Genu Recurvatum Control in Hyper- and Hypo-tonic Children

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ABSTRACT

The present study aimed at comparing the effect of below knee orthosis versus knee cage on genu recurvatum control in children suffering from hypotonic or hypertonic lesion affecting lower extremities. Forty patients, with age ranging from 4 to 7 years were selected from the Out-patient Clinic of the Faculty of Physical Therapy, Cairo University. They were two groups; twenty of them had spastic cerebral palsy (I), while the other twenty patients had flaccid paralysis of lower extremities (II). All patients had genu recurvatum. Each group was subdivided into two groups of equal number, on which either knee cages (KC) or ankle foot orthoses (AFO) were applied for correction of genu recurvatum. Both groups received the same routine physical therapy program. Evaluation was made using tensiometer to evaluate hamstrings, quadriceps and gastrocnemius muscles strength and X-ray to evaluate genu recurvatum degree. Treatment of both groups continued for three successive months, three sessions weekly. Both groups showed significant reduction in genu recurvatum degree. There was also significant increase in the concerned muscles tension, except in the hamstring tension in the KC group (hypertonic) and in the AFO group (hypotonic).
***Key words**: Genu recurvatum - cerebral palsy – orthoses.*

INTRODUCTION

Cerebral palsy is the most common neuromuscular problem in children. It is a non-progressive lesion of the brain that results in abnormal control of movement and posture[20]. Dabney et al.,[3] suggested that cerebral palsy is caused by static lesion to cerebral motor cortex that is acquired before, or within five years of birth. Multiple causes for the condition exist and include cerebral anoxia, cerebral hemorrhage, infection and genetic syndromes.

Genu recurvatum is a deformity of the tibio-fibular joint, in which the range of motion exceeds 0° of extension. It is caused by weakness in the gastrocnemius muscle[7]. It begins when the tibia stops moving forward and disappears when the tibia movement is resumed[10]. Knee extensors weakness and spastic ankle planter flexors favor knee hyperextension. Genu recurvatum can be caused also by neurological dysfunction causing flaccidity of the lower extremity muscles. This leads to weakness of the quadriceps and / or hamstrings and anterior tibial muscle group[8].

Hip flexion contractures can produce hyperextension forces on the knee first[14]. This deformity contributes to the change in the load distribution on articular surfaces[1]. When the deformity gets worse, serious biomechanical changes occur which lead to weakness, pain and instability of the knee. Furthermore, it changes the quality of gait and decreases the velocity, cadence, step and stride lengths[22].

As genu recurvatum may become chronic, it has to be managed during rehabilitation by whether physiotherapy, bracing or surgery. The physical therapy techniques proposed are biofeedback[1], sensory stimulation[13], manual facilitation and

functional electrical stimulation[6]. The surgical procedure may be gastrocnemius neurectomy and correction of hip flexion deformities, tendo-achilles lengthening, bone blocking[19], flexion osteotomy of the femur[11] or proximal osteotomy of the tibia[12]. It has been strongly suggested that ankle foot orthoses (AFO) opposes the excessive planter flexor activity and keeps the ankle joint in 5° of dorsiflexion to correct genu recurvatum, without interfering with the normal knee motion[16]. On the other hand, the knee cage (KC) was recommended as the most effective method in reeducating knee control as it provides the desired protection to the joint soft tissues[4].

Aim of the study

This study way conducted to find out which is more effective; in controlling genu recurvatum in hypotonic and hypertonic cerebral palsy children, knee cage or below knee orthosis?

SUBJECTS MATERIALS AND METHODS

Subjects

A group of forty volunteer children, with ages ranging from 4 to 7 years and intelligence quotient above 60%, participated in the study. Twenty of these patients were suffering from hypotonic neurological lesion (hydrocephalus, spina bifida), while the other twenty had hypertonic CP. All of them were suffering from genu recurvatum, with no previous history of surgery, free from limitations in the range of movement of the ankle, knee or hip and were able to sit unsupported. Each group were subdivided randomly into two groups of equal number, each comprised ten patients. Groups I wore knee cage (KC), while groups II wore ankle foot orthosis (AFO). The traditional physical therapy program was applied to both groups.

Materials

Instruments used for treatment:

- Faradic stimulator: Phyaction 787 uniphy apparatus.
- Knee cage (KC): It is made up of a concave aluminum bar, extending from mid-lower leg to mid-thigh, covered with leather and secured to knee by four straps.
- Below knee orthosis (AFO): it is made up of aluminum, padded with leather and attached to the limb by four Velcro straps. The orthosis was in 5° ankle dorsiflexion.

Instruments used for evaluation:

- Plain X-ray: Siemens 8842379, Germany.
- Cable tensiometer: It shows the weight on a scale by a pointer. Two cables are attached to the scale, one on each side.

Methods

Measuring procedures:

- Plain x-ray: From a standing position on one limb, a lateral view to the knee joint was performed.
- Cable tensiometer: To measure the strength of quadriceps, hamstring and gastrocnemius muscles.

According to the measured muscle group, the position of he patient was adjusted. One cable was attached to the lower part of the moving segment by the leather collar and the other cable was fastened to a stationary object. The child was told to move the part as much as possible, while the reading of the scale was recorded.

These tests were undergone before and after the treatment program for both groups.

Treatment procedures:

Both groups received faradic stimulation and manual therapy.

- Faradic stimulation of knee flexors: One electrode was fastened on the gastrocnemius heads and the other on the skin covering the hamstring heads. The single pulse duration was 1 ms, the train time was 2 sec, while the train pause was 3 sec. The pause time was 19 msec. The intensity was increased slowly till maximum contraction of the muscle was reached. The faradic duration was 20 min in every session.
- Neurodevelopment technique: By using reflex inhibiting patterns and facilitation techniques for normal movement patterns.

The treatment session lasted for 60 min for 3 successive months, 3 times per week.

RESULTS

No significant difference was recorded between the age and IQ mean values of the two groups before the start of treatment.

As shown in table (1) and fig. (1), the mean values of genu recurvatum degrees for both groups before and after treatment were represented. For group I, the mean difference was 0.3° in the KC group, while it was 0.6° in the AFO group, showing significant reduction ($P < 0.05$). Concerning group II, the mean difference in génu recurvatum degree was 0.8° and 0.4° for the KC and AFO groups, respectively. The reduction was also significant in both groups ($P < 0.005$ for the KC group, while $P < 0.05$ for the AFO group).

Table (1): Pre and post measurement of X-ray (in degrees) in the two studied groups.

Statistical Analysis	Hypertonia (I)				Hypotonia (II)			
	KC		AFO		KC		AFO	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	14.3	14.0	13.9	13.3	14.7	13.9	14.2	13.8
SD	±1.252	±0.943	±1.370	±0.949	±1.252	±0.876	±1.478	±1.135
Difference	0.3		0.6		0.8		0.4	
t	1.964		2.250		4.000		1.809	
P	< 0.05 S.		< 0.05 S.		< 0.005 S.		> 0.05 N.S.	

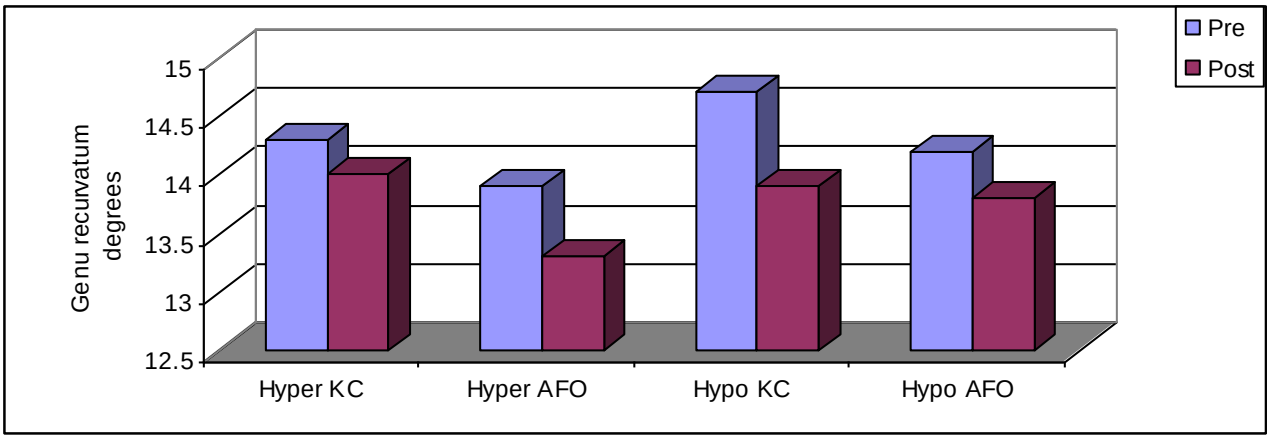

Fig. (1): Comparison between the two studied groups as regard to X-ray pre and post treatment.

Table (2) and fig. (2) show the mean values of muscle tension for the two studied groups. The mean difference in group I was 0.04 kg in the KC group and 0.06 kg for the AFO group. There was a significant increase in quadriceps muscle tension in both groups (P<0.025). For group II, the mean difference was 0.05 and 0.03 kg for the KC and AFO groups, respectively. The change in quadriceps tension proved to be significant (P<0.025 and P<0.05 in both KC and AFO groups, respectively.

Table (2): Comparison between pre and post measurement of quadriceps strength (in kg) in the two studied groups.

Statistical Analysis	Hypertonia (I)				Hypotonia (II)			
	KC		AFO		KC		AFO	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	2.82	2.86	2.83	2.89	2.54	2.59	2.57	2.60
SD	±0.225	±0.190	±0.164	±0.145	±0.165	±0.160	±0.177	±0.200
Difference	0.04		0.06		0.05		0.03	
t	2.449		2.714		2.236		1.964	
P	< 0.025 S.		< 0.025 S.		< 0.025 S.		> 0.05 S.	

The obtained mean values of muscle tension for both groups are represented in Table (3) and fig. (2). For the hypertonic group (I), the mean difference 0.04 and 0.06 kg for the KC and AFO groups, respectively, which was not significant in the KC group (P>0.05) but significant in the AFO group (P<0.025). For the hypotonic group II, the mean difference was 0.07 kg in the KC group (P<0.005, significant) and 0.03 kg for the AFO group (P>0.05, non-significant).

Table (3): Comparison between pre and post measurement of hamstring strength (in kg) in the two studied groups.

Statistical Analysis	Hypertonia (I)				Hypotonia (II)			
	KC		AFO		KC		AFO	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	1.98	2.02	1.87	1.93	1.73	0.80	1.72	1.75
SD	±0.132	±0.123	±0.200	±0.177	±0.149	±0.189	±0.156	±0.172
Difference	0.04		0.06		0.07		0.03	
t	1.809		2.714		3.280		1.152	
P	> 0.05 N.S.		< 0.025 S.		< 0.005 S.		> 0.05 N.S.	

Concerning gastrocnemius, table (4) and fig. (2) show the mean difference in muscle tension. For group I, the mean difference was 0.03 and 0.06 kg for the KC and AFO groups, respectively (P<0.05 and P<0.025, respectively significant). For group II, the mean difference was 0.07 and 0.04 kg for the two studied groups KC and AFO, respectively (P<0.005 and P<0.025, respectively significant).

Table (4): Comparison between pre and post measurement of gastrocnemius strength (in kg) in the two studied groups.

Statistical Analysis	Hypertonia (I)				Hypotonia (II)			
	KC		AFO		KC		AFO	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	1.08	1.11	1.01	1.07	0.90	0.97	0.88	0.92
SD	±0.148	±0.152	±0.120	±0.116	±0.149	±0.125	±0.132	±0.132
Difference	0.03		0.06		0.07		0.04	
t	1.964		2.714		3.280		2.449	
P	< 0.05 S.		< 0.025 S.		< 0.005 S.		> 0.025 S.	

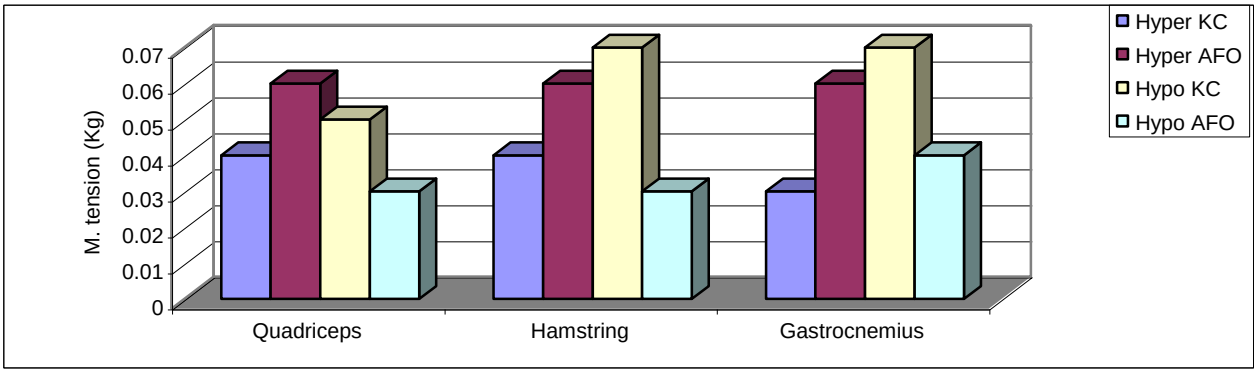

Fig. (2): Comparison between the difference between pre and post treatment of the muscle tension (in kg) in the two studied groups.

DISCUSSION

Hypertonia and hypotonia are two major characteristics of neurological lesions in children. Hypertonic CP shows the characteristics of upper motoneuron involvement (hyper-reflexia, abnormal movement patterns, weakness and loss of dexterity). On the other hand, hypotonic children due to hydrocephalus or spina bifida show an often severe depression of motor function and weakness[21].

Genu recurvatum is a commonly acquired deformity, found in many rehabilitation populations on upper and lower motoneuren pathologies[5]. Genu recurvatum becomes clearly noticed when the child starts his bipedal activities[9]. Quadriceps muscle weakness causes unstable knee during bipedal activities. To provide knee stability, the child encourages knee hyper extension[2].

The use of ankle foot orthosis in children with neuromuscular problems was reported to improve genu recurvatum[9]. On the other hand, improvement in genu recurvatum with the use of knee cage has been also reported[17]. No known research work has directly compared the effect of below knee orthosis and knee cage in correction of genu recurvatum in hyper and hypotonic cases. The present work was conducted to compare between the effects of the two orthoses in improvement of genu recurvatum in children with neuromuscular problems.

This study showed that patients of both groups had achieved a significant reduction in genu recurvatum degree when applying whether below knee orthosis or knee cage in addition to the physical therapy program.

Rosenthanl et al.,[19] and Simon et al.,[22] found that stabilizing the foot and leg by fixing the ankle joint in 5 degree of dorsiflexion,

while the foot is flat, maintains the knee in slight flexion. The below knee orthosis apposes the excessive planter flexion activity and keeps the ankle joint in 5° of dorsiflexion[6]. Below knee orthosis decreases spasticity by prolonged stretch and pressure on the tendons of the triceps surae muscles[18].

The above discussed results came in agreement with those of Nuzzo[16]. He stated that ankle foot orthosis can overcome the excessive planter flexor activity, without interfering with the normal knee movement. Moreover, Rosen and Dickinson[20] proved that ankle foot orthosis is of great help in management of genu recurvatum in spastic cerebral palsied children.

The results of the present work also coincided with the results of Farncombe[4], who recommended the knee cage as the most effective method in regaining knee control as it protects the knee soft tissues. Furthermore, Dabney et al.,[3] in their study investigated the use of knee cage in cerebral palsy patients suffering from genu recurvatum. They recorded significant improvement in genu recurvatum degree.

The results of the present study suggests the use of below knee orthosis in correction of knee recurvatum in spastic CP children as it helps of improving gait pattern. Whereas knee cage has many advantages which makes it more reliable and superior to below knee orthosis in patients having hypotonic lower limbs' muscles[15].

The present work strongly supports using short-width pulse electrical stimulation in increasing muscle efficiency. It also confirmed starting treatment as early as possible to be supported by the period of neural plasticity, which lasts for 4 years after birth[23].

Conclusion

Knee cage is recommended for patients with poor quadriceps muscle, whereas below knee is recommended for hypertonic lower limb. For the treatment of CP, hydrocephalus or spina bifida children with genu recurvatum a special physical therapy program is designed, this should be started as early as possible.

REFERENCES

1- Basaglia, N., Mazzini, P. and Bacciglieri, E.: Biofeedback treatment of genu recurvatum using an electrogoniometric device with an acoustic signal. Scan J Rehab Med; 21:125-130, 1989.

2- Carlson, W., Vaughan, C. and Damiano, D.: Orthotic management of gait in spastic diplegia. Am J Phys Med Rehabil; 76 (3): 219-225, 1997.

3- Dabney, K.W., Lipton, G.E. and Miller, F.: Cerebral palsy. Curr Opin Pediatr; 9 (1): 81-88, 1997.

4- Farncombe, P.: The Swedish knee cage, Management of the hyperextened hemiplegic knee. Physiother; 66: 33-34, 1980.

5- Fish, D. and Kosta, C.: Genu-recurvatum: Identification of three distinct mechanical profiles. Prosthet Orthot J; 10: 26-32, 1998.

6- Isakov, E., Mizrahi, J. and Susak, Z.: A Swedish knee-cage for stabilizing short below-knee stumps. Prosthet Orthot Int; 16 (2): 114-117, 1992.

7- Kendall, E., Mc Creary, E. and Provance, P.: Muscles testing and function: Baltimore, Williams and Wilkins, 1993.

8- Kerrigan, D., Deming, L. and Holden, M.: Knee recurvatum in gait: A study of associated knee biomechanics. Arch Phys Med Rehabil; 77: 645-650, 1996.

9- Knutsson, E., Martensson, A. and Grasberg, L.: Influence of muscle stretch reflexes on voluntary and velocity-controlled movements in spastic paraparesis. Brain; 120: 1621-1633, 1997.

10- Loudon, J., Goist, H. and Loudon, K.: Genu recurvatum syndrome. JOSPT; 27:361-367, 1998.
11- Mehta, S. and Murkherjee, A.: Flexion osteotomy of the femur for genu recurvatum after poliomyelitis. J Bone Joint Surg (Brit); 73:200-202, 1991.
12- Moroni, A., Pezzuto, V. and Pompili, M.: Proximal osteotomy of the tibia for the treatment of genu recurvatum in adults. J Bone Joint Surg (Amer); 74:577-586, 1992.
13- Morris, M., Matyas, T. and Bach, T.: Electrogoniometric feedback: its effect on genu recurvatum in stroke. Arch Phys Med Rehabil; 73:1147-1154, 1992.
14- Moorhead, J.: Cervical myelopathy presenting as a genu recurvatum gait disorder. Arch phys Med Rehabil., 74: 320-323, 1993.
15- Noyes, F., Dunworth, L. and Andriacchi, T.: Knee hyperextension gait abnormalities in unstable knees. Amer J Sports Med; 24: 35-45, 1996.
16- Nuzzo, R.: A simple treatment of genu recurvatum in ataxic and athetoid cerebral palsy. Orthopedics; 9: 1223-1227, 1986.
17- Ohsawa, S., Ikeda, S. and Tanaka, S.: A new mode of plastic ankle foot orthosis FAFO (11) against spastic foot and genu recurvatum. Prosthet Int., 16: 104-108, 1992.
18- Otis, J., Root, L. and Kroll, M.: Measurement of plantar flexor spasticity during treatment with tone-reducing casts. J Pediatr Orthop; 5: 682-686, 1985.
19- Rosenthal, R., Deutsch, S. and Miller, W.: A fixed-ankle, below-the knee orthosis for the management of genu recurvatum in spastic cerebral palsy. J Bone Joint Surg (Amer); 57: 545-547, 1975.
20- Rosen, M.G. and Dickinson, J.C.: The incidence of cerebral palsy. Am J Obstet Gynecol; 167:417-23, 1992.
21- Shepherd, R.B.: Physiotherapy in pediatrics.3rd ed. Butterworth- Heinemann Ltd, Oxford, pp: 110 – 144, 1995.
22- Simon, S., Deutsch, S. and Nuzzo, R.: Genu recurvatum in spastic cerebral palsy: report on findings by gait analysis. J Bone Joint Surg (Amer); 60: 882-894, 1978.
23- Wood, E.P. and Rosenbaum, P.L.: The gross motor function classification system for cerebral palsy: a study of reliability and stability over time. Dev Med Child Neurol; 42: 292-296, 2000.

الملخص العربي

التحكم في الانحناء الخلفي للركبة في حالات زيادة و قلة النغم العضلي عند الأطفال

أجري هذا البحث بهدف مقارنة تأثير استخدام قفص الركبة وجبيرة تحت الركبة في التحكم في الانحناء الخلفي للركبة في حالات زيادة أو نقص النغم العضلي عند الأطفال المصابين ببعض الأمراض العصبية، وقد شارك في هذه الدراسة أربعون طفلاً تراوحت أعمارهم من 4 إلى 7 سنوات ممن يعانون من الانحناء الخلفي للركبة ، تم اختيارهم عشوائياً من العيادة الخارجية لكلية العلاج الطبيعي – جامعة القاهرة ، عشرون طفلا منهم يعانون من زيادة النغم العضلي أما العشرون طفلا الآخرون فقد كانوا يعانون من نقص النغم العضلي، تم تقسيم كلا من المجموعتين عشوائيا إلى مجموعتين : مجموعة قفص الركبة ومجموعة جبيرة تحت الركبة ، وقد تلقت المجموعتين نفس برنامج العلاج الطبيعي ، وتم تقييم درجة الانحناء الخلفي للركبة باستخدام أشعة اكس ومقياس زوايا المفاصل اليدوي ، وتقييم قوة العضلات (العضلتين الأمامية والخلفية للفخذ وعضلة سمانة القدم) باستخدام ميزان حساس ، وقد أظهرت النتائج وجود تحسن ملحوظ في كلتي المجموعتين بالنسبة لدرجة الانحناء الخلفي للركبة، أما بالنسبة لقوة العضلات فقد لوحظ وجود تحسن ملحوظ إحصائيا في العضلات الثلاث في المجموعتين عدا العضلة الخلفية للفخذ في مجموعة قفص الركبة في مرضي زيادة النغم العضلي ومجموعة جبيرة تحت الركبة في مرضي قلة النغم العضلي ، وقد لوحظ أيضا عدم وجود فروق ذات دلالات إحصائية بين المجموعتين في جميع القياسات ، وقد أستنتج من هذه الدراسة أن أي من الجبيرتين يفيد كثيرا الأطفال المصابين ببعض الأمراض العصبية حيث أن كلا منهما يقلل من درجة الانحناء للركبة ، ويفضل استخدام قفص الركبة في حالات قلة النغم العضلي ، وجبيرة تحت الركبة في حالات زيادة النغم العضلي .

الكلمات الدالة : الانحناء الخلفي للركبة - الشلل المخي - الجبائر .