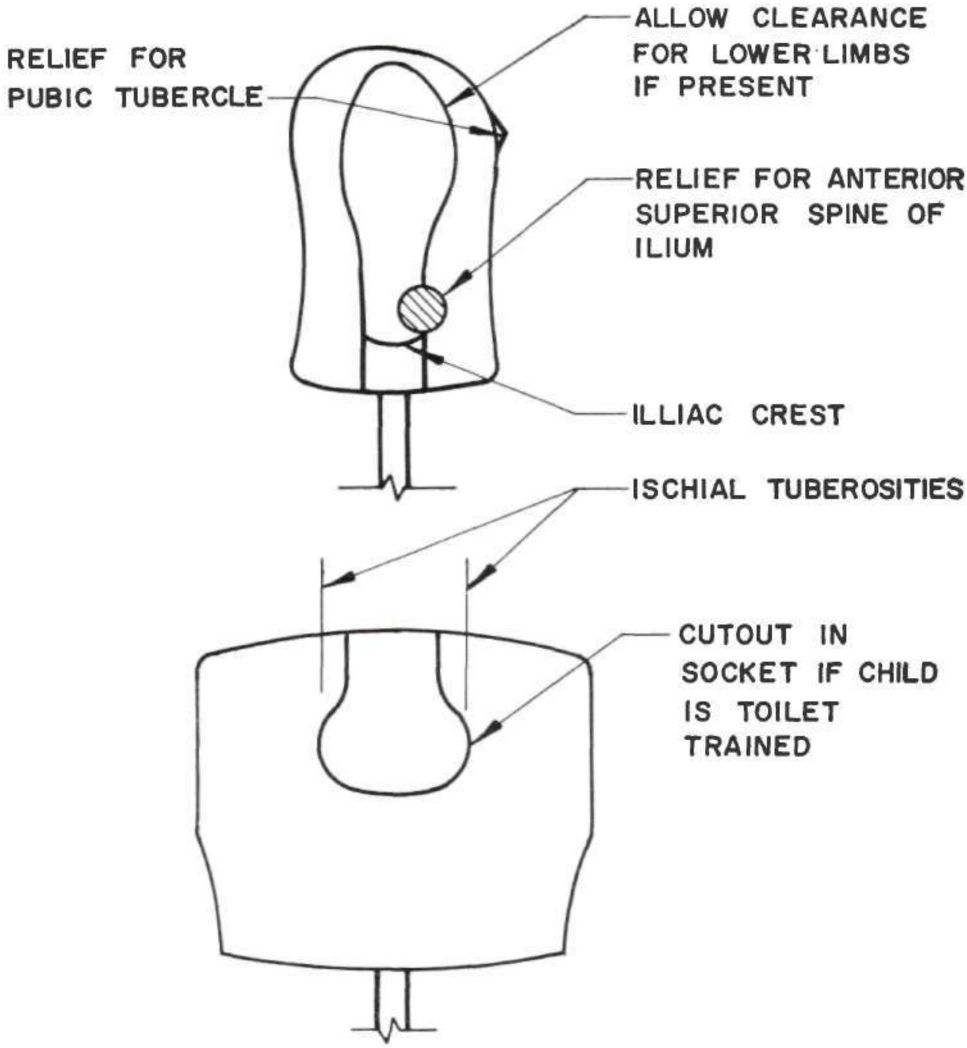

Fig. 4. Modifications of cast.

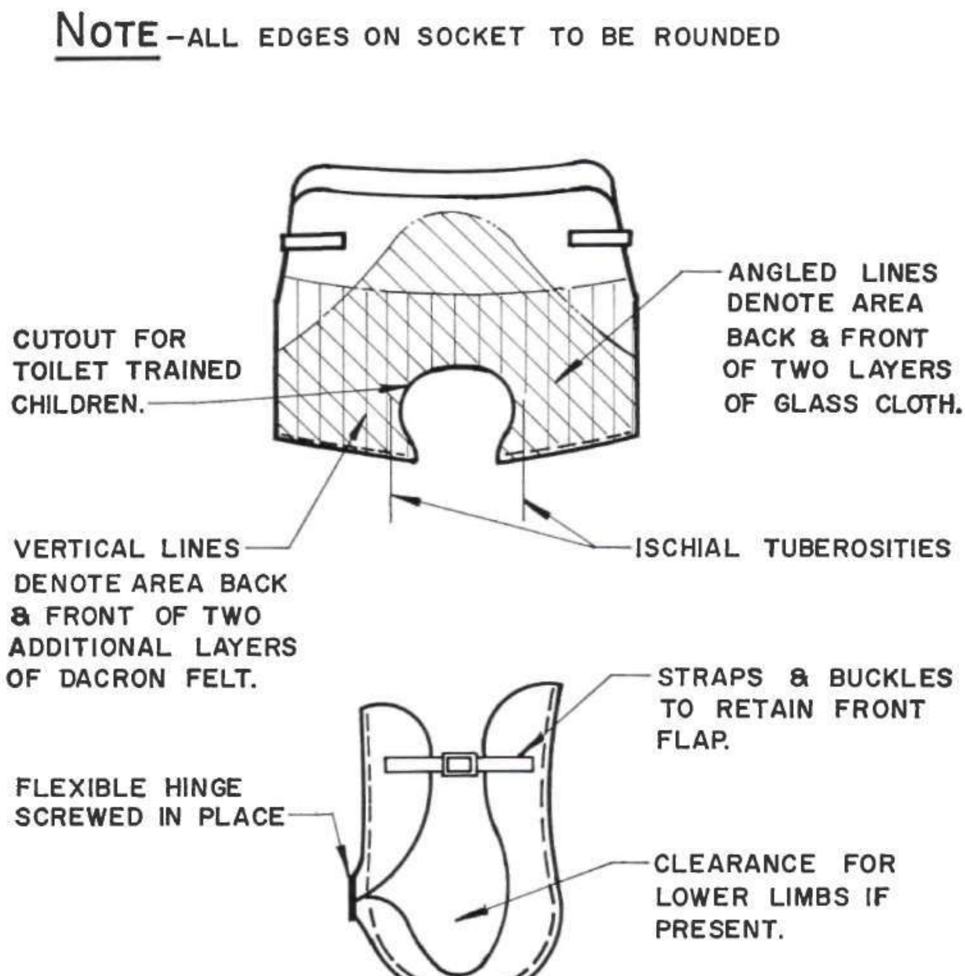

Fig. 5. Recommended socket configuration.

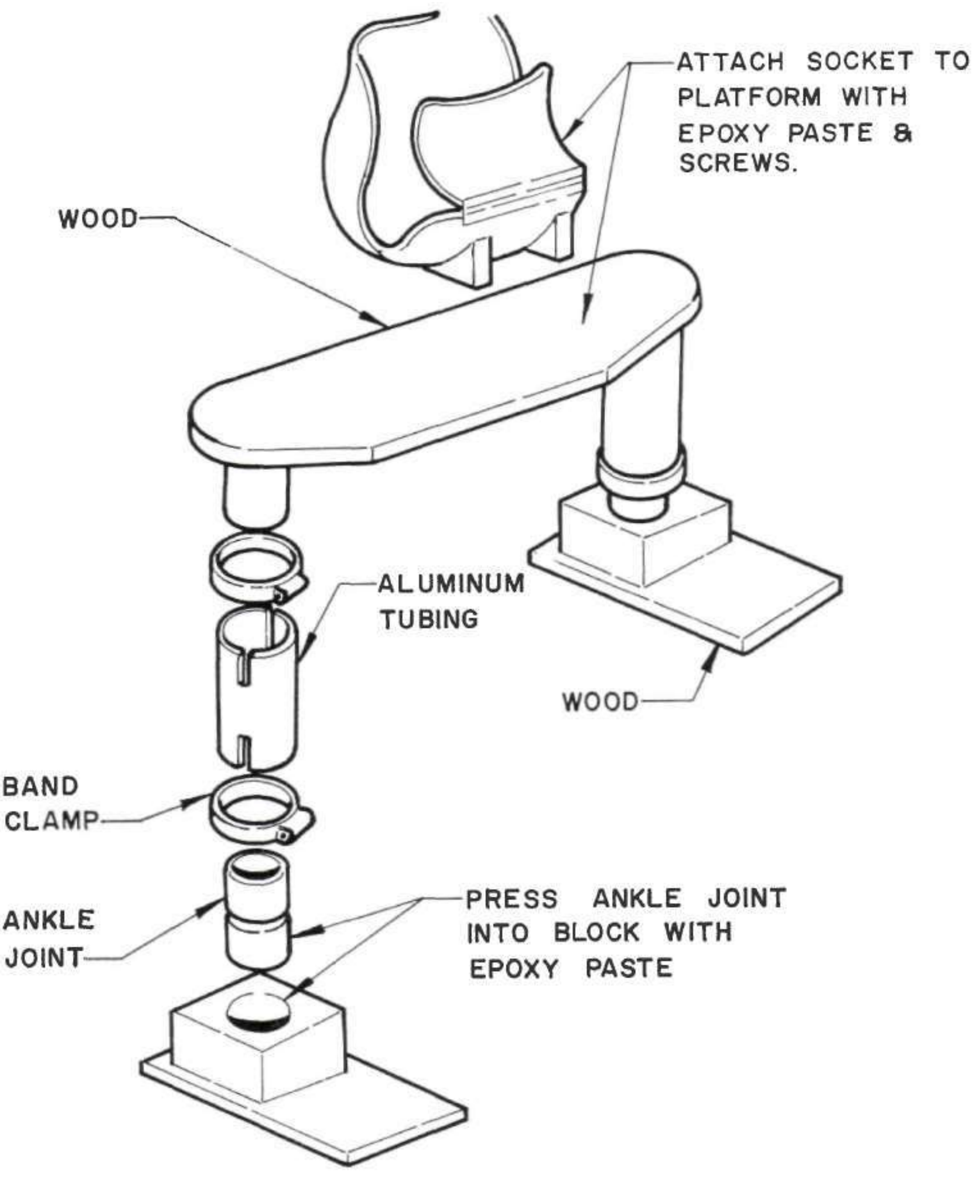

Fig. 6. Assembly of the swivel walker.

as shown in Figure 5 and all edges are rounded and smoothed. Ease of entry and exit is facilitated by an anterior hinge.

A plastic hinge with the trade name of Polyhinge is satisfactory and may be fastened with flat-head wood screws. Either polyester or epoxy paste can be applied to the screw heads to prevent corrosion if necessary.

Wooden blocks are screwed to the base of the socket to provide a level surface for mounting the socket on top of the pylon walker.

The pylons are aluminum tubing, 2-in. outside diameter, 1/16-in. wall thickness. The top ends are fitted with wooden plugs; the bottom ends are fitted over the ankle joints.

The dimensions of the pylon and its placement are based on the "normal" height of the child and are indicated in Figure 3.

An adequate method for fastening the pylons is to slit the ends and use hose clamps (Fig. 6).

ANKLE JOINT

The ankle joint (Fig. 7), mounted between the pylon and the foot piece, permits rotation of the foot piece about a vertical axis to allow forward and backward swing. As can be seen in Figure 7, the foot piece is returned to a neutral position by a spring-loaded roller. Built-in stops restrict rotation to approximately 39 deg. forward and 11 deg. backward. (It is planned that a simpler, less expensive version of the ankle joint will be available commercially in the near future.)

FOOT PIECES

The foot piece (Figs. 2 and 6) consists of a block of wood, a platform sole, and a rubber undersole. The rubber is glued to the wooden platform, which is fastened to the block of wood with glue and screws. The block is bored to receive the lower part of the ankle unit, which is held in place with epoxy resin or paste.

ALIGNMENT

The main considerations in alignment are (Fig. 2):

The center lines of the ankle joints should fall approximately 1 1/2 in. behind the center of gravity of the child's body.

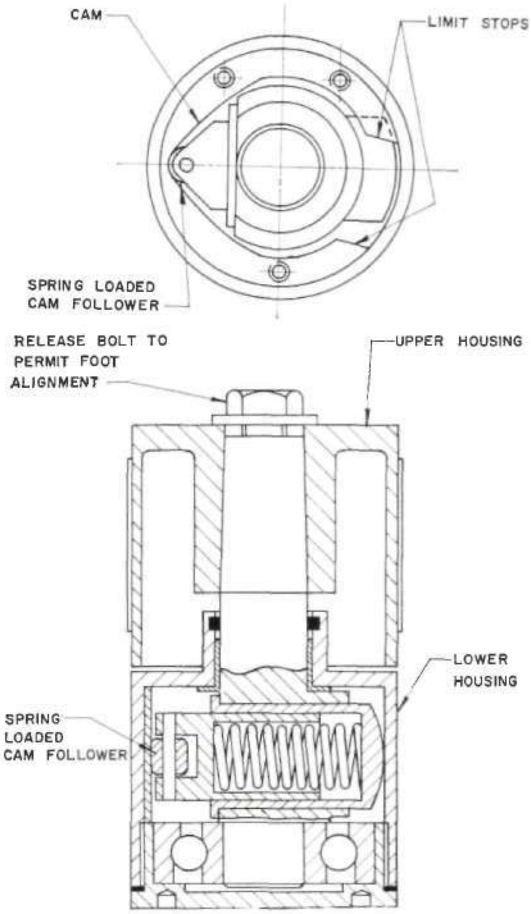

Fig. 7. The ankle unit.

When the walker is at rest, the pylons should be vertical.

The foot platform should tilt about 6 deg. and rest on the medial edge.

When viewed from above, the foot pieces are rotated out about 10 deg. (This adjustment is made by reaching down inside the pylon with an extension wrench and slackening off the bolt. This releases a tapered shaft, enabling the foot piece and lower ankle housing to be rotated to the desired position.)

THE COSMETIC SWIVEL WALKER

To improve appearance and to permit the patient to assume a sitting position, the pylons can be replaced with articulated limbs (Fig. 8).

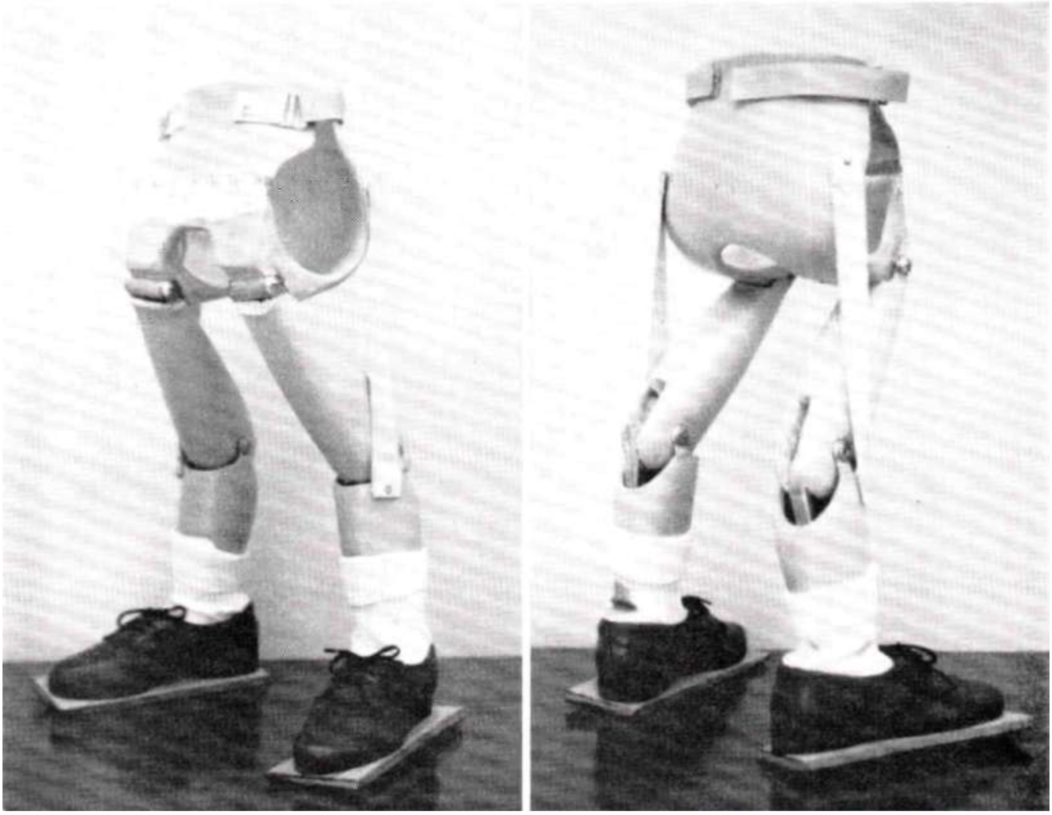

Fig. 8. Swivel walker equipped with articulated limbs to permit sitting, and fabricated to improve cosmesis.

The knee joints and hip joints are those used in a Canadian-type hip-disarticulation prosthesis, and they are aligned in a similar manner. For purposes of stability, the hip joints are placed well forward and the knee joints well back. It is imperative that the alignment between the socket and the foot pieces be identical to that used with the pylon type.

The lateral straps are 1-in. elastic webbing installed with sufficient tension to prevent hip or knee flexion when the limb is lifted clear of the floor. Each strap is attached to the socket and to the lower limb in such a manner that in the standing position the direction of pull is behind the hip joint and in front of the knee joint. In the sitting position, the straps pass in front of the hip joint and behind the knee joint.

The foot is carved from solid wood, bored out to receive the lower housing of the ankle joint. Foot pieces, used for training, are attached by screws through the soles of the shoes into the wooden feet. When the child has progressed to a point where foot pieces can be removed, screws are used to secure the soles of the shoes to the wooden feet. The shoe soles should be flat, with the same 6 deg. tilt from the medial edge.

The shank sections must be hollow so that a wrench may be inserted from the top to adjust the vertical shank bolt.

TRAINING

It is recommended that training for young children be commenced by using a lateral rocker as shown in Figure 9 to enable the child to establish balance, to learn and practice the sideways rocking motion, and to establish a rhythm. When the child feels secure in this arrangement, he is transferred to the swivel walker with short pylons and encouraged to go through the same rocking motion. At this point it is necessary to demonstrate to

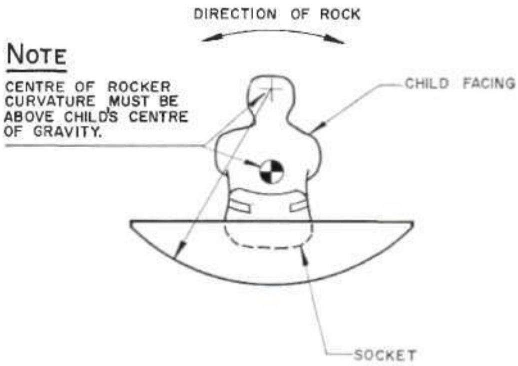

Fig. 9. Device for training patient to use the swivel walker. The lateral rocker enables the child to establish balance, to learn and practice the sideways rocking motion, and to establish a rhythm.

the child the forward swing by placing the hands on the trunk and guiding the child through the side-to-side motion coupled with a forward tilt. This support is gradually decreased until the child can manage unaided.

As proficiency in the use of the swivel walker increases, the height of the pylons is raised in 1-in. increments until a "normal" height is attained. The rate of increase will vary according to the child's capability. Experience at the Ontario Crippled Children's Centre has been that the height can be increased one inch about every two days.

At low heights body sway above the waist is required to operate the walker. As the height is increased, the child's movement alters to a lateral displacement of the hips such that the body moves sideways while remaining vertical.

When patients become proficient in the use of the walker, they do not swing the walker to the limits of the stops.

The ability to walk backward is attained with little more difficulty than walking forward, but smaller steps are generally used. One child was able to walk very well in either direction within a period of two weeks. Walking backward is important because it permits the child to back out of corners or similar situations.

Great care must be taken with the child during training, since it is possible that a few falls will occur until his sense of balance is perfected. Falls from being pushed by other children are likely to be far greater in number than those resulting from overbalancing. It is recommended that some form of protective head covering (such as an ice hockey head guard) be worn during this stage of training.

One child was fitted with the swivel walker shown in Figure 8 after she became proficient with the pylon type. Initially, the foot pieces were larger than the shoes. As proficiency developed, they were gradually trimmed in size and finally removed, leaving the shoes tilted at the same angle.

With both types of walker it was found that the children averaged approximately 120 steps per minute, each step being approximately three inches when walking forward.

Each child had to be treated individually according to his own temperament. One child was extremely nervous and frightened, and so training had to be carried on more slowly than with another child who accepted alterations readily.

From experience gained so far, it is suggested that a child who is nervous and cautious be given a period of at least one week to become used to major adjustments and alignment changes.

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