INTRODUCTION

Hamstring muscles contracture is a major problem in the management of the cerebral palsy CP patient, being among the primary factors in causing the crouch gait which is one of the most resistant conditions to treat [1].

A rational modality in treating crouch gait is to transfer one of the distal hamstrings to just above the knee joint, and lengthen the other hamstrings. In such case, the deforming force is utilized for correction of knee flexion deformity as well as improving hip extension. The biceps femoris tendon is transferred by winding it around the lateral head of origin of the proximal gastrocnemius [2] and sutured to itself at a point which acts as a fulcrum for pulling the femur backwards, to correct knee flexion deformity and to function as hip extensor. The semitendinosus and gracilis tendons are Z-plasty lengthened. The semimembranosus is fractionally lengthened to help in the correction of knee flexion deformity, but retained without transfer to prevent genu-recurvatum. The effectiveness of the procedure weakens the hamstrings as knee flexors and potentiates their role in hip extension.

The objective of the study was to reveal the effectiveness of partial transfer of one of the distal hamstrings combined with appropriate lengthening of the remaining hamstrings in correcting crouch gait in CP diplegic, preventing pelvic tilt and hip subluxation, and avoiding the usual complication of genu-recurvatum associated with complete transfer of the hamstrings reported earlier [2].

PATIENTS AND METHODS

Twenty spastic cerebral palsy CP diplegic patients having knee flexion deformity and walking with crouch gait presented to The National Institute of Neuromotor System of Egypt, from...
January 2010 to January 2011; underwent lateral hamstring transfer and medial hamstring lengthening; and were included in this study. The results in this group, after at least three years of follow-up, were reported in January 2014 using previous medical records, history, and physical examinations.

Inclusion criteria

Patients with cerebral palsy spastic diplegia, knee flexion deformity 20° – 60°, popliteal angle > 30°, and crouch gait were included.

Exclusion criteria

Patients with mental retardation (IQ < 70), visual impairment, hearing impairment, total body involvement (TBI), and iliopsoas, rectus femoris, or gastrocnemius tightness were excluded.

Original Disease, Physical examination, and Treatment

All of the twenty patients had history of difficult delivery and incubation at the time of birth. All were spastic diplegic; no patient was hemiplegic or of the total body involvement (TBI) type. All were able to walk without support but with crouch gait; and were considered to be community level ambulators with Gross Motor Function Classification System GMFCS of level II. Each of them received non-operative treatment as physical therapy programs and skeletal muscle relaxant but no previous surgery. All had bilateral hamstring tightness with knee flexion deformity > 20° but < 60°, popliteal angle > 30°, but no iliopsoas, rectus femoris, or gastrocnemius tightness. The mean age at the time of surgery was 8.4 years (range, 7 –12 years). The patients were 10 males and 10 females.

Operative technique

The operation was performed under general anaesthesia using pneumatic tourniquet with the patient in the prone position. The two knees were approached in the same sitting by two teams of surgeons and nurses working together at the same time in order to minimize the tourniquet time. Two longitudinal parallel incisions were made in the back of each knee to expose its lateral and medial sides. The biceps, gracilis, semitendinosus, and semimembranosus were identified and exposed with care to avoid injury of the common peroneal nerve on the lateral side and the tibial nerve on the medial side. The proximal lateral head of gastrocnemius was identified and exposed. The biceps tendon was divided close to its insertion, transfereed by winding it around the lateral head of gastrocnemius, and sutured around itself (Figure 1) using 0/1 vicryl sutures. The gracilis and semitendinosus tendons were Z-plasty lengthened by suturing them together proximally and distally using 0/1 vicryl sutures, and divided at their proximal and distal ends (Figure 2). The semimembranosus muscle was fractionally lengthened by dividing its aponeurosis transversely distally and semilunar proximally (Figure 3). The wound was closed in layers. An above-knee POP cast (AKC) with the knee straight and the ankle/foot plantigrade was applied.

Postoperative care

The POP cast was changed with removal of the skin stitches after 3 weeks. Another POP cast was applied for further 3 weeks.

Physiotherapy program in the form of knee flexion/extension exercises, quadriceps strengthening exercises, and gait training was instituted after cast removal for further 1 – 3 months. Knee Ankle Foot Orthosis KAFO was applied during sleep or non-walking intervals.

Evaluation

All patients were assessed clinically; and a grading system, with a total score of 10 marks, was suggested. The preoperative values were compared to the postoperative ones regarding clinical evaluation which included the correction of knee flexion (2 marks), the decrease in the popliteal angle (2 marks), the increase in the strength of hip extension (2 marks), the
Component of crouch, is the commonest technique used to treat this condition. Hoffinger and Abou Ghaida [4] (1993) showed that the hamstrings function as important hip extensor in CP diplegics as shown by dynamic electromyography EMG.

Partial distal lengthening of either medial or lateral hamstrings [5-8] total distal lengthening [9,10] and proximal hamstrings lengthening by fractional lengthening or z-plasty [11,12] were reported.

Partial hamstring lengthening usually leads to recurrence of knee flexion deformity [13]. Whereas, total lengthening is associated with incidence of pelvic tilt [3] due to weakness of hip extensors, and genu-recurvatum [5,8].

Other method of weakening of the hamstrings is by local injection of Botulinum toxin in the hamstrings [14]. The effect of the toxin is temporarily, lasting only for a few months. The toxin injection itself is costly and is used only in spasticity but not in contracture.

Ray and Ehrlich [1] (1979) transferred the tendons of semitendinosus and semimembranosus to the lateral intermuscular septum and the tendon of Biceps femoris respectively, with good results in relieving knee flexion deformity. The procedure succeeded in correcting knee flexion deformity, but had little effect in improving hip extension.

Egger’s operation, which was total transfer of distal hamstrings to the femoral condyles without leaving any muscle to flex the knee [15], improved pelvic tilt as it would function as hip extensor. However, genu-recurvatum was the commonest complication of this operation [2]. In the original Egger’s operation, attachment of tendons to the posterior surface of the femoral condyles was technically difficult being in the deeper plane [2] and the presence of the popliteal vessels, genicular

### DISCUSSION

Crouch gait is the most resistant condition to treat in the diplegic spastic cerebral palsy [1-3]. Crouch complex consists of flexion at hip and knee and dorsiflexion at ankle [3]. Weakening of hamstrings to reduce knee flexion, which is the most important
Central technique. Both hamstring lengthening and transfer are avoided in this operation. Serious complications of diplegia are effectively relieved in cerebral palsy with spastic lengthening of semimembranosus being retained in position, is lengthening of gracilis and semitendinosus tendons and fractional pull of origin of gastrocnemius, combined with appropriate Z-plasty of femoris tendon to just above the knee around the lateral head of origin of gastrocnemius, being itself indirectly to the posterior surface of the femoral condyles through the lateral head of origin of gastrocnemius, being itself attached to the lateral femoral condyle, acting as a fulcrum to pull the femur backwards, to improve hip extension and to prevent pelvic tilt or hip subluxation. There was neither residual knee flexion deformity nor genu-recurvatum. The surgery was previously performed to avoid complications of diplegia.

**CONCLUSION**

Transfer of one of the distal hamstring, namely the biceps femoris tendon to just above the knee around the lateral head of origin of gastrocnemius, combined with appropriate Z-plasty lengthening of gracilis and semitendinosus tendons and fractional lengthening of semimembranosus being retained in position, is effective in relieving crouch gait in cerebral palsy with spastic diplegia.

The operation is technically the same as any type of distal hamstrings transfer and lengthening. Serious complications of both hamstrings lengthening and transfer are avoided in this technique.

The encouraging criteria include correction of knee flexion deformity, decrease in the popliteal angle, increase of hip extension strength, and improvement of gait quality.

**REFERENCES**


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**Table 2: Evaluation of the result.**

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<th>Case no.</th>
<th>Age (years)</th>
<th>Gender</th>
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