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Technical note

Multiaxial orthotic hip joint for squatting and cross-legged sitting with hip-knee-ankle-foot-orthosis

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Abstract

In view of the importance of squatting and cross-legged sitting in the activities of daily living in Asian and African countries, a multiaxial orthotic hip joint has been developed which when fitted to a Hip-Knee-Ankle-Foot-Orthosis (HKAFO) can permit the user to squat and sit cross-legged. The design consists of a modified ball and socket joint.

Introduction

The majority of the activities of daily living in India and in a number of countries in Asia and Africa are performed in squatting or cross-legged sitting positions, e.g. eating, preparing food, home making, working in the farms, sitting in meetings or religious gatherings, attending school etc. It is so much merged in the routine life style that wearing a caliper with a hip joint of the presently available designs, means a total change in life style from floor level to chair level living. This applies more so to rural schools in India, where children have to sit on the floor mat, cross-legged. Those wearing calipers can not wear them in school, thereby increasing the rate of rejection.

With the presently available designs of orthotic hip joint squatting is not possible due to the constraints on the range of motions available. Orthotic knee joints, which allow full flexion as with the human knee are available commercially, but the orthotic hip joint having movements in the various planes that are required for squatting and cross-legged sitting, is not available.

The movement of squatting in man requires about 130° flexion, 15° abduction and 5° external rotation at the hip besides full flexion at the knee and dorsiflexion at the ankle joint. During cross-legged sitting the hip moves about 90° in flexion, 45° in abduction and 60° in external rotation. The range of movements varies to some extent with the individual.

The requirements of an orthotic hip joint, which when fitted to a HKAFO allows squatting and cross-legged sitting, are as follows.

(a) It should allow movements only of flexion and extension during walking as with other orthotic hip joints.

(b) There should be no abduction-adduction or rotation during standing or walking, but these movements should come into play when one squats or sits cross-legged.

Design

As in the human hip joint, a ball and socket orthotic joint has been developed. The ball socket is connected to the pelvic band. Figure 1 shows the schematic diagram of this joint. The socket is made in two halves, secured together with rivets, to allow the ball to be contained in the socket firmly. The permitted movements of the ball in the socket are controlled by channels cut in the socket. The lower part of the socket is split to form a channel to allow the bar connected to the ball to move in the antero-posterior plane only. For this excursion of the joint, the socket is reinforced by having thicker walls at the lower part, as shown in Figure 1. The lateral half of the socket is cut open in such a way that on flexion beyond 40° the bar connected to the ball is released to let the ball move in further flexion up to 130°, abduction up to 45° and external rotation up to any angle desired.

Functionally this joint works as a simple hinge joint (uniaxial) for standing and walking and as a ball and socket joint (multiaxial) for squatting and cross legged sitting.

A vertical rod, within the socket locks the ball by slotting into a hole cut in the upper part

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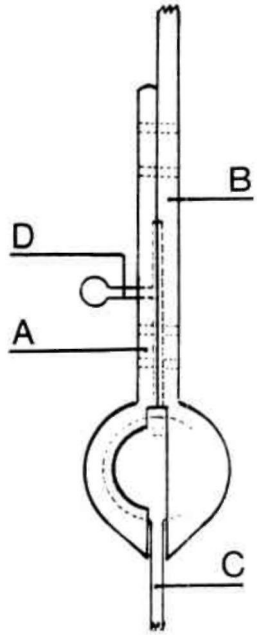

Fig. 1. Diagram of the multiaxial orthotic hip joint. A—lateral half of socket. B—medial half of socket. C—bar connecting the ball. D—lock.

of the ball. The lock is manipulated by a lever projecting through the lateral bar which comprises half the socket. If desired, a spring loaded lock can also be incorporated to facilitate locking. The mechanism locks the joint in the neutral position, when the lever is pushed down (Fig. 2).

Other modifications required in a caliper to permit squatting and cross-legged sitting are:

(i) The knee joint should allow flexion up to 165°. Such joints are commercially available.

(ii) When squatting for a long time, the knee cap may be subject to undue pressure in a few patients. This can be avoided by loosening the knee band a little on squatting, and retightening before standing again.

(iii) The ankle joint should allow dorsiflexion. A 90° posterior stop at the ankle is adequate. In those cases where this movement at the ankle is not permitted during standing or walking, an additional lock can be provided at the ankle joint, that can be opened when required. For patients finding difficulty in operating the ankle lock, its operation can be controlled by a small cable with its control lever attached to the lateral thigh bar.

Fig. 2. Patient wearing the HKAFO fitted with the multiaxial hip joint. Top—squatting. Centre—close up of the hip joint in squatting position. Bottom—cross-legged sitting.

Conclusions:

The design presented here is a concept in design. Further work for finalizing the right materials and dimensions continues. Preliminary results following clinical trial fittings were satisfactory in regard to acceptability, utility in activities of daily living, comfort of wearing and ease of operation.