Research Paper Medical Science

Functional Outcomes of Correction of Spastic Equinus Deformity by Distal Gastrocnemius Recession

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ABSTRACT

BACKGROUND: Spastic equinus contracture is the most common deformity of the lower extremity in children with cerebral palsy. The optimal treatment of the ankle equinus is a widely debated topic and procedure selection is often based on surgeon preference due to lack of consensus regarding the superiority of a single procedure.

AIM OF THE STUDY: To assess the outcome parameters of correction of equinus deformity by Gastrocnemius Recession

MATERIALS AND METHODS: A total of 11 legs were included in the study with mean follow up of one year. The parameters being evaluated were popliteal angle, ankle dorsiflexion and plantarflexion range, Modified Ashworth score, GMFCS, motor power and pain score.

RESULT AND CONCLUSION: The results of surgical treatmentwere satisfactory. The mean followup was 12.2 years. Mean Passive ankle dorsiflexion increased significantly after the treatment being 12 ° at 6 weeks.Evaluation of spasticity showed reduction of at least one grade in 18.18% of patients. GMFCS level showed insignificant change (p>0.05). Mean pain score was 2.27 at day 1. The current study reports good short-term results following GR in appropriately selected children with spastic equinus deformity.

KEYWORDS : Equinus; Spasticity; Cerebral palsy; Gastrocnemius recession

INTRODUCTION

Spastic equinus contracture is the most common deformity of the lower extremity in children with cerebral palsy[1]. Contracture of the gastrocnemius, predominantly, and the soleus muscles are responsible for the equines deformity[2]. Inadequate opposition from the anterior tibial musculature results in a dominance of the spastic triceps surae (TS), which can in time lead to soft tissue contractures and bony deformities with decreased joint range of motion[3].

Aims of treatment are to achieve a plantigrade, cosmetically acceptable foot of near normal shape and mobility and to maintain the achieved correction. Numerous methods have been used for correction of deformity including surgical as well as nonsurgical techniques. Non operative methods include serial corrective castings, stretching exercises, night splints, heel lifts, botulinum toxin-A, pulsed shock wave therapy etc. Surgical methods include tendoachilles lengthening, gastrocnemius recession, percutaneous tenotomy, neurectomy, heel cord advancement and other bony procedures. After correction of deformity, an orthosis can be prescribed and worn for many months afterwards to maintain the position. An Ankle Foot Orthosis (AFO) or knee-ankle-foot orthotic (KAFO) is commonly used.

Aim of this study was to assess the outcome of surgical correction of equinus deformity by V-Y Plasty (Gastrocnemius Recession)and to assess functional improvement.

MATERIALS AND METHODS

The prospective study was done in a tertiary care teaching institution. A total number of 50 consecutive subjects were diagnosed as spastic equinus, out of which 31 responded to conservative methods. Surgical management was needed in 19 subjects out of whom11 were treated with gastrocnemius recession. The decision-making between tendoachilles lengthening and Gastrocnemius recession (GR) was based on the results of physical examination (including the Silfverskiold test) which was performed under anaesthesia. A positive Silfverskiold test was indication for GR procedure.Inclusion Criteria used for enrolment of subjects were Patients having a documented diagnosis, confirmed by physical examination, Spasticity present over foot region, Patient age between 1 years and 18 years, Ability to stand/walk , with or without support, Mental status normal or below normal but able to follow instructions and informed consent of parents.

Exclusion Criteria included Disorders of movements such as hereditary spastic paraplegia, dystonia or ataxia, Severe muscle disorders like arthrogryposis multiplex, myelodysplasia, Previous corrective orthopaedic surgery, Previous selective dorsal rhizotomy or the administration of intrathecal baclofen, Severe asymmetrical fixed deformity of spine or scoliosis(Cobb's angle > 20 °), Limb length discrepancy >2.5 cm, Dislocation of hip, Any sensory loss in the foot, Cases having spastic adductors / flexors contractures of hip, Any physical conditions, disease, or disorder that would exclude subject from being a candidate for elective surgery.

Demographics, previous treatments, details of surgery, and follow-up results were obtained from a review of patient charts. All patients were evaluated in the outpatient clinic at scheduled follow up periods.

Assessment Parameters included Passive and Active ankle dorsiflexion at full knee extension and at 90° knee flexion, Ankle Plantar Flexion And Dorsiflexion Power using the Medical Research Council (MRC) grading system, Pain Score as visual analog scale (VAS), Spasticity Grade using Modified Ashworth Scale(MAS), Improvement In Gross Motor Functional Classification System (GMFCS) Level.

Subjects were treated with gastrocnemius recession (GR) by Vulpi-

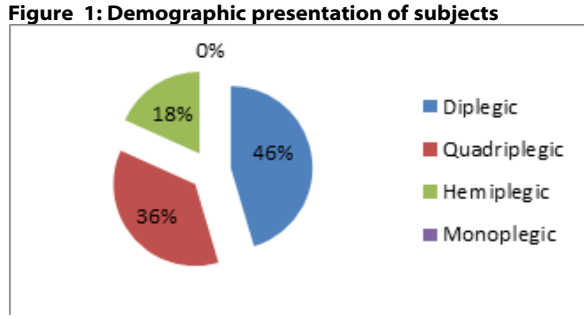
ustechnique (division of the aponeurotic tendon of the gastrocnemius and soleus just below the middle of the leg giving an inverted V shaped incision, leaving the underlying soleus muscle fibres intact). Each affected limb was considered a case and analyzed. The Bohannon modification of the Ashworth score[4] was assessed. The evaluating authors were the same in all cases and they were familiar with the preoperative and postoperative status of the patients. Measurements were made using a goniometer, by aligning one limb of the goniometer parallel to the long axis of the limband the other limb parallel to the sole of hind part of the foot. The angle 0 was measured when both the limbs of the goniometer overlapped and 90 degree when foot was in neutral. Thus, all the dorsiflexion range measured less than 90 degree and plantarflexion range measured more than 90 in the continuum. All statistical analyses were performed on STATISTICA software (Windows version 6.0). Data were summarized as Mean ± SD. A two-sided (α=2) p values less than 0.05 (p<0.05) was considered statistically significant.

OBSERVATIONS AND RESULTS

The current study assessed the outcome of Gastrocnemius recession in children with spastic equinus deformity. The improvements were significant. Mean age of patients was 5.45 yr. Male to female ratio was about 2:1. Illiteracy of caregivers was profound in study population; with high percentage 72.72 % not educated beyond primary schoolingwhich also was the most likely reason to undergo delayed treatment. Etiological basis of majority of the subjects was found to be hypoxic ischaemic encephalopathy(45.45%) followed by preterm (36.36 %) and infections (18.18 %).

Most common type of CP seen was diplegic type (45.45%), quadriplegic (36.36%), followed by hemiplegic (18.28%). No patient was found to have monoplegia.

Figure 1: Demographic presentation of subjects



Mean Passive ankle DF in Knee extension angle increase significantly after the treatment at 6 week was evident 18.45°(20.50 %). Mean Active Ankle DF in Knee extension angle showed insignificant increase (F=2.67, p=0.08) and effect of treatment at all post-operative periods.

TABLE 1: Range of motion changes in study group at time intervals

	KNEE EXTENDED				KNEE FLEXED TO 90 DEGREE			
	PRE OP (MEAN ± SD)	POST OP AT 6 WEEK (MEAN ± SD)	POSTOP AT 1 YR (MEAN ± SD)	P value	PREOP (MEAN ± SD)	POST OP AT 6WEEK (MEAN ± SD)	POST OP AT 1 YR (MEAN ± SD)	P value
PASSIVE DORSIFLEXION	100.64 ± 5.16	78.00 ± 8.45	84.27 ± 7.49	<0.001	89.82 ± 4.94	69.45 ± 9.34	77.45 ± 10.27	<0.001
ACTIVE DORSIFLEXION	108.45 ± 14.03	95.73 ± 16.64	101.90 ± 14.70	<0.001	102.09 ± 10.33	87.64 ± 17.93	94.18 ± 16.49	<0.001

Evaluation of spasticity according to Modified Ashworth Score showed insignificant effect on grading (F=4.05, p=0.009). Reduction of at least one grade was seen in 18.18% of patients. Spasticity did not change significantly with surgical procedure. GMFCS level showed insignificant change (p>0.05).

The results were satisfactory in our study with good healing in all surgically treated patients. No infection or scar complications occurred in any of the 11 surgically managed subjects. Mean pain score was 2.27 at day 1 but difference was not statistically significant (p=0.336). We found good parent satisfaction and compliance to treatment (dropouts being nil). In our study, recurrence rates were found to be nil in the short follow up period of one year. No case of postoperative calcaneus was seen.

DISCUSSION

Numerous procedures have been used in the treatment of equinus contracture with variable success rates. The surgical management of the ankle equinus is a widely debated topic and procedure selection is often based on surgeon preference because there is no consensus regarding the superiority of a single procedure.

The recurrence rates in the literature ranges from 0% to 50 %, depending on the type of the patient and length of the follow up. Over lengthening of the gastrosoleus should be avoided because it can cause weakness in push off and crouch gait. Because over lengthening is much less common with a gastrocnemius recession , surgeons prefer this procedure and reserve TendoAchilleslengthening for patients with severe equinus deformities that cannot be corrected by recession .

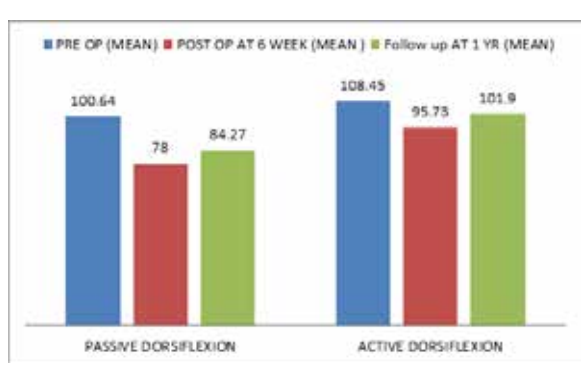
The current study demonstrates improvements in both static and dynamic measures following surgical lengthening of the triceps surae in children with spastic equinus deformity. The improvements are significant.

In our study, it was seen that the mean age of patients was 5.45 year. It seems that gastrocnemius is involved earlier than soleus in pathological process of contracture formation due to spasticity. This difference may be due to the length of the musculotendinous unit, activity level of muscle and role in gait and balance.

It was seen that illiteracy was profound in study populationwhich also was the most likely cause to undergo delayed treatment. Other important reasons for delay in seeking medical advice are financial constraints and lack of awareness. Although financial constraints cannot be resolved to a major extent in a short time, negative impacts of financial constraints and lack of awareness can be addressed by setting up specialised cerebral palsy clinics at district and tehsil levels and launching awareness programs to be conducted in these distant rural settings as well as improved mother and child care services to decrease the etiological factors. Awareness should be created not only for disease aspects, but also about facilities offered by the government and help them avail them to the fullest.

The study showed that the mean Passive ankle DF in Knee extension angle increase significantly after the treatment and at final evaluation was evident at 22.25° (20.9%). The comparison of mean Active Ankle DF in Knee extension angle showed insignificant (F=2.67, p=0.08) effect of treatment, that is, not improved significantly. This indicates minimal effect of management procedures on muscle power.

Figure 2 : Changes in ankle dorsiflexion angles at various time intervals.



Evaluation of spasticity according to Modified Ashworth Score showed insignificant effect on grading (F=4.05, p=0.009). Reduction of at least one grade was seen in 18.18% of patients. Spasticity did not changed significantly with surgical procedures. Similar results were reported by **Kay et al (2004**). **Vlachou et al (2009)** reported that Ashworth scale was reduced by at least one grade in 78% of subjects reduction of spasticity in the triceps surae group of the children with preoperative Ashworth 3 and above. Such difference in results may be due to differences in initial status of patient, age at which surgery performed, amount of contracture present in treated muscle groups, stretch ability of muscle / soft tissues in that region. Further, **Kay et al (2004)[11],** (n=55) found mean postop change in spasticity differed in GR group (Kay- 1.6, ours- 0.18). Thus, it can be concluded that although surgical lengthening procedure have a decremental effect on spasticity, further evidence is required with increased sample size and longer follow up.

Comparing the mean GMFCS grading in our study, we found insignificant change in grade (p>0.05). It is rather clear that the reduction of spasticity, as well as, the responsiveness of the patients to the surgical intervention are strongly related to the preoperative passive and active range of motion of the joints, the structure of the muscle (length of muscle fibre, length of tendon, pennation angle), the preoperative level of spasticity, the baseline of GMFCS level and the age of the patient. **Abel et al[13] (1999)** reported improvements in walking ability and stride length at 6 months after surgery and were maintained at two years after surgery, but the overall score of the GMFM (Gross Motor Function Measurement) level showed minimal change. Similar trend in GMFCS was seen in our study too with change in GMFCS level being insignificant at p>0.05.

The results were satisfactory in our study with good healing in all surgically treated patients. No infection occurred in any of the 11 subjects. Qualitative parent satisfaction and compliance of caregivers and patient were assessed at each visit in follow up. We found good parent satisfaction and compliance to treatment (drop-outs being 0). **PJ Flett et al[16] (1999)** stated that there is increasing evidence that patient satisfaction has a significant influence on the effectiveness of services: greater satisfaction with health services is associated with better treatment compliance, less premature 'drop-out' from treatment, and less delay in seeking further treatment. However, the parents in our study consistently pointed out preference for a single event effective treatment and about the inconvenience of plaster for child handling, especially toileting and bathing.

In our study, recurrence rates were found to be nil at mean follow up period of one year. This may be due to limitation of our study with very short follow up period.**Rattey et al (1993)[14]** reviewed 57 patients with 77 tendoachilles lengthening surgeries and after follow up of 10 yrs reported half of children 3 years old or younger at the time of surgery had a recurrence of deformity compared with no recurrence in children who were at least 6 years old at the time of initial procedure. **Olney et al (1988)[15]** reported 48% recurrence after GR if surgery was performed before five years of age. **Craig et al (1976)[11]** reported 9 percent recurrence in 100 limbs operated by GR in spastic equinus cerebral palsy children. Recurrence was 11 percent in 0-5 yr, 4.3 % in 6-10 yr and no recurrence found in 11-15 yr age groups. These reports are in compliance with our study results. Assumptions can be made that the rate of recurrence in surgical correction of equinus deformity decreases as the age of child increases and can be used in planning of timing of surgery and procedure. Early surgery may have an unpredictable outcome and recurrent equinus is related to the age of surgery[7,8,14]. **JC Borton et al (2001)[8]**reported sharp rise in good results and a dramatic fall in poor calcaneus results in those over eight years at surgery. In patients undergoing surgery at over eight years there was a good outcome in 70% and a calcaneus outcome in 17% compared with 37% and 46%, respectively, in those under eight years (p = 0.046). Further, they recommended preoperative gait analysis, postponing surgery until after the age of eight years, carrying out simultaneous proximal lengthening of the hamstrings and psoas when appropriate, and using a selective gastrocnemius lengthening procedure in spastic diplegic patients.

CONCLUSION

We conclude that conservative method used by us in our study is a useful method to postpone surgery in younger children until they grow up to age group of favourable outcome. Conservative methods are rapid, cheap and dependable method for correcting dynamic or mildly fixed equinus in young children. Intensive physiotherapy is indispensable after all the procedures to maintain correction and can be a useful adjunct to neurodevelopmental therapy programme to facilitate motor skills in children with cerebral palsy.

Treatment of the spastic patient requires a team approach. For the spastic patient, particularly in dealing with lower extremity deformities, it is felt that a trial of conservative management may be given before any surgical procedure to assess compliance with post-operative program by the patient and to get an idea as to whether cooperation can be expected for proper post-operative care. These results suggest that GR is a good treatment method in appropriately selected patients. The results of this study, however, do not allow a generalization to all patients in whom such selection criteria are not utilized.The current study reports good short-term results following GR in appropriately selected children with spastic equinus deformity. We suggest that the physician decide between the procedures based on CLINICAL evaluation.

LIMITATIONS

Strength of our study was prospective consecutive enrolment of subjects, a uniform treatment protocol and careful follow up. Weakness of study was a small sample size and short follow up period (1 year).

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