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Orthotic devices and gait in polio patients

Appareillage et marche du patient poliomyélitique

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Abstract

Polio survivors are aging and facing multiple pathologies. With age, walking becomes more difficult, partly due to locomotor deficits but also as a result of weight gain, osteoarticular degeneration, pain, cardiorespiratory problems or even post polio syndrome (PPS). These additional complications increase the risk of falls in this population where the risk of fractures is already quite high. The key joint is the knee. The muscles stabilizing this joint are often weak and patients develop compensatory gait strategies, which could be harmful to the locomotor system at medium or long term. Classically, knee recurvatum is used to lock the knee during weight bearing; however, if it exceeds 10°, the knee becomes unstable and walking is unsafe. Thus, regular medical monitoring is necessary. Orthoses play an important role in the therapeutic care of polio survivors. The aim is usually to secure the knee, preventing excessive recurvatum while respecting the patient's own gait. Orthoses must be light and pressure-free if they are to be tolerated and therefore effective. Other joints present fewer problems and orthoses are rarely indicated just for them. The main issue lies in the prior evaluation of treatments' impact. Some deformities may be helpful for the patients' gait and, therefore, corrections may worsen their gait, especially if a realignment of segments is attempted. It is therefore essential to carefully pre-assess any change brought to the orthoses as well as proper indications for corrective surgery. In addition, it is essential for the patient to be monitored by a specialized team.

Keywords: Poliomyelitis; Gait; Orthotic devices; Orthosis

Résumé

La population des patients poliomyélitiques est vieillissante et polypathologique. La marche est rendue difficile par le déficit moteur induit par la maladie mais aussi la prise de poids, la dégénérescence ostéoarticulaire avec les douleurs induites, les complications cardiorespiratoires, voire le syndrome post-polio. Ces troubles de la marche sont pourvoyeurs de chutes dans une population dont le risque fracturaire est important. L'articulation clé est celle du genou. Souvent déficitaires, les muscles stabilisateurs de genou sont compensés par des stratégies de marches qui peuvent à moyen ou long terme être délétère pour l'appareil locomoteur. Le recurvatum de genou permet classiquement de verrouiller le genou lors du pas portant. S'il s'aggrave et dépasse 10°, il devient instable et ne permet plus des déplacements en sécurité. Il nécessite donc une surveillance clinique régulière. L'appareillage est le pivot de la prise en charge du patient poliomyélitique. Il s'attachera souvent à sécuriser le genou, prévenir un récurvatum excessif tout en s'inscrivant dans le schéma de marche habituel du patient. Il doit être léger sans zone d'hyper-appui pour être toléré et donc efficace. Les autres articulations sont moins problématiques et l'appareillage est rarement indiqué uniquement pour ces articulations. La difficulté réside dans l'évaluation, a priori, des retentissements du traitement proposé. Certaines déformations sont aidantes et certaines corrections envisagées, notamment celles voulant se rapprocher de la normalité anatomique, sont délétères. Toute modification d'appareillage et toute chirurgie correctrice des membres inférieurs doit être évaluée avec soins. Cette prise en charge doit être réalisée par des équipes spécialisées.

Mots clés : Poliomyélite ; Marche ; Appareillage ; Orthèse

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1. English version

1.1. Introduction

Gait in patients with polio sequelae can vary according to the pathological lesions, the age of onset of the initial acute attack (psychomotor development and growth) but also the age of the patient at the time of the consultation. In fact, in France, we are following a cohort of ''aging'' polio survivors since this pathology was eradicated at the beginning of the sixties. Nowadays, we estimate that there are 55,000 polio survivors in France [1]. Besides, the locomotor deficit and bone deformities, we also see degenerative osteoarticular lesions of the lower limbs but also on the upper limbs promoted by the use of technical aids (crutches, canes, manual wheelchair...). This generation of patient often suffers from significant weight gain (quite detrimental to functional gait prognosis), decrease in physical activity and thus underused muscles with sometimes cardiovascular risks [5] and/or sleep apnea syndrome or even a real diagnosis of post-polio syndrome (PPS) [7].

Patients develop some compensation techniques that are a real ''analytical and functional paradox'' leading to respecting deformations or bad postures that would seem harmful to the patient. Commonly, this becomes complicated especially when in their childhood patients had surgeries on various limbs: arthrodesis, osteotomy, muscle transfers... or a history of falls [4].

Another particular characteristic for the therapeutic care of these patients' gait is to make sure that there is no sensitive nerve affection. This guarantees the lack of skin lesions in case of excessive weight bearing (on the floor or in an orthotic device) but adds to the difficulty of designing a comfortable device perfectly fitted to the patient while keeping the mechanical properties of this orthosis.

Alongside maintaining or improving the gait's prognosis, the therapeutic strategy focuses on preventing falls and fractures. The risk of falling is related to the paralysis and the improper use of the limb. The basic principle is to respect the functional axis (for example by keeping or sometimes creating a knee recurvatum), prohibit the joint areas that promote falls such as knee flexion deformity. The risk of fractures is quite high in polio survivors. It is probably caused by the risk of falls (muscular command disorders) and bone fragility (decreased muscle tone of the affected segments, less loading on the affected limb, decreased physical activities, age...). This risk of fracture seems higher in these patients than in the general population [9]. For poliomyelitis, it seems to affect principally the limbs rather than the spine, the upper extremity of the humerus and the lower extremity of the femur (with patella fractures). This risk of falls can be an indication to modify an orthotic device or even prescribe a new one.

1.2. Biomechanical and kinesiological issues

1.2.1. A "key" joint for the lower limb: the knee [8]

Poliomyelitis mainly affects the knee, the triceps is more affected than the knee flexors and an isolated affection of the quadriceps is rare. It is essential to control this joint for weight bearing and gait but the knee is also the source of disorders because of the great lever arms used for resistance and the weaker lever arms for motor movements. This joint is mainly controlled by the muscles used for standing upright, the quadriceps, and a good orthopedic prognosis requires maintaining proper joint range of motion (ROM).

The first problem is often to comprehend how patients can lock their knee with a deficit in extensor muscles of this joint mainly weak quadriceps? In case of partial or complete paralysis of the quadriceps, loading on the lower limb is still possible if the gravity line is in front of the knee's axis, if the capsular and tendinous structures of the knees are resistant enough and finally if the triceps or gluteus maximus muscles are adequate. Gait on a flat surface is possible because the gluteus maximus and triceps muscles compensate the quadriceps deficit only if there is a complete passive knee extension, with a slight recurvatum. The quadriceps deficit becomes a problem when going down the stairs or walking on an uneven surface. When the gluteus maximus is weak the patient must pull backwards the thigh's axis by pushing it back with the hand or by operating a sudden extension movement of the trunk. When the triceps muscle is also weak, knee stability is bad with a risk of collapsing when the knee is in flexion. A moderate equinus deformity (10° to 20°) allows for a dynamic stability of the knee thanks to the recurvatum triggered by the tibia when the foot is flat on the floor (Fig. 1). If the triceps is paralyzed, the knee stabilization is quite difficult even with adequate

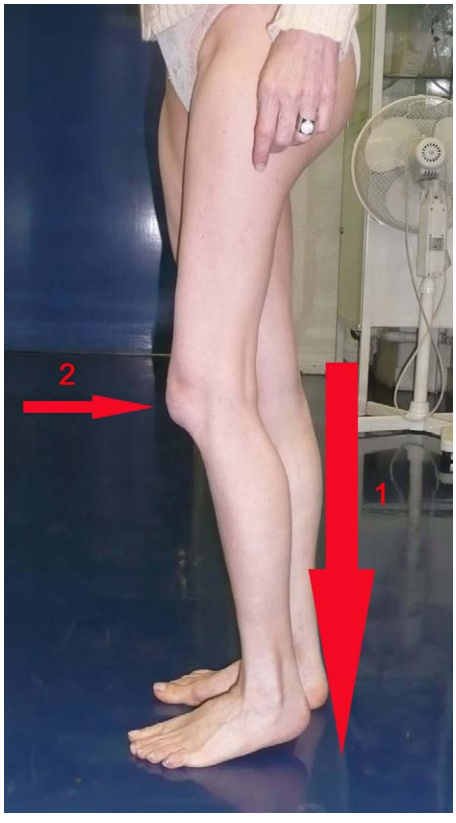

Fig. 1. Useful equinus deformity allowing stability of the knee. Heel contact lock the knee in extension.