e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2022; 12 (9); 348-357

Original Research Article

Sciatic Selective Motor Fasciculotomy and Hamstring Lengthening for Spastic Knee Flexon in Cerebral Palsy in Tertiary Care Hospital, Telangana State

E. Rajendra Kumar[1], Venkateshwara Prasanna Govindappagari[2], A.K. Purohit[3]

[1]Associate Professor, Department of Physical Medicine & Rehabilitation, ESI Medical College / Hospital, Sanath Nagar, Hyderabad, Telangana

Received: 25-07-2022 / Revised: 27-08-2022 / Accepted: 26-09-2022
Corresponding author: Dr E. Rajendra Kumar
Conflict of interest: Nil

Abstract

Aim: To develop a surgical technique for relieving harmful hamstring spasticity without much deterioration in muscle power and help to improve preexisting motor functions, provide comfort and relief pain.

Material & Methods: A total of 30 patients underwent Sciatic SMF in the Tertiary Care Hospital, Telangana State. Twenty out of these 30 patients who had at least six months follow-up were included in this study.

Results: There were 30 patients who underwent sciatic and 20 patients could be followed-up. These 20 patients have been evaluated. There were 8 patients who underwent only SMF and did not require STR, while there were 12 patients who required both SMF and STR.

Conclusion: Sciatic SMF help in improving motor functions. The improvement is seen in existing motor function in most of the cases. However, maximum improvement is seen in case having good control in lower limbs.

Keywords: Selective Motor Fasciculotomy (SMF), Spastic Knee Flexion (SKF), Soft tissue release (STR)

Introduction

Cerebral palsy (CP) is a neuro developmental impairment caused by a non-progressive defect or lesion in single or multiple locations in the immature brain. This defect causes cognitive and motor impairment and possible sensory deficits that are usually evident in early childhood. The first description of cerebral palsy was done in I860 by a British surgeon named William Little [1]. He noticed this disorder struck children in early years of life causing stiff, spastic muscles in their legs, and to a lesser extent, their arms. This condition which was known for long as Little's disease is now known as spastic diplegia.

At school age, in industralised countries, the prevalence of cerebral palsy is about 2 per 1000 live births and the most common type is spastic diplegia associated with prematurity [2,3]. Overall, cerebral palsy has been observed to occur in 1.2 to 2.5 children per

1000 by early school age. Prevalence of moderate or severe congenital cerebral palsy is 1.23 per thousand, 3 yr old children [4]. CP occurs more commonly in children who are born very premature or at term. Data from Sweden on 241 children with CP indicate that 36% were born at a gestational age (GA) of less than 28 weeks; 25% at 28 to 32 weeks GA; 2.5% at 32 to 38 weeks GA; and 37% at term [5]. In an analysis of 1000 cases of CP from India, it was found that spastic quadriplegia constituted 61% of cases, followed by diplegia 22% [6]. Acquired causes of cerebral palsy constituted a significant proportion of cases. These children have gross spasticity in the lower limbs with minor deficits in the upper limb but are able to walk independently. Surgery to improve the appearance or reduce the effort of walking is best performed after the child has developed a stable gait pattern.

Aim of the Study

1. To develop a surgical technique for relieving harmful hamstring spasticity without much deterioration in muscle power.
2. The technique should help to improve preexisting motor functions, provide comfort and relief in pain.

Materials and Methods

A total of 30 patients underwent Sciatic SMF from Aug 2019 to July 2020 in the Tertiary Care Hospital, Telangana State. Out of these 30 patients, twenty who had at least six months follow-up were included in this study. Ten patients could not be interviewed and were excluded from the study. Out of the twenty patients included in this series, 12 were studied prospectively and 8 were studied retrospectively. All patients were examined by a team of neurosurgeons, physiatrists and physiotherapists.

There were 8 patients who underwent only SMF and did not require STR, while there were 12 patients who required both SMF and STR. Data evaluation of all patients was done in a serial order starting with the patient having the longest follow-up.

Inclusion criteria

1. Non-progression of neurological deficits: The diagnosis of cerebral palsy was established.
2. Harmful spasticity
3. Resistant spasticity: Children who did not respond to physical methods like physiotherapy, serial Plaster of Paris cast applications, temporary myoneural blocks and anti-spastic pharmacotherapy.
4. Trunk and limb control of varying grades.

Exclusion criteria

1. Patients with severe mental retardation
2. Patients with dyskinesias

Finally, motivation of both the patient and family were assessed. Based on the above features, following goals of surgery were determined

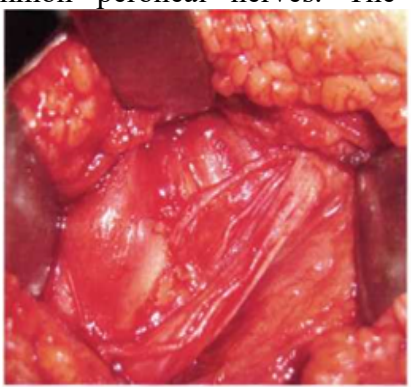
a) Patients who had reasonably good control in lower limbs were considered for motor functional improvement

b) However, in absence of good control, the goals were limited to nursing care, prevention of contractures and to obtain relief in pain and discomfort.

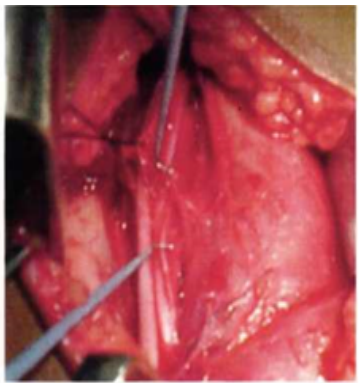
Posterior view of lower limb showing Sciatic nerve

The Sciatic (n. ischiadicus; great sciatic nerve) nerve is the largest and broadest nerve in the body and is formed by the anterior rami of L4 to S3 that converge on the anterior surface of the piriformis. The Sciatic nerve supplies nearly the whole of the skin of the leg, the muscles of the back of the thigh, and those of the leg and foot. It is the largest nerve in the body, measuring 2 cm. in breadth, and is the continuation of the flattened band of the

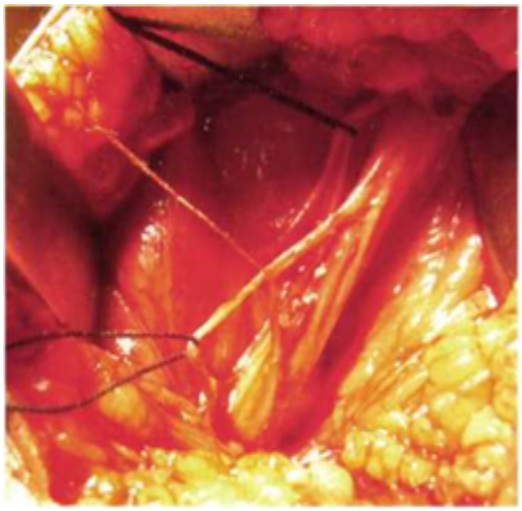
sacral plexus. It passes out of the pelvis through the greater trochanter of the femur and the tuberosity of the ischium and along the back of the thigh to about its lower third, where it divides into two large branches, the tibial and common peroneal nerves. The articular branches *(rami articulares)* arise from the upper part of the nerve and supply hip-joint, perforating the posterior part of its capsule; they are sometimes derived from the sacral plexus.



Sciatic Nerve Branches Supplying Hamstrings

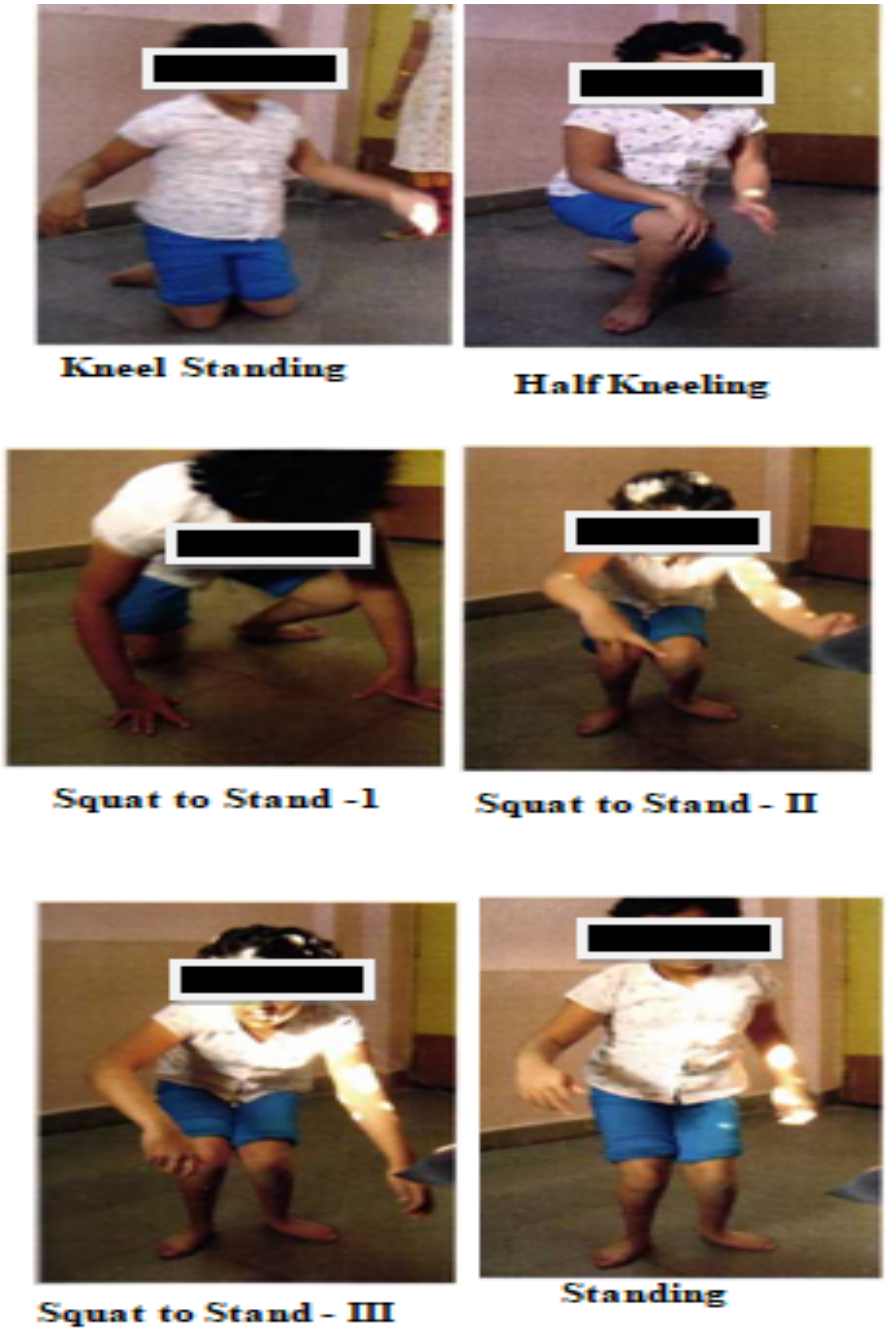


Microneurosugical Hook Electrodes Lifting Sciatic Nerve Fascicles for Stimulation Selective Motor Fasciculotomy



Sciatic Nerve Fascicles Shown Lifted on Different Colored Threads for Identification of Different Stimulation Parameters

Figure 1: Intra-operative photographs of sciatic nerve



Figurer 2: Various Stages of Functional Assessment as a Measure of Control

Results

Age, Gender and Etiology

The age group of patients ranged from 7-15 years with an average age of 13.5 years. There were 15 males (75%) and 5 females (25%) in this series. There were 12 (60%) patients who suffered from prematurity, 12 (60%) from low birth weight and 8 (40%) from delayed birth cry at birth. Three patients had all the three risk factors. Eight patients had at least two risk factors and three patients had one of the factors.

Body Topography: The topographical

distribution of patients in this series was assessed. There were 13 patients with diplegia (65%), 1 triplegic (5%), 4 quadriplegic (20%) and 2 (10%) mixed varieties.

The average duration of follow up was 54.1 months. In patients who underwent STR, the average duration of time when these patients underwent STR was 21.16 months.

APGAR score

The APGAR scores at the time of birth were assessed in all these patients. There were 9 patients who had scores in the range of 8-10, while 10 patients had from 5-7 and 1 had less than 5.

Spasticity

Change in spasticity as measured by modified Ashworth scale. Preoperative average fey in hamstrings was 3.2. Post- operative average spasticity was 1.5. Spasticity improved in all 20 patients. The improvement in spasticity in this series was statistically significant (p=0.00001).

Functional Outcome

Eighteen patients showed improvement in their ability to kneel stand, kneel walk and squat to stand following SMF. One patient deteriorated in her ability.

Voluntary

Of the 20 patients who underwent surgery, 16 (80%) patients showed improvement in their voluntary movements following SMF. 3 (15%) patients showed no improvement and one patient (5%) deteriorated in her voluntary control.

Change in Range of Motion (ROM)

All patients showed improvement in Range of

Motion (ROM) following SMF (p=0.0005) in initial follow-up. The pre-operative ROM was 20 degrees while post-operative ROM was 40 degrees. However, 4 (20%) patients showed worsening of ROM in the long term follow-up. All 12 (60%) patients who underwent STR showed improvement in their ROM**.** This improvement in STR was found to statistically significant (p=0.005).

Change in GMFS: Following SMF in 20 patients, 19 (95%) improved in their immediate Gross Motor Functional Score while 1 (5%) patient deteriorated. This improvement was found to be statistically significant (p= <0.001). There were 12 (60%) patients who underwent STR following SMF. Following STR there were 11 (55%) patients who showed statistically significant improvement and 1 (5%) patient deteriorated (P= <0.05).

Change in FIM score: Of the 20 patients, 16 (80%) patients showed improvement in their F1M score. Of the remaining four, 3 (15%) patients showed no change in their scores while 1 showed deterioration. Of the 12 patients who underwent STR, there were 9 patients who showed improvement in their FIM scores. One patients showed worsening of her score and two patients showed no further improvement following STR. The improvement in FIM scale was not found to be statistically significant (p<0.05). However, when this improvement was evaluated in diplegics. the improvement was found to be statistically significant (p=0.013).

Figure 3: Pre and post- operative photographs

Discussion

The goal of this work is to provide a scientific basis for the management of crouch gait, one of the most prevalent and troublesome abnormalities among adolescent children with cerebral palsy who are able to walk. Crouch gait is characterized by excessive knee flexion during stance, which is usually accompanied by exaggerated flexion, adduction, and internal rotation of the hip. Excessive knee flexion substantially increases the energy requirements of walking and if not corrected, can lead to chronic knee pain and joint degeneration. This is usually accompanied by hamstring muscle contractures. Multidisciplinary team approach was adopted to improve motor functions in our study. Initially, non-invasive methods were tried so as to reduce spasticity and improve control (motor functions). On observation of residual harmful spasticity, second stage ablative procedure (STR) whenever necessary was performed. This two-staged different ablative procedural methodology has helped in lesser ablation of a particular tissue (nervous or muscle), thereby reducing the chances of reduction in their functions in otherwise

normal tissue. It may not be irrelevant here to remind that in cerebral palsy damage occurs to brain and not to peripheral nerves or muscles.

Mechanism of Extensor mechanism at knee joint in normal people

The muscular body-supporting mechanism in human beings is elaborately developed. Antigravity activities of the vastus lateralis, medialis and intermedius give anterior stability while the gluteus maximus and tensor fascia lata support the lateral side of the knee through iliotibial tract. The sartorius supports the medial wall of the knee.

In cerebral palsy, however, the monoarticular body supporting muscles such as the vastus medialis, lateralis and intermedius are mostly weakened, and consequently there is hypertonicity of antigravity muscles i.e. hamstrings leading to flexion deformity of knee. Long lasting deformity leads to fixed ligamentous contracture of knee joint capsule. Many approaches have been proposed for this correction.

Surgical Procedures

A. Neurosurgical

1. Selective Motor Fasciculotomy (SMF): The motor branch of a peripheral nerve is divided in the procedure to reduce the spastic hypertonia of a muscle or muscle group. Successful peripheral Neurotomy provides permanent reduction in spasticity.

Selective motor fasciculotomy of tibial nerve for equinus gait is a well-accepted modality. However, Sciatic SMF for hamstring spasticity is relatively less practiced and there is very meagre work done on this subject.

Decq *et al* (1996) [7] performed sciatic SMF for hamstring spasticity in 11 patients. There were 9 patients with cerebral trauma and 2 patients with cerebral palsy in the study. The patients were followed up for a period of 16 months and it was noticed that spasticity improved in all of these patients.

Abdennebi *et al* (1996) [8] performed selective neurotomies in the lower limb nerves in 58 patients. Tibial nerve selective neurotomy was performed in 42 patients while in 10 other patients the hamstring branches of the sciatic nerve for hamstring spasticity were sectioned. After a mean follow- up of 4.2 years the authors noticed that regression of spasticity was noticed in 72.4 % and motor capacities improved in 65.5% of cases.

With vast experience gained in performing various neurotomies, the team in this series could select patients suffering from focal hamstring spasticity.

B. Orthopaedic

Distal Hamstrings Transfer (Egger's procedure}

Eggers in 1952 [9] reported hamstrings transfer, from the tibial condyle to the femoral condyle to correct flexion deformity, by converting the biarticular hamstrings to monoarticular hip extensors, thereby preserving the extension activity of these muscles in the hip. Bieck stated that the total transfer often resulted in a straight knee in which the flexors could not function and so stability and flexible weight bearing posture with slightly flexed knee was lost [10].

This resulted in a locked straight knee and when flexor spasticity was moderate then led to knee hyper extension or 'genu recurvatum'. Moreover, this procedure leads to serious difficulties, especially in Indian scenario where knee flexion and squatting is extremely essential for toilet and eating food. However, he advocated iliopsoas resection for hip flexion deformity.

Hamstrings Lengthening

Lengthening of the hamstrings are also commonly used for correction of flexion deformity of the knee [11]. Similarly, Hsu and associates reviewed 49 patients in whom the semitendinosus and gracilis tendons were

elongated by Z-Plasty and the semimembranosus and biceps femoris were elongated by section of intramuscular tendon for correction of crouched posture [12]. They reported that 40 of 49 patients had significant improvements in gait pattern and 18 had improvements in motor function level. In 1992, Dhawlikar [13] and associates presented 126 CP patients who had been treated with tenotomy of the semitendinosus and gracilis and aponeurotomy of the semimembranosus and biceps femoris with improved results in walking.

Twenty-four of sixty-two patients who could not walk before the procedure were able to walk about the house postoperatively. Mild recurvatum developed in ten patients, and twenty-two patients had a reoperation because of recurrence. The review of this article shows that there was high recurrence rate in the varied follow-up period of one to fourteen years. We feel the high recurrence rate was due to persisting excessive flow of impulses to muscles (spasticity).

Topography: The inclusion criteria in our study were those patients suffering from crouch gait and it is manifested only in patients having focal hamstring spasticity. In patients with focal hamstring spasticity the feet are normally unaffected or only minimally affected. Crouch gait is manifested when patients walk which is seen mostly with diplegics. However, in quadriplegics the involvement of feet is seen and therefore crouch is not manifested. There were 2 patients with generalized cerebral palsy with severe spasticity and contractures. These patients were subjected to sciatic SMF as a part of palliative measure to relieve them of painful contractures and help in better nursing.

Causative Factors: Prematurity, low birth weight and delayed cry were the most important factors thought to be responsible for cerebral palsy. However, the importance of these causative factors is debated. In this series there were three patients in whom the exact cause could not be determined as detailed records were not available. There were 12 patients who suffered from prematurity, 12 from low birth weight and 8 suffered from delayed cry at birth. There were three patients who had all three risk factors, while eight patients had at least two risk factors and three patients had one of the factors.

APGAR score: The APGAR score at the time of birth was assessed in the patients. There were 19 patients who had APGAR score of more than 5, indicating the mild to moderate effect of cerebral insult at the time of delivery. There was only one patient who had APGAR score of less than 5 indicating possibility of severe cerebral insult at the time of birth and the child presented with quadriplegia with mental subnormality.

Spasticity: Children with harmful focal resistant spasticity involving hamstrings were subjected to Sciatic SMF. Significant improvement in spasticity was seen in all the patients. The average spasticity of these patients was 3.2 (modified Ashworth Grade) pre-operatively. The average spasticity was 1.5 post-operatively. There were two patients who had severe spasticity and were bed ridden. Spasticity in these two patients reduced from 4 to 2 in one of them and from 4 to 3 in another patient (modified Ashworth Grade). There was another patient who had spasticity recovery from 4 to 3. Surgery was performed as a palliative measure to prevent complications and to aid in nursing. In this series, there were 16 patients who were ambulatory before surgery indicating good control in them. Nociception because of spasticity was an important limiting factor for ADL, ambulation and for assessment of spasticity in these patients. Improvement in spasticity following SMF had a concomitant improvement in nociception and improved functional outcome in terms of ADL and ambulation.

Range of Motion (ROM): There was an improvement in Range of Motion (ROM) in all of these patients following SMF during the initial six months period. The average ROM was 20 degrees pre-operatively and increased to 40 degrees post- operatively. The preoperative restriction in ROM may also be due to nociception in addition to spasticity as discussed earlier.

Upon further follow-up, 5 patients presented with complaints of decrease in ROM following an initial improvement. This corresponded with their growth spurt leading to contractures. Soft tissue release in these patients showed increase in their ROM. Intervention by SMF at the peak of growth spurt (rapid increase in height) relieves nociception and increases ROM, decreases fatigue and improves functional outcome and prevents complications.

GMFS: There was an improvement in GMFS in 19 patients following SMF during an initial six-month period. Of these 19 patients, 16 had good control pre- operatively and were ambulatory. They presented with complaints of spasticity associated nociception and deteriorating GMFS. In these patients, SMF relieved spasticity which reflected in improved GMFS.

Two patients underwent simultaneous soft tissue release along with SMF as they were suffering from severe spasticity associated with contractures and were bed ridden. Following sciatic SMF, there was marked improvement in GMFS of the lower limbs. However, it was also observed that there was also an improvement in these patients of their prehensile movements. This emphasizes the fact that correction of focal spasticity improves their overall functions. Upon further follow-up, 5 patients presented with complaints of pain and started to show a downward trend in their GMFS. When this deterioration was analyzed, it was found to be corresponding with their growth spurts. Hamstring contracture was found to be primarily responsible for this deterioration in GMFS. When these patients were interviewed it was noticed that they had considerably neglected the physiotherapy aspect. This one patient showed deterioration, which may be due to poor control or due to over correction by soft tissue release.

FIM Score: There was improvement in FIM scale following SMF in 15 patients in the initial six-month follow-up period. Of the remaining five, two patients had poor preoperative status. They underwent simultaneous soft tissue release to facilitate better nursing as discussed earlier. Two other patients showed improvement in GMFS and spasticity, but this did not reflect in improved FIM scale. One patient deteriorated in her FIM scale following SMF. Sciatic SMF was performed in her as she developed complications following a trial dose of baclofen as discussed above.

On further follow-up, six patients who initially showed improvement presented with deterioration in their FIM scale. This corresponded with their growth spurts and hamstring contracture was the cause of deterioration. Soft tissue release was performed in these patients and five out of six showed marked improvements in their FIM scales. One patient showed worsening of her scales which may be due to poor control or due to over correction of her soft tissue release as explained earlier.

Conclusion

1. Sciatic SMF is helpful in relieving spastic hypertonia in all the cases and can produce normal tone in a few cases.
2. Most cases who have mild residual spasticity following sciatic SMF, if any continue to perform therapeutic exercises and/or able to walk to certain extent (having good control) eventually develop normal tone.
3. Following sciatic SMF, no recurrence in

spasticity occurs with an average followup of 5.6 years (maximum follow- up of 10 years).

4. Sciatic SMF helps in improving motor functions. The improvement is seen in existing motor functions in most of the cases. However, maximum improvement is seen in cases having good control in lower limbs. They can even have a gain in motor functions.
5. Following an average follow-up of 18 months or more of sciatic SMF, some cases require hamstring lengthening. This is required in whom the contracture does not improve, residual spasticity and spurt of growth contributes to motor function deterioration. However, in some cases it is indicated for comfortable fitting of orthotic devices.
6. Spastic diplegics and other topographical (quadricplegic and generalized) varieties of spastic cerebral palsy naturally deteriorate at the time of growth spurt. The deterioration is seen earlier in females compared to males. The deteriorations are in the form of motor functions and worsening of pain and discomfort. The cases who have spastic knee flexion may benefit from sciatic SMF.
7. Following sciatic SMF, mixed pathophysiological variety of cerebral palsy patients do not show any motor function improvement.
8. Following sciatic SMF. Generalized topographical variety of cerebral palsy patients do not show much motor function improvement.

References

1. Little WJ. The course of lectures on the deformities of the human frame. Lancet 1843; 1: 318-322.
2. Paneth N, Hong T, Korzeniewski S. The descriptive epidemiology of cerebral palsy. Clin Perinatol. 2006 Jun; 33(2): 251-67.
3. Stanley FJ, Blair E. Why have we failed to reduce the frequency of cerebral Palsy? Med J Aust 1991 May 6; 154(9): 623-6.
4. K.C. Kuban, Alan Leviton. Cerebral Palsy. N Eng J Med 1994;330: 188-195.
5. Hagberg B, Hagberg G, Beckung E, *et al*. changing panorama of cerebral palsy in Sweded VIII. Prevalence and origin in the birth year period 1991-94. Acta Paediatr. 2001;90: 271-277.
6. Singhi PD, Ray M, Suri G. Clinical Spectrum of Cerebral Palsy in North India – An Analysis of 1000 cases. J Trop Pediatr 2002; 48: 162-166.
7. Decq. Cuny E, Filipeti P, feve A, keravel Y. peripheral Neurotomy in the treatment of spasticity. Indications, techniques and results in the lower limbs. Neurochirugie. 1998 Sep;44(3): 175-82
8. Abdennebi B, Bougatene B. Selective neurotomies for relief of spasticity focalized to the foot and to the knee flexors. Results in a series of 58 patients. Acta neurochir (Wien). 1996;138(8): 917-20.
9. Eggers GW. Transplantation of hamstring tendons to femoral condyles in order to Bone Joint Surg Am. 1952 Oct; 34A(4): 827-30
10. Bleck EE, Management of hip deformities in cerebral palsy: Curr Pract Orthop Surg. 1996;3: 75 – 124.
11. Thometz J, Simom S, Rosenthal R. The effect on gait of lengthening of the medial hamstrings in cerebral palsy: J Bone Joint Surg Am; 1989 Mar;71(3): 345-53.
12. Hsu LC, Li HS. Distal hamstring elongation in the management of spastic cerebral palsy: J Pediatr Orthop. 1990 May – Jun;10(3): 378-81.
13. Dhawlikar SH, Root L, Mann Rl. Distal lengthening of the hamstrings in patients who have cerebral palsy. Long term retrospective analsysis. J Bone Joint Surg Am. 1992 Oct;74(9): 1385-91.