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EMG Guided Selective Tibial Neurectomy in Reduction of Gastro-soleus Spasticity - its Role in the Treatment of Cerebral Palsy

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Abstract :

A study to find out effectiveness of EMG guided selective tibial neurectomy in spastic cerebral palsy patients and also to ascertain the optimal age for this surgery was conducted on fifty one patients (M-35, F-16), age ranging from 2 to 8 years ,during the period from January 1991 to December 1999. EMG guided selection and neurectomy of the branches of tibial nerve supplying gastrocnemius muscle in the popliteal fossa was performed. Results were graded as good, fair, and poor according to a set of dynamic and static tests. Out of 51 cases, 27(52.94%) were graded as good, 27(23.94%) as fair, 6(11.76%) as poor. There were no major intra-operative and post-operative complications in the series. Optimum age was found to be between 3 to 4 years. EMG guided selective neurectomy of tibial nerve was found effective in relieving gastro-soleus spascity in 85.88% cases studied, thereby helping to carry out neuro developmental exercises for the treatment of cerebral palsy.

Key words : Cerebral Palsy (CP), Spasticity, Equinus, Gastrocnemius, Tibial neurectomy

Introduction

Spasticity, the commonest manifestation in Cerebral Palsy patients hinders motor development, nursing care, and often leads to contracture formation within the long standing cases. Gastro-soleus spasticity is the primary problem that hampers standing balance and normal gait pattern, which are the major concern of the patients. Conservative management such as exercises, physical therapies, orthoses, and medicines are not generally effective to give a permanent relief.

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There are many orthopaedic procedures for reducing gastro-soleus spasticity for a longer duration. They are; a) intra muscular injection of phenol/ alcohol either at the motor point or muscle bulk[1,2,] b) intra-neural infiltration of phenol/alcohol in the tibial nerve[1,2,] c) injection of botulinum toxin in gastro-soleus muscle[3,4,] and d) neurectomy of tibial nerve in the popliteal fossa[5,6]. The first three procedures are effective in reducing spaticity for a period of weeks to months. Their effect is temporary and their efficacy cannot be ascertained with a degree of certainty. Botulinum toxin is very costly and at present it is out of reach of majority of Indian patients, though this injection also results

in definite degree of reduction of spasticity. Moreover, neuro-surgical methods, intra-thecal baclofen[7,8] and selective dorsal rhizotomy[9,10] are also used to reduce spasticity. These procedures can only be done in advanced centres; hence they are out of reach for majority of our patients. Neurectomy of branches of tibial nerve to gastro-soleus muscles results permanent reduction of spasticity in these muscles.

This study was conducted to find out effectiveness of the EMG guided selective neurectomy of tibial nerve in spastic cerebral palsy patients and also to ascertain the optimal age at which tibial neurectomy should be done.

Materials and Method

Subjects : Study subjects included Cerebral palsy patients, who attended the Department of Physical Medicine and Rehabilitation, Regional Institute of Medical Sciences, Imphal during the period from January, 1991 to December, 1999. There were 513 patients in total; of which 258 were diplegic, 136 were hemiplegic, 59 were quadriplegic, 46 were triplegic and remaining 17 were monoplegics. About 79% of these cases were spastics. Neuro-developmental exercises to improve neck holding, sitting and standing balance, etc. were started depending on their developmental milestones. Passive range of mobilization exercises; reflex inhibitory positions to reduce spasticity were started. Tendo achiles stretching exercises were instituted specially for gastro-soleus spasticity. In those cases in which conservative treatment is not yielding satisfactory result, a trial of injection phenol or alcohol either in the nerve or muscle (alcohol) was given. In 24 cases, Ankle Foot Orthoses were tried to keep ankle and foot in neutral dorsiflexion

Fifty one cases (35 males and 16 females) were selected for selective tibial neurectomy. Age ranged from 2 to 8 years (mean- 3.84). Age distribution is given in Table 1.

Table 1 : Age distribution (N = 51 , M-35, F-16)

Age Group	*Number*	*Percentage*
2 - 3	11	21.56
3 - 4	18	35.29
4 - 5	12	23.52
5 - 6	8	15.68
6+	2	3.92

Inclusion criteria for the study were : a) spastic diplegic and hemiplegics who failed to respond to non -operative treatment to reduce spasticity, b) Spasticity grade II and III(modified Ashworth scale), c) presence of ankle clonus, d) presence of sitting balance, e) no structural tightness of tendo-achiles, hamstrings, adductors of hip ,etc. Exclusion criteria were; a) triplegic and quadriplegic patients, b) patients with associated mental retardation, hearing and visual impairment and systemic diseases.

Procedure : After proper antiseptic/aseptic precautions and under a mid thigh pneumatic tourniquet, a horizontal incision 5cm - 7.5cm long was made at the popliteal crease. Gastrocnemius were exposed. The plane between two gastrocnemi was deepened and retracted to expose the tibial nerve, which lies in the superficial plane to the posterior tibial vessels. Tibial nerve was properly isolated from the vessels and was held up with a strip of gauge. Muscular branches to medial and lateral heads of gastrocnemius were identified by using EMG (teflon coated) needle. The effects were seen as visual contractions of the muscles and compound motor action potential (CMAP) in the EMG monitor. The important step was to exclude the sural communicating nerve which also arose from tibial nerve and was a purely sensory nerve. Inadvertent section of this nerve led to painful neuroma at this site.

Usually there were one to two muscular branches for medial and one for lateral gastrocnemus muscle. These nerves were traced

to muscle bellies and sectioned at two points; one at the motor point and the other at 1cm from the first. Wounds were closed in layers. Pressure bandage was applied.

Exercise to re-educate dorsiflexion of ankle and toes were started within one week after surgery or as soon as pain subsided. Further follow-up were done at Six week, 3months, 6months, 12months intervals. Along with tibial neurectomy, release of hamstring tendons were performed in 14 cases with hamstring spasticity and partial obturator neurectomy was also performed in 12 cases to reduce adductor spasticity leading to scissoring.

Results

The results were graded as 1) Good 2) Fair 3) Poor, according to static and dynamic tests done as follows (Table no.2):

Table - 2 : Results

Tests	*Good*	*Fair*	*Poor*
Static			
1) Passive stretching of ankle into dorsiflexion.	Free	With resistance	Upto neutral
2) Active dorsiflexion of ankle.	Normal	Neutral.	Unable.
3) Squatting - observe the symmetry of limbs.	Normal	Possible with limbs abducted.	Unable
Dynamic		Neutral	
1) Toe clearance with active dorsiflexion of toes during swing phase.	Normal	dorsiflexion.	Plantar flexion.
2) Global assessment by the patient's relatives/treating team.	Normal	Fair.	Poor.
Number-51	27(52.94%)	18(32.94%)	6(11.76%)

The regular follow up was done upto 1 year in all cases. Most of the cases were taken up in an age group ranging from 2-4 years, as this is the time for training sitting balance and walking. Along with reduction of gastro-soleus spasticity, other associated spastic/athetoid conditions in the upper limb or other parts of lower limbs were also reduced in 9 cases.

There were no major intra-operative complications in this series like injury to the popliteal vessels. Post-operatively, no calcaneus deformity was observed. Minor complications, like wound dehiscence, stitch infection were observed in 10 cases, which resolved with treatment.

Discussion

The first neurectomy was reported in 1913(Stoffel) and this became a popular method of reducing gastrocnemius spasticity in 1951(Phelps); soleus spasticity in 1952(Eggers)[13]. Use of Botulinum toxin for the treatment of spasticity in cerebral palsy was reported extensively in recent literature. Neville reviewed the role of this method of treatment in cerebral palsy[14] and pointed out many shortcomings in this method. Neurosurgical procedures like selective dorsal rhizotomy, intrathecal Baclofen became very popular treatment for spasticity in cerebral palsy.

Subramanian et. al[15] reviewed cases of selective dorsal rhizotomy (SDR) after 10 years and found that SDR was not useful as expected in all cases. As for intrathecal Baclofen, this is too complicated technology to be practical in our set-up. Orthopaedic procedures like tendo-achilles lengthening, tendon transfer for equines foot were reported by the authors like Steinwender et.al[16], Camacho et.al[17]. These were done in older children who had developed fixed equinus deformities. There were a few recent reports of tibial neurectomies either for gastrocnemius and/ or soleus[18,19]. There were no attempts to find out the suitable age to perform this operation. Bleck[5] reported the incidence of calcaneus deformity as result of gastrocnemius neurectomy.

We observed that selective tibial neurectomy gives effective and more or less permanent relief of gastrocnemius spasticity in 85.88% of cases. This operative procedure was relatively easy and could be completed in 30 minutes or less. We didn't encounter any major intra operative complication. The component of gastrocnemius spasticity was completely relieved. However, the nerve supply to soleus was left untouched. By this way, we avoided the post operative calcaneus deformity in our series. However, the spasticity due to soleus component may be the cause for our poor and fair results in 44.70% cases. This operation can also be done without EMG guidance. However, with this procedure the chance of crushing the wrong nerve is high. Two cases of painful neuroma were encountered. This procedure should be done as early as possible in around the age of 3-4 years in properly selected cases.

Conclusions

Hence, we concluded that selective tibial neurectomy is a safe, effective and permanent method of reducing gastrocnemius spasticity in Indian context. This should be done as early as possible, at 3 to 4 years age which helps the functional recovery in terms of the ease of carrying out neuro-development exercises.

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Early Surgical Intervention to Facilitate Ambulatory Potential in the Rehabilitation of Spastic Diplegics

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Abstract

With the development of Intensive neonatal Care, the Spastic Diplegia associated with Prematurity has become the most common type of Cerebral Palsy. Spastic Diplegia constitutes most common type of Cerebral Palsy. The efficacy of treatment for Improvement must be analyzed according to the prognosis of the motor disorder. Hemiplegics generally become free ambulators, whereas Quadriplegics can hardly walk. More than 50% of Diplegics can be expected to walk freely and the remainder will become crutch ambulators or will not walk at all. Although the severity of brain damage determines the prognosis of locomotion, the developmental potential and plasticity of the brain, presents the possibility of Improvement in locomotor function by systematic and aggressive treatment. Aggressive physical and rehabilitation therapy and selected rehabilitation surgery for correction of deformities and contractures of lower limbs is particularly effective in whom brain damage is moderate. Few have reported the effectiveness of surgical Treatment on locomotor function.

Materials & Methods

For the present study 56 patients out of 315 Spastic Diplegia were selected, who received systematic treatment for one year and could be followed upto 3 years. The age range was from 1 year to 18 years. The initial treatment was Physical Therapy including neurodevelopmental therapy upto 3 years. They were given home exercises programme and after every 2 months they were reviewed. They were encouraged crutch walking (who were wheel chair bound) by the age of five years.

Surgical consideration was taken up to improve the gait and pattern. Surgery was done at the age of minimum 4 years when a matured gait pattern gets established. usually the patients have physical therapy long enough for operative indication to become clear.

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Different Surgical procedures were carried out according to the following indications.

1. When abduction of each hip was less than 30 degrees, abductor longus Fractional Lengthening + Ant. branch obturator neurectony was done.
2. For fixed Flexion contracture of hip more than 20 degrees, Fractional Lengthening of Iliopsoas was done.
3. Popliteal Angle of more than 25 degrees - Fractional Lengthening of Hamstrings was done.
4. For tight T.A. - Fractional Lengthening of Tendo Achilis was done.
5. For Dynamic varus deformity of Foot in equinus - split Transfer of Tibialis post to peroni was carried out.
6. When Internally rotated knee-internal hamstring to lateral side was performed.
7. Rectus Femoris Tightness - Rectus Femoris to sartorius was performed.

The deformities were corrected in a single sitting as far as possible. This practice was followed because any residual deformity in one joint might cause a new deformity or recurrence of old deformity. The Physical Therapy started on 5th post-operative day when pain subsides. The Physical Therapy included standing balance, practising SLR and walking in parallel Bar or with crutches. They required this vigorous therapy from 3 months to six months. Parents were taught Home exercises programmes.

The results were evaluated according to the amount of improvement in joint deformities, malalignment of lower limbs and locomotor function. Walking Function was divided into three groups. They are :

1. Free Ambulators
2. Crutch Ambulators
3. Non ambulators.

Results

At the follow up examination 33 out of 56 patients were free ambulators, 20 were crutch ambulators and 3 were non ambulators. It is shown in Table - 1.

TABLE - 1

Group	*Results with no. of patients*		
Gr-I	Free Ambulators	-	33
Gr-II	Crutch Ambulators	-	20
Gr-III	Non Ambulators	-	03
	Total	-	56

The group-I patients had reported early and received rehabilitation therapy early. Surgery was performed at the age of 4 to 5 years. 28 patients out of 33 in group-I became free ambulators before six years. The other 5 became free ambulators at the age of 9 years. The average age was 3 to 8 years when they started walking. The age at achievement of free ambulation (Group-I) is shown in the Table-2.

TABLE - 2

Achievement of Free Ambulation in years	*No. of patients*
1 year	0
2 years	8
3 years	6
4 years	7
5 years	4
6 years	0
7 years	1
8 years	2
9 years	5
Total	33

The surgical procedures were performed to improve the GAIT pattern and make them free ambulators. Different surgical procedures are shown in Table-3.

TABLE - 3

Surgical procedures in 33 children in Group-I

Surgical procedures	Bilateral	Unilateral
F/L. of Iliopsoas	04	2
Adductors long. Tenotomy + Ant. Branch obturator neurectomy	20	2
F/L of Hamstrings	30	1
F/L of Tendo-Achilis	29	1
Split transfer of Tiabialis post	03	2
Internal Hamstring to lateral side	-	2
Rectus femoris to Sartorius	02	1

In Group-I most common surgeries were F/L. of adductor longus + Ant. Branch obturator neurectomy coupled with fractional lengthening of hamstrings and tendo-achilis. Relatively few cases required Iliopsoas release. Other surgeries were few.

In Group-II patients treatment began at late age. Average time of reporting was 5 years. After systematic rehabilitation therapy for a long period, surgery was performed at an average age of 6 years. 18 of 20 patients of crutch ambulators had rehabilitation surgeries performed either before or after gaining ability to walk with crutches.

2 out of 20 patients gained ability to walk with crutches without any prior surgical intervention. Their treatment started earlier. These two however needed surgical correction for deformities.

The surgical procedures needed in Group-III are same as Group-I only difference being more no. of hip flexion contractures were released by fractional lengthening of Iliopsoas.

In Group-III, 3 children would not even walk with crutches. They practice with walkers and wheel chair bound. They are mainly having severe spasticity coupled with mental retardation. Nonetheless, their sitting posture has improved there by facilitating Tioletting. Their average age of starting treatment was 7 years.

Discussion :

Reports have stated that 70-79% of spastic Diplegia become free ambulators whether they have physiotherapy or not (Beals, Bleck). In present series free ambulators, Crutch ambulators and non ambulators were 59%, 35.1% and 5.9% respectively. Because the patients studies were not homogeneous in their degree of brain involvement and at the age they started their first treatment, it is difficult to use ambulatory status to compare the results of treatment. For example children who began treatment at one year had severe spasticity, hence early diagnosis. A child who was seen at 2 years and after wards had less spasticity and some gait abnormality during walking.

Whereas Bleck (1975) reported that most patients attained ambulation before 4 years. Beals (1966) reported this age to be six years. In present authors study five children started walking after 9 years.

These children started their treatment at average 4.5 years. They could become crutch ambulators around 6.5 years and become ambulatory after hamstring and Gastrocnemius lengthening between ages 6 to 9 years.

Three children who were non ambulators benefitted from fractional lengthening of Iliopsoas and Adductors that their position of sitting and Toileting were improved. They are severely mentally retarded patients.

The effect of Intensive Physical Therapy was that surgery for hip flexion contracture was minimal. However, it had less effect on hamstrings contracture.

The 3 years follow up study by authors is much longer than in other reports such as Palmer (6 months) & six weeks study by Herndon et. al. Despite this follow-up average age of the patient studied are insufficient to comment upon the adolescent deterioration of motor functions or recurrence of deformities which is a possibility till the growth is completed. We have not yet encountered recurrence of deformities, though the time period might be short or they all are extreme good at home exercises programme.

Therefore, additional long term studies are needed.

Conclusions :

- 5 children became free ambulators after the age of 9 years due to surgical intervention.
- Physical Therapy only managed to prevent hip flexion contracture to some extent.
- Most children with spastic diplegia who have intensive physical therapy combined with adjuvant corrective surgery before the age of 9 years can acquire ambulatory function.
- Early Surgical Intervention along with Physical Therapy holds promises for the spastic diplegia.

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Treatment of Rheumatoid Arthritis with Combination of Disease Modifying Anti-Rheumatic Drugs: A Three-year follow-up study

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Abstract

Rheumatoid arthritis is a multisystem disease causing substantial morbidity. Disease modifying anti-rheumatic drugs induce clinical remission in such patients. The study aims to find out the efficacy of these drugs in producing disease remission in patients of rheumatoid arthritis reporting even at the later stage of illness.

A prospective study was carried out in 61 patients of rheumatoid arthritis. Mean duration of illness was 2.9 years, age ranging from 20-65 years. The patients were followed up for a mean period of 20.29 ± 9.79 months (range 6-36 months). Chloroquine phosphate - 150 mg/day, Methotrexate -7.5 to 15.0 mg/week Sulfasalazine 500-2000 mg/day were given in saw-tooth strategy regime. Clinical response was measured for clinical markers of synovial inflamation. Disease control was achieved in 39 % of the patient at 6 months and in 60% of patients in 24 months, still maintaining at 50% improvement in clinical markers. Chloroquine and Methotrexate was the most commonly used combination (52.5%) for achieving remission,without any major adverse effects.

Disease modifying anti-rheumatic drugs have a role in achieving disease remission even in comparatively later stages of illness. Methotrexate and Chloroquine can be safely given for longer period. Side effects can be monitored by periodic check up.

Key words : **Rheumatoid Arthitis, Disease Modifying Anti-Rheumatic Drugs, Saw-tooth strategy, Disease remission, Outcome measures, Adverse effects.**

Introduction:

Rheumatoid Arthritis (RA) is a chronic multisystem disease causing substantial morbidity and socio-economic impact. It has been demonstrated that 50% of the patients suffering from RA will have significant impairment of their work activities after 10 years of diagnosis[1,2]. Since the pathogenesis of RA is obscure, the treatment remains emperical and the mechanisms of action of disease modifying anti-rheumatic drugs (DMARDS) are not clearly understood[3,4]. However, there is strong evidence that DMARDS can alter the short-term course of the disease[5,6]. Treatment of RA with DMARDS is problematic because of various adverse effects and drugs also tend to loose their effectiveness with time.

It is also reported that only 5 - 15% of the patients of RA in whom there was initial response to a DMARD will continue benefit from the drug therapy after 5 years[4,7,8]. Increasing knowledge about the pathogenesis and long-term morbidity and the importance of early treatment in RA has led to

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a more aggressive approach[9]. And, clinical trials with DMARDS in early RA indicate definite decrease in radiographic progression when inflammation is effectively suppressed, suggesting that the inflammatory process is at least the major factor in joint destruction[10]. Individual DMARDS have to be changed repeatedly, in order to find out the most effective and least toxic drug for the individual patient. Since the traditional pyramid approach has become ineffective in suppressing the rheumatoid inflammation and in preventing joint destruction in most RA, new treatment strategies have been proposed[11-13]. In our set up, we find the majority of the cases of RA reporting to us in the later stage of illness. Hence, the present study aimed to find out the efficacy of DMARDS in producing disease remission and arresting progression of disease process in RA patients even at the later stage of illness and to find out the toxicity and tolerance of DMARDS used thereof.

Patients and Methods

A prospective study was carried out in sixtyone patients of classic RA fulfilling the revised criteria of American College of Rheumatology 1987[14], attending the Department of Physical Medicine and Rehabilitation, Regional Institute of Medical Sciences, Imphal. The inclusion criteria were RA patients with duration of illness more than 6 months with history of unsuccessful treatment but without history of any DMARD therapy. Patients with functional classification stage IV of American College of Rheumatology, pregnant woman or woman of childbearing age group without contraceptive cover were excluded from the study group. So also, the patients with history of liver, renal, haematological, cardio-pulmonary or active peptic ulcer disease and with visual difficulties were also excluded.

There were 5 male and 56 female patients. The patient characteristics were given in table 1. The period of study was from January 1997 to December 1999.

Study design

Assessment for the clinical variables was done at entry (baseline), at 1 to 2 months interval for the first 6 months and thereafter at 3 to 6 months interval. The clinical variables tested were swollen joint count (JS), tender joint count (JT), range of motion (ROM) of the joints, grip strength in Kg/cm2 (using grip dynamometer), duration of morning stiffness in minutes and pain using visual analogue scale (VAS) of 100 mm. Baseline investigations for RA factor, C-Reactive protein, haemogram, liver function test (LFT), kidney function test (KFT) and radiological investigations viz. X-ray of the wrist and hand, chest X-ray were also done. Investigations like LFT, KFT, haemogram were done at 3 months interval if no untoward adverse effects were reported. Ophthalmologic examination was carried out every six months for all the patients receiving Chloroquine for its potential ocular toxic effects.

DMARD therapy

DMARDS were instituted on saw-tooth strategy regime[11] using Chloroquine phosphate 150 mg/day, Methotrexate 7.5 to 15mg/week, Sulfasalazine 500-2000 mg/day. As has been outlined in the objective of the present study, most of our patients have reported in the later stage of illness. Single DMARD was instituted for mild and moderate disease activity while double or triple drugs combination was instituted for severe disease activity and for those reporting at later stage of illness.

Concurrent therapy

Non-steroidal anti-inflamatory drugs were given on regular basis for the initial period of 10 to 14 days and thereafter as and when needed basis. Intra-articular steroid injection was also given, if required to control acute local inflammation of the joint. But no systemic corticosteroids were

administered during the study period.

Outcome measures

The main end point was the improvement of patients' condition by at least 50 per cent among the clinical variables measured with special consideration to joint counts, pain, and morning stiffness and grip strength. We have considered 50 percent improvement as clinically relevant and the treating physicians could readily recognise the change. We have taken into consideration of the Modified Paulus composite criteria[15] and preliminary improvement criteria of American College of Rheumatology[16] for measuring the treatment response. The criteria were JS decreased by 50 percent, JT decreased by 50 percent, absence of morning stiffness or less than 30 minutes duration. Besides, the evaluations of additional measures like grip strength and pain improvement in patients' and physician's global assessment in VAS was also considered.

Table 1: Showing patient characteristics (n = 61).

Male: Female	5:56
Mean age of the patients	48. 97± 11.74 years (range 25 - 65)
Mean duration of illness	2.71 ± 1.90 years (range 0.5 - 6.00)
Mean duration of follow-up	20.29 ± 9.79 months (range 6 - 36)
RA factor positivity (%)	26 (42.6%)
Extra-articular manifestation, vasculitis	1

Statistical analysis:

Differences in the mean values of the outcome variables were evaluated by using two-tailed student's t-tests, after putting the data in a computer using dbase. The statistical significance for all the variables were put at $p<0.05$.

Results:

All the patients received at least one DMARD during the study period. DMARD therapy with the number of patients recieving them are shown at Table 2. Chloroquine and Methotrexate were the most frequently used combination of DMARDS as received by 32 patients (52.5%). 18 patients i.e. 30% received either Chloroquine or Methotrexate while only 6 patients [10%] needed all the three drugs viz. Chloroquine, Methotrexate, Sulfasalazine for the control of disease remission.

Table 2. Showing number of patients (%) recieving DMARDS as single or in combination.

DMARDS	Number of Patients	% of Patients
CQ	8	(13)
MTX	10	(16)
CQ+MTX	32	(52.5)
CQ+SLZ	4	(6.6)
MTX+SLZ	1	(1.6)
CQ+MTX+SLZ	6	(10)

CQ = Chloroquine, MTX = Methotrexate, SLZ= Sulfasalazine

Table 3 shows the number of patients receiving treatment with each specific DMARD at a specific period of time. Chloroquine was the commonest initial DMARD instituted in 46 patients (75%) while 23 patients (37%) recieved Methotrexates as the initial single DMARD. For lack of therapeutic response, combination of DMARDS were instituted in the following 3 to 6 months. Mean cumulative time of DMARDS used in combination for achieving disease remission was 9.6 months without any significant adverse effects in 43 patients (70%).

There were 37 patients (60%) who recieved combination of 2 DMARDS at a single point of time. 18 patients (30%) took only one DMARD for achieving clinical remission. Of the total patients

only 6 patients discontinued DMARD therapy due to adverse effects requiring temporary withdrawal of DMARD. 10 patients needed addition of another DMARD or change to another DMARD for lack of response in 3 to 6 months period, as shown in Table 4. We observed improvement in the clinical markers of the disease viz. JS, JT, ROM of the joints, grip strength, morning stiffness duration and improvement in pain scored by 3 to 6 months of the DMARD therapy. Significant improvement was sustained at the end of 24 months with the continuation of DMARDS. Table 5 shows changes in the mean values in the clinical variables mentioned above.

Table 4 : Showing number of DMARDS prescribed, DMARDS discontinued due to adverse effects or needing addition of another DMARD for lack of efficacy in the study group (n= 61)

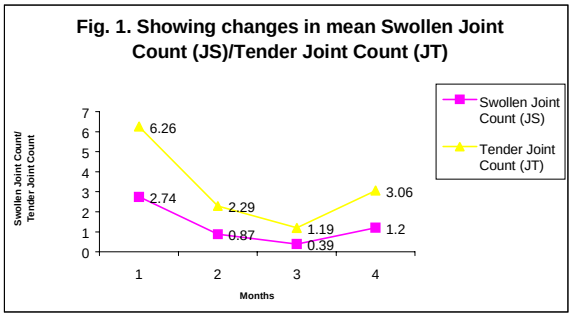
Number of DMARDS prescribed	Number of patients(%) receiving DMARDS	Number of patients stopped DMARDS due to adverse effects	Number of patients needing additional DMARD for inefficiency
1	18 (30%)	2 (1MTX+1CQ)	8
2	37 (60%)	2 (1MTX+CQ) (1CQ+SLZ)	2
3	6(10%)	2 (MTX+CQ+SLZ)	0

CQ = Chloroquine, MTX= Methotrexate, SLZ= Sulfasalazine,

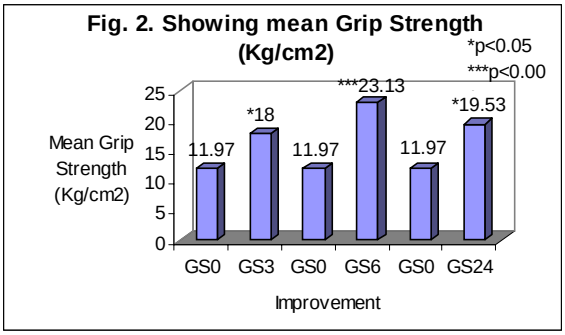
Table 5: showing change in mean value ± standard deviation in clinical variables at the end of 3,6,24 months from baseline (0 month).

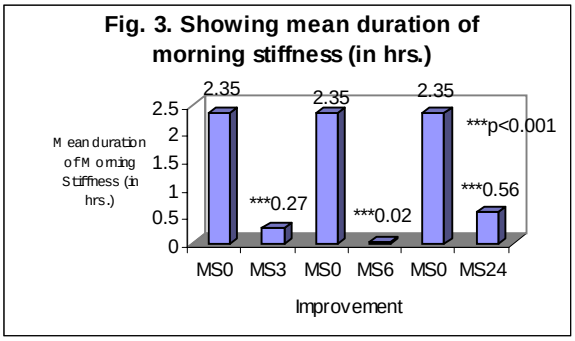
Variables	Months			
	0	3	6	24
No. of Swollen Joint	2.61 ± 1.58	0.87 ± 1.05	0.39 ± 0.88	1.20 ± 1.78
No. of Tender Joint	6.26 ± 2.71	2.29 ± 1.81	1.19 ± 1.55	3.06 ± 2.63
Range of Motion	115.97 ± 60.40	173.06 ± 89.43	203.22 ± 108.90	177.33 ± 70.40
Grip strength (kg/cm2)	11.97 ± 7.39	18.00 ± 9.03	23.13 ± 8.84	19.53 ± 9.37
Morning stiffness (hrs.)	2.35 ± 0.84	0.27 ± 0.46	0.02 ± 0.89	0.56 ± 0.79
Pain (in VAS)	100	49.35 ± 16.57	31.29 ± 26.45	36.33 ± 29.30

Figure 1 shows the changes in the mean values of JS and JT at 3, 6, 24 months of DMARD therapy. Mean value of the number of JS got significantly reduced from 2.61±1.58 to 0.87±1.05 at 3 months ($p<0.01$) and to 0.39±0.88 ($p<0.001$) at 6 months. After 24 months, the improvement in the mean JS was still significant ($p<0.05$). Mean value of number of JT also significantly reduced at 3 months ($p<0.001$). Reduction in mean value of JT was still significant at 24 months follow-up ($p<0.001$).



Improvement in the mean values of ROM of the joints was also significant by the end of 6 months ($p<0.001$) and the significance was still maintained at the end of 24 months ($p<0.01$). We also observed significant improvement in the mean values of grip strength at 3 months ($p<0.05$) and still more significant at the end of 6 months ($p<0.001$) as shown at figure 2. Moreover, the improvement in the mean scores of morning stiffness and pain remained significant from 3 months to 24 months of DMARDS therapy ($p<0.001$) as shown in figure 3 and figure 4.





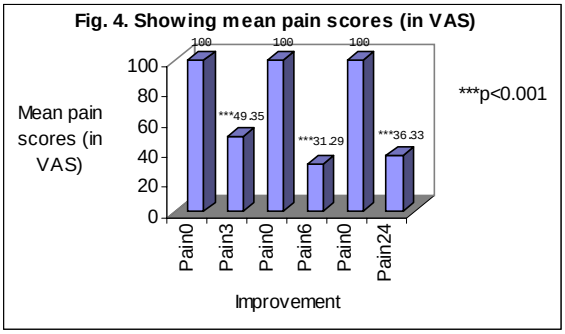


Table 3. Showing number of patients receiving treatment with each specific DMARDS at a specific period of time.

DMARDS	MONTHS					
	0	3	6	12	24	36
HCQ	46	42	44	18	4	
MTX	23	30	40	28	12	12
SLZ	2	3	6	2	1	

CQ =Chloroquine, MTX=Methotrexate, SLZ=Sulfasalazine

In the present series, 31 patients (51%) were followed up for 6 to 12 months while 24 patients (39%) were followed up for 24 to 36 months. The patients have been followed up for a mean duration of 20.29 ± 9.79 months (range 6 to 36 months). Out of the total 61 patients, 24 patients i.e. 39% achieved clinical remission at the end of 6 months follow up. Out of 24 patients followed up for two years 15 patients (60%) maintained clinical remission. 50% improvement in clinical markers were maintained in these patients. However, remission was temporary if DMARDS was stopped after the remission, as was observed in 4 such patients showing relapse of signs and symptoms within 2 months of stoppage of DMARDS therapy.

Toxicity and adverse reactions:

6 paitents needed to stop DMARDS therapy temporarily or switch to another DMARDS due to adverse reactions .1 patient receiving Chloroquine developed blurring of vision at 3 months and switched to Methotrexate. 1 patient recieving Methotrexate developed anaemia at 6 months , for which 2 units of whole blood transfusion was given . The patient had a history of dependance on non-steroidal anti-inflamatory analgesic drugs before being admitted into the present study. 2 patients recieving Methotrexate and Chloroquine combination developed severe nausea and liver function abnormalities at 6 months. Liver function test alteration was in the form of altered Albumin and globulin ratio but with SGOT and SGPT levels maintained within 2 times the normal value. 2 paitents recieving combination of all the three drugs developed nausea, loss of appetite and dizziness at 6 to 10 months. 1 paitent recieving Chloroquine and Methotrexate developed vasculitis which was rather an extra-articular manifestation of the disease.

Discussion

The treatment of RA with DMARDS are now a days started early in the course of the disease with the aim to achieve clinical remission as early as possible. However, complete remission of RA is rare, inspite of the currently available DMARDS therapy modalities[17,18]. Although early treatment seems to be the common denominator in all newer strategies, it is also generally agreed that aggressive therapy should be used in severe RA and even in comparatively later stage of illness[19].

In the present study disease remission was

achieved in 39% of patients at the end of 6 months. Burhoo AM[20] reported that at 8 to 10 weeks all the 20 patients had shown complete remission with low dose Methotrexate at 7.5 to 15mg /week with encouraging results till 6 months follow up period. In our series, out of 24 patients followed up for 2 years, 15 patients (60%) showed maintenance of remission of the disease with the continuation of DMARDS. In a 2 year double blind randomised study, O'Dell and colleagues[21] compared Methotrexate alone (7.5-15 mg/week), Sulfasalazine (1gm/day) with hydroxyChloroquine 400 mg /day combination or all the three drugs. The primary endpoint of their study was also 50% improvement in the composite symptoms of arthritis as comparable to those of our study. Fifty of 102 paitents had a 50% improvement at 9 months and maintained at least the same degree of improvement for the two year period without evidence of major side effects. Of these, 24 of 31 patients recieved all the three drug combination, 14 of 35 patients were treated with Sulfasalazine and hydroxyChloroquine and 12 of 36 patients were treated with Methotrexate alone. In our study, 37 of 61 patients (70%) needed combination of DMARDS, out of which 6 patients recieved all the three drugs while 32 patients (52.5%) recieved Methotrexate and Chloroquine combination. 60 % of patients in our series maintained 50% clinical improvement at the end of two years as compared to 49% of patients in O'Dell et al series[21].

Mottonen et al[22] carried out a prospective study in 142 patients treated according to saw-tooth strategy using gold sodium thiomalate, Sulfasalazine, Methotrexate, hydroxy Chloroquine, d-penicillamine etc. They observed clinical remission in 20% of patients at end of first year and in 27% of patients after 2 years of DMARDS therapy. The difference in the percentage of patients who achieved clinical remission at 2 years(i.e 27%) in the series of Mottonen et al[22], may be because of the severity of the cases (51% of them were in Steinbrocker functional class II to IV) and injectable gold (sodium aurothiomalate) being the most common initial DMARDS used in 82% of patients. The above findings indicate that it is not too late to institute DMARDS treatment in RA patients, even in whom erosions have appeared already.

Clegg and colleagues[23] reported an interesting study where 121 patients who had responded to a combination of Methotrexate and Hydroxy Chloroquine were randomized to one of three continuation therapy protocols for control of flare of the disease activity viz., (group I - 40 patients) on hydroxychlroquine with pulse Methotrexate, (group II - 41 patients) on Hydroxychlroquine with placebo pulse, (group III- 40 patients) on placebo with pulse Methotrexate. They observed that patients improved on a combination of Methotrexate and hydroxy Chloroquine. And continuation of Methotrexate or Hydroxy Chloroquine delayed the onset of flares. In our study also, after clinical remission was achived we continued with either Chloroquine or Methotrexate. As such combination therapy of 2 or 3 DMARDS were given with a mean cumulative period of 9.6 months only. Other series also recorded the mean duration of combination therapy for 13.2 months[22].

In our series, 6 patients out of 61 patients (10%) needed to stop DMARD therapy because of adverse reaction as comparable to that of 0'Dell et al[21] which has similarity of DMARDS used and moreover the moderate duration of follow-up as well, upto 24 to 36 months duration. The higher percentage (29%) of adverse effects encountered in Mottonen T et al series[22] may be because of different drug combinations and probably also for comparatively longer period of follow-up (mean 6.2 years) .

Chloroquine was the most commonly used initial DMARD in 46 patients (64%) while 23

patients (32%) recieved Methotrexate as initial DMARD in the present study. One important observation we have found in our series was that patients taking Chloroquine decreased to 18 patients at 1 year while patients taking Methotrexate kept on increasing by 6 months (40 patients) and at 1 year (28 patients). It appears that Methotrexate has moderate potency in controlling the dieasese activity as compared to Chloroquine. Better clinical remission was achieved in patients recieving combination therapy taking Chloroquine and Methotrexate as also observed by other workers[21,23].

Conclusions

DMARDS with more aggressive approach like saw-tooth strategy has a role in inducing disease remission even at a comparatively later stage of RA. DMARDS treatment seems to retard the progression of the disease in patients of RA .The present finding showed that DMARDS substitution can be made safely for those becoming ineffective or showing toxic effects.The beneficial effects of continued treatment with DMARDS may be extended for longer periods. Methotrexate and Chloroquine can be safely given for longer periods (upto 3 years in the present series) without any major side effects However, despite initiation of early aggressive therapy, RA may continue to progress in some patient. In this group with progrssive disease, inspite of continued aggressive treatment with DMARDS, treatment with drug combinations should be tried as early as possible. Moreover,the role of newer biological agents and how they will perform as combination therapy in such patients needs to answer critical questions in near future. For this we need to review the combination therapy and to encourage appropriately designed studies to answer these questions.

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Acceptability of Conventional Lower limb Orthoses in the Rural Areas

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Abstract :

A study to find out level of rejection, reasons for rejection and association between rejection and various parameters was conducted on 100 loco-motor handicapped patients belonging to rural areas in Manipur, fitted with Conventional lower limb orthoses in the year 1993 from the Department of Physical Medicine and Rehabilitation, Regional Institute of Medical Sciences, Imphal. Rejection in the hilly areas was 82.75% in comparison to 49.29% in the plain areas. Rejection was slightly higher in females (64.86%) in comparison to 55.55% among males. Rejection was lowest among graduates (28.57%) and highest in no-formal education group (80%) and labourers (100%). Bilateral and unilateral lower limb involved cases were comparable in number (51% versus 49%). Rejection was around 59% in both. 56% of patients were fitted with KAFO's, 29% with AFO's and 15% with HKAFO's. Rejection was highest among patients using AFO's (86.20%). 100% rejection was observed among patients using Bilateral HKAFO's. Architectural barriers such as threshold in doorways, step/staircase, high floor level housing, uneven roads, hilly terrain were observed. Negative social attitudes also contributed in rejection in 76%. Lack of significant improvement with orthoses was the commonest reason for rejection. Other common reasons were architectural barriers, ability to ambulate without orthoses, heaviness, and poor cosmesis. Financial problems, poor social acceptance, restriction in activities of daily living and in social and religious places, and dependence to others for donning and doffing, etc. were other contributory reasons. Sex, age, occupation, type of affliction, extent of involvement had no statistically significant association with rejection.

Key words : **acceptability, rejection, orthoses, rural areas.**

Introduction :

There has been increasing awareness of the need of audit in medical practices. One specific area, which has received scant attention, is that of orthoses. Most of the conventional lower limb orthoses designed and developed on western standards overlook innate problems of the rural areas in India where the floor is used for various activities like sitting, sleeping, eating, working, worshipping, toileting, etc. Squatting and cross leg sitting has been a tradition. Due to warm climate closed shoes are uncomfortable. Most people walk barefoot or in open well-ventilated footwear, often on a rough terrain of the countryside where suppleness of foot is a vital attribute in adapting to uneven surfaces[1]. Again, insurmountable barriers

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in the form of steps, staircase, and thresholds on doors make mobility of locomotor disabled more restricted[2]. Over and above this, few reports available in the literature indicate that there is a large dissatisfaction or low acceptability rate of the lower limb orthoses even in the western set up[3-5]. Common reasons for dissatisfaction were that they were heavy, cumbersome, and cosmetically unacceptable. Therefore, most of the patients prefer to limp around without orthoses for obvious reasons[1]. This amounts to considerable financial loss.

As such no definite planning for community rehabilitation can be done without a thorough understanding of the actual need. There has been very little research data on patient's satisfaction with lower limb orthoses especially in the rural areas of this country. Therefore, in view of the lack of this vital information, a study to find out rejection level of patients with lower limb orthoses especially in the rural set up of Manipur was conducted.

Materials and Methods :

One hundred patients who had been fitted with different lower limb orthoses in the year 1993 at the Department of Physical Medicine and Rehabilitation, Regional Institute of Medical Sciences, Imphal, and using the same for at least one year were studied.

Acceptability/rejection of the conventional lower limb orthoses were studied in relation with various variables such as location, age, sex, level of education, occupation, types of affliction, extent of involvement, types of orthoses, architectural barriers, understanding about the orthoses, etc. Patients' age group below 5 years, patients with associated systemic diseases and those from outside the state were excluded from this study.

Data were collected through a personal questionnaire during home visits. Attempts were also made to interview patients in presence of other family members and neighbours. Orthoses and architectural barriers were examined during the home visits.

Collected data were entered using Dbase program. Cross checking of the data for any inconsistency was done before the data was put to the statistical analysis. Association of the rejection and different parameters were done by using chi-square test.

Results :

Out of 100 patients studied, 41 patients were found using the orthoses and other 59 were not using the orthoses after one year of fitment. 71 patients belonged to the plain and remaining 29 to the hilly areas. Rejection in the hilly area was 82.75% against 49.29% in the plain area ($p < 0.01$).

Rejection among females (n=37) was 64.86% (n=24) and among males (n=63) was 55.55%(n=35)($p=0.495$). 30%of patients belong to age group of 11 -20 years, 28% in the age group below 10 years, and 9% above 51 years of age. Rejection rate was highest (77.77%; n=7) in the age group 31-40 years (n=29) and also above 51 years of age group. Rejection in the age group below 10 years was 64.28% (n=18). However association between rejection and age was not significant.

Twenty eight percent of patients studied up to middle level, followed by 23% up to high school level, 14% up to primary level, 2% professionals and remaining 26% had no-formal education. Rejection was highest in the no-formal education group (80%; n=21) followed by primary level of education (64.28%; n=3), and lowest among graduates (28.57%; n=2) ($p<0.05$). 68% of patients were students; others as housewives (9%), businessmen (8%), government service (6%), cultivator (3%), labourers 2% and independent profession 2% and nonoccupied (1%). Rejection was highest among labourers and cultivators (100%) followed by government services (83.33%;

n=5), housewives (77.77%; n=7) and students (57.35%; n=39). Association between rejection and occupation was not significant.

Thirtyseven percent patients had poliomyelitis followed by paraplegia (19%), trauma (9%), cerebral palsy 8% and arthritis (8%), hemiplegia (5%), congenital deformity (3%), 1% each for leprosy, nerve injury, and neuropathy. 80% rejection was observed in hemiplegia, 77.77% in trauma, 75% in arthritis, 52.63% in paraplegia, 50% in cerebral palsy and 45.94% in poliomyelitis ($p = 0.36$). 51% of patients had bilateral involvement. Rejection among bilateral groups was 58.82% and among unilateral lower limb involved patients 59.18% ($p = 0.87$). 56% 0f the patients were fitted with KAFOs including 28 bilaterals, 29% with AFOs including 9 bilaterals and 15% HKAFOs including 6 bilaterals. Rejection was highest with AFOs (86.20%). 100% rejection was observed among patients using bilateral HKAFOs and 88.88% in bilateral AFOs. 50% rejection was observed for KAFOs. Association between types of orthoses and rejection was statistically significant ($p<0.01$). Threshold on doors, step/staircase, high floor level of housing, uneven roads, hilly terrains were observed as important architectural barriers. Rejection was highest in the hilly areas (82.75%).

Reasons for continued uses of orthoses even 1 year of fitment were observed in 41 patients. 26 patients could walk better with orthoses, 11 patients couldn't walk without orthoses, 4 patients felt that orthoses reduced pain and deformity. Again main reasons for rejection / discarding in the remaining 59 patients were lack of significant improvement in mobility with orthoses, architectural barriers, ability to ambulate without orthoses, heaviness, and poor cosmesis, etc. Other reasons were; a) financial difficulties, b) poor social acceptance, c) restriction in activities of daily living and field activities, d) restriction in social and religious places and functions and e) dependence on others for donning and doffing, etc.

Discussion :

Inspite of disadvantages like heaviness, poor cosmesis, cumbersome doning and doffing, frequent wear and tear, etc. 41 % of patients were found to be using lower limb orthoses even after one year of fitment. 59% rejected or discarded orthoses mostly during the first three months of fitment. This rejection rate of 59% is comparable to 50-60% reported by Kumar et al[6], 59% by Sant, 60% by Hariharan et al[7], 17-50% by Haslok et al[4], Park and Craxford[5]. Association between rejection and location was statistically significant. Higher rejection rate in the hilly areas (82.75%) can be explained by the fact that hilly terrains act as architectural barrier where significant degree of joints mobility, suppleness of foot is restricted by the orthoses. Above knee orthoses are purely nonfunctional so far as ambulation in hilly areas is concerned. Amar[8] also reported difficulty in walking on uneven surfaces or steep slopes of hills with lower limb ambulation aids. Association between sex and rejection was not significant. Hariharan[7] and Fischer et al[3] also reported a similar finding. Hariharan[7] reported unexplained discard rate among male patients in contrary to our finding where rejection rate was higher in females (82.75%). It may be because of the reason that conventional lower limb orthoses are not suitable for household activities where most of the work is done at the floor level. Presence of closed leather shoe and poor cosmesis could be other contributory factors for higher rejection among females.

Association between age and rejection was not significant. Similar finding was also reported by Hariharan[7] and Fischer et al[3]. higher rejection among patients in the age group above 51 years can be explained by ; a) lack of strength and co-ordination, b) most of them are hemiplegics who

can ambulate without orthoses because of the unilateral involvement, and c) more association with social and religious activities where shoes are restricted. It was observed that using orthoses in the age group below 10 years was wholly dependent on the initiative and effort of parents, mostly mother. Association between rejection and educational level was significant in contrary to Hariharan's[7] reports. Rejection was highest among no- formal education group (82.76%) and lowest among graduates (28.57%). It was observed that lack of understanding by the parent or patient about the disease has strong impact on discard or rejection.

Association between occupation and rejection was not significant. However, rejection was observed more among labourers, cultivators and housewives who need lots of activities at the ground level. Hariharan[7] reported higher rejection among occupied groups. Poliomyelitis represented highest number of patients. This supported a similar finding by various authors[7,9,10,11]. Association between types of affliction and rejection was not significant. Fischer et al[3] also reported a similar finding. 52.63% (n=10) was observed among paraplegics. Prescribing orthoses for functional ambulation in high level of spinal cord injury patient above D-10 was futile. Rejection among hemiplegics was due to their ability to ambulate without orthoses because of unilateral involvement and in arthritis due to physical intolerance. High rejection among myopathy patients was due to the progressive nature of the disease.

Hariharan[7] reported higher rejection among unilaterally involved cases due to the greater independence that these persons enjoy without the orthoses. Important findings of the higher rate of continued use of orthoses among bilaterals were due to a) initiatives and efforts of the parents among cerebral palsy patients, and d) inability to ambulate without orthoses among paraplegics, etc. Discardal rate among unilateral and bilaterally involved cases were similar in this study. Among lower limb orthoses, AFOs had highest rejection (86.20%; n=25). This is due to greater independence in ambulation since they are less affected. Hariharan[7] also reported a similar finding. Fischer[3] however reported only 16% discardal. Bilateral HKAFOs usually end in discardal because of difficulty in donning and doffing and greater dependence on others, heaviness, and breakage, etc. Pelvic band should be avoided to reduce dependency in doffing and donning, to minimize weight, frequent breakage to reduce energy consumption[12]. Again lots of flexibility in the joints is needed for ambulation in the hilly areas. Therefore, above knee orthoses are always ended up with discardal, more so in bilateral cases

Architectural barriers such as threshold in doorways, steps, staircases, high basement level of the traditional housing, uneven roads and in addition, the hilly terrain were present for all. Major problem is due to restriction of flexibility and loss of suppleness of foot imposed by the orthoses. Association between rejection and architectural barriers was significant. Saharasbudhe et al[2] also reported restriction of mobility of the locomotor disabled due to architectural barriers.

Better walking ability with orthoses followed by inability to walk without orthoses and reduction of pain and deformities were main reasons for the continued uses of orthoses. Varma[11] and Saharasbudhe et al[2] reported higher rejection if patients are able to ambulate without orthoses.

Various reasons were given for rejection of orthoses by various authors[2,3,6,7]. Important reasons were; a) heaviness weight, b) takes longer time to fabricate, c) get rusted soon, d) frequent wear and tear, e) cosmetically poor, f) high cost, g) cumbersome, h) physical intolerance(pain, heaviness, ulcer, itching). In the present study, lack of significant improvement in mobility with orthoses,

ability to ambulate without orthoses, heaviness, poor cosmesis were found to be the main reasons for rejection. Other significant reasons were; a) financial problem, b) poor social acceptability, c) restriction in activities of daily living and field activities mostly due to restriction of floor activities, d) restriction in social and religious places, and e) dependence on others for doffing and donning.

This study has highlighted the wasteful expenditure on the design that is not suitable for disabled in the rural areas. Therefore, a careful rethinking in orthoses prescription is to be emphasized. Few suggestions are made to minimize rejection;

a) Prescription of orthoses should be done in an individualized approach keeping in view economic, social, cultural, climatic, religion, local architectural barriers, materials and resources, locally available form of technology[13].

b) Proper exposure and training should be given for all medical officers involved in rehabilitation care services to avoid unnecessary and incomplete prescription, incomplete or wrong training methods, careless check out, etc

c) Provision of locally available materials and technology should be given priority. Quality, function and cosmesis should never be compromised in the name of low cost appliances to avoid rejection.

d) Use of newer synthetic and lightweight materials which are more acceptable to the patient both functionally and cosmetically should be promoted[14].

e) A close monitoring of the patient at each stage of orthotic fitting and a regular follow up service should be developed.

f) Hip and knee joints allowing squatting and cross-legged sitting should be made available to all the rehabilitation centers. ALIMCO should take responsibility for mass production and distribution[14].

g) Legislation to minimize architectural barriers on the existing structures and new constructions should be enforced[2].

h) Local artisans should be trained in minor repairing. Provision for improving local infrastructure for minor repair should be considered[7].

i) Concept of Mobile workshop where a qualified orthotist and rehabilitation technician from central rehabilitation center periodically visits peripheral centers/contact villages , carries out necessary repairs and register for fresh orthoses should be implemented.

More and more labour should be given to develop concept of community based rehabilitation and to establish community involvement and participation, thereby making this programme self sustainable without much external support. It would help patients in many ways such as; a) reduce social isolation problem, b) nonavailability of accompanying person for visiting rehabilitation centre, c) some free time to the members of the family to earn their livelihood, d) financial problems to a certain extent, e) minimizing architectural barriers in the community, f) socializing person with disabilities, etc.

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An Objective Approach for Assessment of Balance Disorders and Role of Visual Biofeedback Training in the Treatment of Balance Disorders : A Preliminary Study

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Abstract :

Normal equilibrium is defined as the ability to maintain the centre of body mass over its base support with minimal postural sway. Human balance is a sensitive and complex process and normal postural control underlying balance involves both motor and sensory processes.

The purpose of this preliminary study was to study the components of balance disorder in patients attending for balance rehabilitation and to find out the effectiveness of visual biofeedback training in reestablishing postural control in these patients.

Twenty out-patient cases presenting with various balance problems were included in this study. They included hemiplegic following stroke, post-head injury, cervical spondylosis, cerebellar ataxia, etc. Quantitative assessment about balance problems was done using force plate system in regard to centre of gravity (COG) alignment, postural sway and dynamic balance measures within limits of stability (LOS). Visual biofeedback training to improve COG alignment, to reduce postural sway and to increase LOS was given for 3-6 weeks duration on alternate days. Improvement in static balance was observed by 12% in hemiplegics, 14% in head injury patients, 16% in cervical spondylosis patients. Improvement in dynamic measures of balance was also recorded.

Quantitative assessment of balance problems allows better understanding of defective balance components. Observation from this preliminary study suggests that visual biofeedback training facilitates appropriate balance strategies and enables in achieving improved postural control.

***Key words* - postural sway, limits of stability, centre of gravity, biofeedback, balance.**

Introduction :

Balance control is an essential component for any locomotion system and may be defined as the ability to maintain the body's center of gravity (COG) over the base of support during quiet standing and movement. Balance control in a normal adult usually takes place at the subconscious level. It is a complex process involving the co-ordinated action of biomechanical, sensory, motor and central

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nervous system components[1]. Biomechanically, a person maintains his ability to move within the limits of stability (LOS) in order to maintain balance and LOS is an imaginary cone projecting upwards at an angle of about 12° antero-postereorly and 16° side-to-side[2].

Human balance is a complex process which involves the integration of sensory inputs from the end organs to detect body position and integrating these information by the central nervous system to produce adequate motor output responses in the form of automatic postural response. The sensory factors involved for the maintenance of balance are visual, vestibular and stomato-sensory (proprioceptive) inputs[3]. The sensory information so integrated by the central nervous system leads to discrete leg and trunk muscle responses to produce the required motor responses to maintain COG over the base of support[4]. When the balance mechanism fails, only then the importance of different factors responsible for the maintenance of balance is realized. In neurological conditions where balance problem is evident, the equilibrium or saving reaction is often slowed down or lost. Rehabilitation of balance disorders in such condition utilizes re-education by facilitation techniques, which use the approach based on stimulus response model for motor control. Advances in technology have assisted in the study and analysis of postural control although no one measure has been reported to adequately reflect postural control because of its complexity[5,6].

Force platform systems have advantages in objectively quantifying body sway and measuring the location of an individual's center of pressure related to the base of support. Hageman PA et al[7] observed measures of sway sensitive to age related changes in healthy elderly subjects. The Balance Master system was selected for the present study. It provides continuous feedback of the position of COG in relation to theoretical LOS, as a performance source during quiet standing and leaning in various directions. And moreover, the authors could easily access to the system for testing and training of the patients. Treatment strategies involving visual feedback exercises require training over repeated sessions. Postural exercises using visual feedback of positon have been shown to reduce body sway in selected patient population[3,5].

The purpose of this study was to find out the effectiveness of visual biofeedback training in re-establishing the postural control in a clinical spectrum of patients with balance disorders.

TABLE 1.

Showing spectrum of patients (n = 20)

S.No.	Patient spectrum	No. of patients
1.	Cervical spondylosis with symptoms of vertigo.	11
2.	Cerebro-vascular accident with hemiplegia	5
3.	Post-head injury sequelae with balance problems.	3
4.	Cerebellar infarction (Ataxia) following complication of radioactive ablation in Rheumatic heart disease	1
	Total number of cases = 20	

Methods :

Subjects : Twenty outpatient subjects with various balance disorders were included in the study. All the patients were attending the Rehabilitation department, Safdarjang Hospital, New Delhi during August '95 to December '96. Distribution of the cases reporting with balance problems is shown in table no.1. Age ranges from 29 to 63 years. There were 3 females and 17 males.

After the initial clinical assessment was performed, quantitative assessment of balance problem was done using Balance Master system.

Apparatus : The Smart Balance master with software version 3.4 was used for this study. It consists of two adjacent forceplates measuring 9 inches X 18 inches. Each forceplate rests on two force transducers with the sensitive axes oriented vertically. The transducers are mounted along the front-to-back centerline of each forceplate. A cable carries the forces detected by the forceplates to a computer interface. Thus the computer receives force measurements from the dual forceplates, analyses the information, generates a screen display or gives a printed report. One of the monitors of the computer is positioned at the eye-level in front of the patient while the second monitor is provided for the operator. There is also a visual surround dome, which can either be moved separately or along with the forceplate system in the antero-posterior axis at various difficulty levels.

The system can assess quantitatively the basic components of balance control by means of six standard protocols. It has got facilities for assessment and treatment sessions under altered visual and surface support conditions. The assessment and training results using the visual feedback can be objectively documented for further reference to the changes in the post-treatment session.

Assessment : The particulars of the patient including patient demographics and height of the patient were recorded. According to the height of the individual, the foot placement on the force plate is adjusted into three standard positions. Then the following tests were carried out and recorded: (i) Align COG-eyes open, fixed surface (ii) Align COG-eyes closed, fixed surface (iii) Align COG-sway vision, fixed surface (iv) Align COG-normal vision, sway surface, (v) Align COG-eyes closed, sway surface (vi) Align COG-sway vision, sway surface.

The sensory organization tests can isolate the three sensory input components responsible for the disturbance of body balance system. Before the actual assessment, the patients were made familiarized with the test batteries. Weight bearing on two lower limbs in terms of percentage of weight distribution on the two lower limbs was also recorded for hemiplegic patients.

The software programme in the system can perform a standard sequence of tests for comparison to the normative data and can create or perform a customized sequence of tests or exercise program. Facilities for review of test or exercise data are also available with this system. The stored data can easily be retrieved later on, for easy comparability with post-training results. Thus, an objective outcome of the static and dynamic measures of balance between pre-and post training sessions can be obtained from this system.

Therapy protocol : After initial documentation of the balance deficit areas, thereapy using visual biofeedback was given using the system. It was aimed to improve COG alignment, to reduce postural sway and to increase LOS. Therapy session was given for 3-6 weeks duration on alternate days, each session lasting for 30-45 minutes duration. In addition, the hemiplegic patients also practised to transfer equal weight on the lower limbs, as they tend to transfer less percentage of body weight on the affected lower limb.

Dynamic control of balance was practised as the patient attempted to reach the peripheral targets at increasing LOS cone, while considering the factors like movement time, excess pathsway, distance error, asymmetry etc.

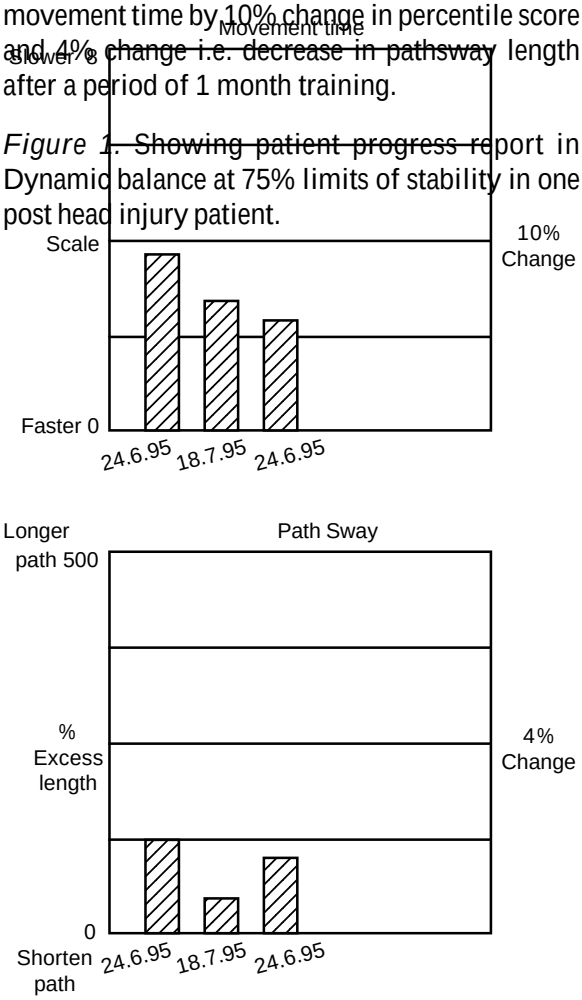
Data analysis : Pre-test and post-test scores in static and dynamic measures of balance were

analysed in percentile scrores relative to a clinically normal population. Though no functional improvement scores were used in this preliminary study, we attempted to find out the quantitative progress in percentile scores with available normative data.

Results :

Figure no. 1. shows a progress of record on a patient of post-head injury with balance problem over the period of treatment course. We found improvement in dynamic balance measures like movement time by 10% change in percentile score and 4% change i.e. decrease in pathsway length after a period of 1 month training.

Figure 1. Showing patient progress report in Dynamic balance at 75% limits of stability in one post head injury patient.



– Bar shows average score
– % change is from the first to the last test period shown

Even though we did not use to record functional improvement scores in these patients, subjective improvement was reported by all the patients in mobility and locomotion with confidence. The mean improvement in percentile scores in case of cervical spodylosis patients with symptoms of dizziness, after the treatment course is shown in table no. 2. All the scores were expressed in percentile relative to a clinically normal population available with the software of the system. The average number of treatment session lasted about 18 sessions. The average stability improved from pre-treatment 54% to 70% at post-treatment. And the improvement for static balance was 16% while that of dynamic measures of balance were recorded as 25% decrease in movement time and 40% decrease in pathsway length.

TABLE NO. 2

Showing mean improvement in % scores expressed in percentile scores in patients of cervical spondylosis with symptoms of dizziness after treatment course (n = 10).

Sl. No.	Balance components	Mean % improvement	Range
1.	Static balance improvement	16%	7-26%
2.	Dynamic balance improvement		
	Movement time	25%	15-53%
	Excess pathsway	40%	18-47%
	Distance error	12%	6-16%
	Asymmetry	11%	9-22%
3.	Average stability		
	Pre-treatment	54%	49-58%
	Post-treatment	70%	63-84%
4.	Average Number of treatment sessions	18	15-21

Table no. 3. shows the mean improvement in balance components in hemiplegic patients after the treatment course. Static balance improvement was 12%. In regards to dynamic balance measures,

the improvement observed in the hemiplegic patient group was maximum decrease in excess pathsway by 72%, while movement time and

TABLE NO. 3

Showing mean improvement in percentile scores in patients of hemiplegia with balance problems (n = 5).

Sl. No.	Balance components	Mean % improvement	Range
1.	Static balance improvement	12%	8-18%
2.	Dynamic Balance improvement		
	Movement time	33%	25-39%
	Excess pathsway	72%	50-81%
	Distance error	32%	28-36%
	Asymmetry	14%	7-24%
3.	Average stability		
	Pre-treatment	49%	36-60%
	Post-treatment	61%	54-67%
4.	Average Numer of treatment sessions	20	15-24

TABLE NO. 4

Showing mean improvement in percentile scores in patients of head injury with balance problems (n = 3).

Sl. No.	Balance components	Mean % improvement	Range
1.	Static balance improvement	14%	10-16%
2.	Dynamic Balance improvement		
	Movement time	25%	21-27%
	Excess pathsway	23%	12-40%
	Distance error	13%	9-16%
	Asymmetry	10%	7-18%
3.	Average stability		
	Pre-treatment	40%	39-42%
	Post-treatment	55%	50-58%
4.	Average Number of treatment sessions	17	12-24

asymmetry decreased by 33% and 32% respectively. Overall average stability improved from 49% at pre-treatment to 61% at post-treatment.

Table no. 4. shows the mean improvement in balance components in the head injury group. The improvement in static balance after the treatment course was 14%. They also showed improvement in dynamic measures of balance. The decrease in movement time was 25% and those of excess pathsway, distance error, asymmetry were 23%, 13%, 10% respectively. Moreover, the average stability improved from 40% at pre-treatment to 55% at post-treatment.

One patient with cerebellar ataxia showed improvement in the static balance by 10%. Decrease in 30% movement time, 68% decrease in excess pathsway, 32% decrease in distance error and 13% decrease in asymmetry was recorded as the improvement in dynamic balance. The overall average stability improvement was from 42% at pre-treatment to 68% at post-treatment.

Discussion :

The measure of body sway in a static central position is often used as an indicator of postural stability[5]. Hamman and colleagues[5] observed no significant change in static postural sway in normal population subjected to visual feedback of COG from Balance Master system. However, in the present study, all patient spectrums showed improvement in static postural sway. All the patients had significant balance deficit. Hence, the improvement in static postural sway was significant in this study group. This finding is in agreement with Brandt T et al[8], who have also concluded that the percentage of improvement through training depends upon the degree of initial instability. The present finding of improved static balance in terms of postural sway using visual biofeedback was also in agreement with the finding of other series on hemiplegic patients[3,9]. Winstein CJ and collegues[9] studied the effects of

standing balance training using forceplate system in hemiparetic adults. They observed that hemiplegic subjects trained with feedback device showed significantly better static standing symmetry than those who did not receive augmented feedback ($p < 0.05$). Shumway-Cook A et al[3] also studied the effects of centre of pressure biofeedback in hemiplegic patients and found greater improvement in stance symmetry and static postural stability in experimental group of patients than those in conventional therapy groups.

In the dynamic balance assessment also, all the patient groups showed significant changes from pre-treatment to post-treatment mean scores. In all the groups this was more so in the two variables viz., movement time, pathsway or path length. The mean improvement in movement time ranges from 25% to 33% and that of pathsway from 23% to 72%, while trying to reach the peripheral targets within the LOS cone. Liston RAL et al[9], in a study of stroke patients to find out the validity outcome measures of Balance Master system, observed that movement time and pathsway were found as highly reliable measures of balance performance in stroke patients. Therefore, the present finding showing maximum improvement in the two dynamic measures of balance viz., movement time, pathsway could be taken as comparable with such observation in stroke patients[9]. Moreover, all patients reported subjective improvement in mobility, locomotion and skills of transfer with more confidence, even though we did not use functional improvement scores in this preliminary study.

Inspite of the improvement in average stability after the treatment as observed in this preliminary study, proper patient stratification, valid and reliable paramenter selection is warranted to come to a definite conclusion. However, quantitative assessment of balance problems allows better understanding of defective balance components. And, we can specifically plan to stimulate the defective component or other functioning sensory inputs to compensate the defective components of balance. Observation from this preliminary study suggests that visual biofeedback training facilitates appropriate balance strategies and also enables in achieving improved postural control. Functionally also, improvement in mobility and locomotion with confidence is achieved with improved postural control.

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Primary Prevention of Coronary Heart Disease

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Introduction

The rise and fall in the CAD mortality in the western world in the latter half of the 20th century, correlates directly with changes in lifestyle in the society rather than changes in the genetic pool. In India, a similar life style transformation with enormous significance is taking place; the middle class is undergoing tremendous changes in lifestyle and socioeconomic factors such as acquiring cars and consuming increasing amounts of alcohol and tobacco. Eating patterns are also changing rapidly with greater use of fast foods, meats and fats. These changes are leading to sedentary habits and increased consumption of unhealthy foods. An epidemic of CAD is already underway in India because of these factors. There is also an age related increase in CAD in India. The onset of CAD in younger aged individuals is a cause of concern. Genetic factors that are modified by environment could be important.

Primary Prevention

The World Health Organization (WHO) has defined primary prevention of coronary heart disease (CHD) as prevention of the first events of these diseases beginning early in childhood and continuing through out childhood, youth and adult life.

What is primary prevention?

- Educating people about risk factors and lifestyle changes to reduce risk.
- Identifying and altering risk factors to prevent the onset of cardiovascular diseases leading to heart attack or stroke.

AHA Recommendation

The decline in death rates from cardiovascular disease is probably largely due to the public adopting a healthy life style. This underscores why it's important for the medical profession to advocate prevention strategies.

Primordial Prevention

Primordial prevention is defined as prevention of risk factors themselves beginning with the social and environmental conditions in which the major risk factors are observed to develop, and continuing for high risk children, adolescents and young adults.

Cardiovascular risk factors

The 27th Bethesda Conference on Matching the Intensity of Rsik Factor Management with the hazards for Coronary Disease Events is a landmark document that offers clear guidelines for management of risk factors.

CARDIOVASCULAR RISK FACTORS BASED ON PRIORITY FOR INTERVENTION

Class 1 : Factors for which interventions have proved to lower coronary artery disease risk.

- Cigarette smoking
- High LDL cholesterol
- High fat/cholesterol diet
- Hypertension
- Left Ventricular Hypertrophy
- Thrombogenic factors

Class 2 : Factors for which interventions are likely to lower coronary artery disease risk.

- Diabetes Mellitus
- Physical inactivity
- Low LDL cholesterol
- High triglycerides; small dense LDL
- Obesity
- Postmenopausal status (women)

Class 3 : Factors that if modified might lower coronary artery disease risk

- Psychosocial factors

- Lipoprotein (a)
- Homocysteine
- Oxidative stress
- No alcohol consumption

Class 4 : Factors that cannot be modified or for which modification would be used would be unlikely to lower coronary artery disease risk.

- Age
- Male Gender
- Low socioeconomic status
- Family history of early onset CVD

Guide to Primary Prevention of Heart Diseases

Diet

The results of 50 years of intensive research support the conclusion that diet is the major environmental cause of atherosclerosis and cardiovascular diseases. A high caloric density of diet due to high fat content combined with limited physical activity contributes to obesity, insulin resistance and dislipidemia. All these abnormalities increase the risk of CAD. Salt intake in susceptible persons is associated with elevated blood pressure, the foremost risk factor for stroke.

Cholesterol Management

PRIMARY GOAL -

LDL cholesterol less than 160 mg/dl if there is no more than 1 risk factor or LDL less than 130 mg/dl, if there are 2 or more risk factors.

SECONDARY GOAL -

HDL cholesterol greater than 35 mg/dl. Triglycerides less than 200 mg/dl.

RECOMMENDATION -

The American Heart Association Step I Diet - no more than 30% of calories as fat, 7-10% of calories as saturated fat and less than 300 mg of dietary cholesterol per day.

If LDL cholesterol is 160 mg/dl or greater with no more than one risk factor or is 130 mg/dl or greater on 2 occasions with two or more risk factors, then AHA Step II Diet - less than 30% of calories as fat, no more than 7% of calories as saturated fat and less than 200 mgs per day of dietary cholesterol- as well as weight control. The secondary causes of high LDL cholesterol (liver function tests, thyroid function tests, uric acid) should be ruled out.

If LDL cholesterol is 160mg/dl or greater with 2v risk factors, or 190 mg/dl or greater, or 220 mg/dl or greater in men under age 35 or in pre-menopausal women, then drug therapy can be added on to the Step II Diet.

Smoking

GOAL-Complete cessation

RECOMMENDATIONS

- Ask about smoking status as part of routine evaluation. Reinforce nonsmoking status.
- Strongly encourage patient and family to stop smoking.
- Provide counseling, nicotine replacement and formal cessation programs as appropriate.

Blood Pressure Control

GOAL- less than 140/90 mm of Hg in people with diabetes, heart failure or renal insufficiency.

RECOMMENDATIONS

- Measure blood pressure in all adults every 2-21/2 years.
- Promote lifestyle modification: weight control, physical activity, moderation in alcohol intake, moderate sodium restriction.
- If blood pressure is greater than 140/90 mm Hg: Add blood pressure medication to patient's other requirements and characteristics.

Physical Activity

GOAL - Increase amount; exercise regularly; 3 to 4 times per week for 30-60 minutes

RECOMMENDATIONS

- Ask about physical activity status and exercise habits as part of routine evaluation.
- Encourage at least 30-60 minutes of vigorous, dynamic exercise 3 or 4 times per week as well as increased physical activity in daily life habits for persons who are inactive.
- Encourage regular exercise to improve conditioning and optimize fitness levels.
- Advice medically supervised programs for those with low functional capacity and health problems.
- Promote environmental factors conducive to health.

Weight Management

GOAL - Achieve and maintain desirable weight (body mass index 18.5-24.9 kg/m2)

Recommendations :

- Measure patients' weight and height, body mass index (BMI), and waist circumference at each visit as part of routine evaluation.
- Start weight management and physical activity as appropriate. Desirable BMI range : 18.5-24.9 kg/m2. People with a BMI of 25-29.9 are considered overweight, while people with a BMI of 30.0 or higher are considered obese; desirable waist circumference 88 cm (35 inches) or less for women, 102 cm (40 inches) or less for men.

Trials on Primary Prevention :

Two important large primary trials that have been done are the following :

4S. The Scandinavian Simvastain Survival Study (4S) examined whether cholesterol reduction with simvastatin in persons with CHD and elevated cholesterol would reduce total mortality. A total of 4,444 patients with angina or prior MI whose total cholesterol level was between 212 and 310 mg/dL were randomized to simvastatin or placebo. The simvastatin dose was initially 20 mg/day and was titrated to 40 mg/day in an attempt to reduce the total cholesterol leel to less than 200 mg/dL. Patients were followed for a mean of 5.4 years. There were 111 deaths in the simvastatin group and 189 in the placebo group, resulting in a highly significant 30% relative reduction in total mortality (p<.0001). The relative risk of a major coronary event was reduced by 34% (p<.00001). Revascularization procedures, such as coronary bypass surgery and percutaneous transluminal coronary angioplasty, were also significantly decreased by 37%. An economic analysis based on the 4S data concluded that in the United States, the reduction in hospital costs alone as a result of simvastatin treatment would offset the entire cost of the medication. An interesting finding was that it was not only patients with the highest cholesterol levels who benefitted from treatment; the quartile with the lowest low-density lipoprotein (LDL) cholesterol levels at baseline had proportionately as much benefit from treatment as the highest quartile.

WOSCOPS. The first was the landmark WOSCOPS. This study included 6,595 healthy Scottish men from 45 to 64 years of age with a fasting total cholesterol level greater than 252 mg/dL and an LDL cholesterol level ranging from 174 to 232 mg/dL. Although none of the study participants had documented CHD, 5% had a positive Rose questionnaire indicative of probable angina. Patients were randomized to pravastatin, 40 mg/day, or placebo, and followed for a mean of 5 years. The primary end point of the study was nonfatal MI or CHD death.

There were 248 (7.9%) definite events in the placebo group and 174 (5.5%) definite events in the pravastatin group, resulting in a 31% reduction in the relative risk of nonfatal (first) MI (Figure 2) or CHD death (p<.001) in the pravastatin group. In addition, there was a significant 32% reduction in cardiovascular mortality (p<.033) and a 37%

reduction in revascularization procedures (p<.009). There was no significant difference in non cardiovascular mortality, indicating that cholesterol reduction with pravastatin did not increase the risk of death from other causes. In fact, the relative risk of death from any cause was reduced by 22% in the pravastatin group over the entire duration of the trial. This study clearly established the benefit of cholesterol-lowering treatment, even in persons without prior evidence of CHD. A pharmacoeconomic analysis suggested that treatment can be highly cost-effective, especially if it is targeted to individuals at the highest risk of acute coronary events.

Coronary Risk Factors Greater in Urban Indians

Sedentary lifestyle
Hypertension
Body-mass index, obesity
Waist:hip ratio, truncal obesity
Total and LDL cholesterol, hypercholesterolaemia
Triglycerides levels
Fasting insulin levels, insulin resistance

Conclusions

In summary, coronary heart disease in India can be prevented by controlling intake of tobacco, salt, saturated fats, and calories; by increasing both work-related and leisure-time physical activity; increasing consumption of heart healthy foods such as fruits and vegetables, high fiber cereals, oils containing balanced amounts of polyunsaturated and monounsaturated fats (e.g., canola (genetically engineered mustard-rapeseed) oil, soyabean oil), and spices and cereals with high flavonoid content. Stress management techniques especially yoga may be important. Reverting to traditional Indian social lifestyles (joint families, small families, and good education) is also important.

Before embarking on an ambitious prevention program it is essential to realize the problems in its implementation. Barriers to a national cardiovascular disease prevention policy are : competing priorities with infectious diseases, lure of technology-based interventions in cardiology which relegate preventive cardiology to the periphery, inadequate CHD epidemiological data in the form of cohort studies, poor presentation of message to policy-makers and the media who do not realize that CHD is preventable, discordant messages released by various vested interests, failure to recognize the importance of prevention and its cost-effectiveness, lack of peer recognition for prevention efforts, economic and social constraints, vested interests of food-groups and tobacco companies, and lack of community mobilisation. The need to contain the epidemic as well as combat its impact and minimize the cardiovascular diseases toll in Indians is obvious and urgent. National strategies to meet this objective must be developed and effectively implemented. Regional and global initiatives by international agencies concerned with health care are required. Physicians have key roles in this regard. This group of health care workers can interact with other community sectors and spread the message of prevention at various levels (Table 4). However, as always, the need for prevention should come from within the population. A large number of social issues that are determinants of health behavior must be considered. These are high levels of illiteracy, nuclear family structure, breakdown of traditional family system, improper peer influence and guidance, caste system, social heirarchy, lack of media awareness, and unwillingness to change. Increasing levels of affluence and acculturation leads to greater recognition that preventive measures of chronic diseases are useful and cost-effective.

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Advances in Lower Extremity Prosthetics

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The earliest reference to Lower Extremity Prosthetics is from the Rig Veda from the period 3500-1800 B.C. It gives the account of a militant Queen who lost her leg in a battle, had it replaced with an iron prosthesis and subsequently returned to combat. Ambrose Pare constructed a metal above knee prosthesis with articulated joints in the middle of the 16th century.

Contemporary advances in Prosthetics include simple but highly effective Solid Ankle Cushioned Heel (SACH) foot developed in 1956 and the Patella Tendon Bearing Below Knee Prosthesis in 1959, both from the University of California. The Hydra Cadence unit was developed in 1960 and helped commercialize Hydraulic Knee units. The Endoskeletal Prosthesis was introduced in 1971 and a new generation of Prosthetic feet was introduced in the 1980's.

Lighter and stronger materials have been developed in the fabrication of Prosthesis. Carbon fiber, Titanium, Thermoplastic material, Silicone to name a few has made the prosthesis lighter and improved function in the amputee.

The following will be discussed briefly :

1. Suspension and harness systems.
2. Socket designs for the above and below knee amputee including the flexible socket design.
3. New Knee units
4. Prosthetic feet Dynamic Elastic response (Energy storing feet)
5. Custom design in lower extremity prosthetic for athletic activity
6. Computer Automated Design and manufacture of Prosthesis

Suspension and Harness system

Good functioning of a prosthesis begins with a stable base of support. In general, the appropriateness of a given suspension system will depend on both the length and shape of the residual limb.

Silicone suspension :

Silicone liners offer a solution to those patients who could benefit from suction, but are unable to manage the often-difficult process of donning. A silicone locking liner used for the below knee amputee also can be used for the above knee amputee. It is used with a pin and shuttle lock. It allows for volume fluctuations through the addition of Prosthetic socks. Longer limbs may not allow sufficient space for the shuttle lock hardware and result in a knee center discrepancy. Rotational control caused by weak musculature or redundant tissue can be corrected by the addition of a belt.

Total Elastic Suspension :

A recently available alternative to Silesian suspension is the total elastic suspension or TES belt. It is made of Neoprene with reinforced elastic bands running in oblique angles anteriorly and posteriorly. No rivets are required to attach the belt to the socket. The belt is pulled up snugly around the proximal part of the socket. The patient wears the belt around his waist, and fastens it anteriorly with velcro. The belt is available in prefabricated

sizes ranging from infant to adult extra large. This can also be custom made for bilateral amputees. Sometimes the Neoprene does not conform well. Newer materials have elastic in them, which conform better. The TES belt also covers and spreads pressure over greater surface area. It is also a great auxiliary suspension for patients who need it only occasionally for higher activities such as sports, because it can be applied or removed by the patient as needed.

Socket Designs

The Flexible socket : Before 1980's all sockets were made from rigid materials which included laminated plastics or wood. Patients complained of inability to sit comfortably and lack of tactile feedback through socket walls. Kristinesson developed a technique to construct a socket with flexible walls. Working with colleagues in Scandinavia and the United States, they refined a technique of a rigid frame within which a thermoplastic liner resides. The Socket was termed the ISNY socket (Icelandic-Scandinavian-New York) socket. The 1987 consensus conference described flexible sockets as having the benefits of improved sitting comfort, improved proprioception, better heat dissipation, improved muscle activity, reduced weight and enhanced suspension if suction is used. Also the socket can be interchanged more readily without loss of alignment, should it require replacement because of wear or slight change in patient residual limb volume. A biomechanical study in 1986 showed that the femoral position was virtually identical in a flexible socket as that of a rigid socket.

Ischial Containment Socket

In 1975 Long noted that the adduction of femur in many instances did not match the adduction of the Quadrilateral prosthetic socket when observed through radiographs. This he concluded was the reason that many patients had an inefficient adductor lurch during gait. He narrowed the medial-lateral dimension to gain better control of the femur. He also believed that when the ischium is located on the brim or seat, the quadrilateral socket tends to move laterally on weight bearing. Ischial containment sockets are also narrower from medial to lateral than their quadrilateral counterparts, hence the name Narrow M-L Socket.

Workshop on Above Knee Fitting Techniques held in Florida in 1987 reached the following consensus :

1. Maintain normal femoral adduction and narrow based gait.
2. Enclose ischial tuberosity and ramus in the socket so that forces involved in the maintenance of medial lateral stability are borned by the bones of the pelvis medially and not by the soft tissues.
3. Maximize effort to distribute forces along the shaft of the femur.
4. Decrease emphasis on a narrow anterior posterior diameter to maintain ischial gluteal weightbearing.
5. Provide total contact.
6. Use suction socket suspension where indicated.

The term ISCHIAL CONTAINMENT became widely used subsequent to this workshop and is now a generally accepted term.

Prosthetic Feet

There are a number of criteria to consider when deciding on a prosthetic foot with an amputee. The most universal criteria are shoe size, heel height, patient weight, left or right, activity level, and maintenance. Some of the subjectivity has been removed from the category of activity level with the creation of the Medicare HCFA prosthetic K levels. The levels Ko to K4 describe and define amputee activity levels from the non-prosthetic candidate Ko to high level athletes K4. K levels represent potential functional abilities as defined

by Medicare. Patient records must document the patients' current functional capabilities and his or her expected functional potential.

Prosthetic K Levels

K0: Does not have the ability or potential to ambulate or transfer safely with or without assistance and a prosthesis does not enhance the quality of life or mobility.

K1: Has the ability or potential to use a prosthesis for transfers or ambulation on levels surfaces at fixed cadence. Typical of the limited and unlimited household ambulator.

K2: Has the ability or potential for ambulation with the ability to traverse low level environmental barriers such as curbs, stairs, or uneven surfaces. Typical of the limited community ambulator.

K3: Has the ability or potential for ambulation with variable cadence. Typical of the community ambulator who has the ability to traverse most environmental barriers and may have vocational, therapeutic, or exercise activity that demands prosthetic use beyond simple locomotion.

K4: Has the ability or potential for prosthetic ambulation that exceeds basic ambulation skill, exhibiting high impact, stress, or energy levels. Typical of the prosthetic demands of the child, active adult, or athlete.

The Energy stroring (Prosthetic Feet) have the characteristics of storing energy during stance and releasing it during toe off. Compared to the SACH foot it allows a small increase in stride length and subsequent walking velocity and it is more amenable to passive dorsiflexion in mid stance, hence allowing a normal extensor movement at the knee. The following feet will be briefly discussed :

The Flex Foot
The Variflex
Springlite
Carbon 2
Arthroglide systems
Total Concept

Custom Design in Lower Extremity Prosthetics for Athletic Activity

Prosthetic adaptations can be made specifically to help the amputee to be physically more active, enhancing the quality of life and health of the individual. An increasing interest on the part of the amputee to extend the scope of physical activity, in particular, sports and recreation prompted a survey asking lower limb amputees what functions they missed most and what areas of prosthetic improvement should be addressed to improve quality of life. The survey overwhelmingly indicated that the most needed function was the ability to move quickly and to run. Most blamed the socket and the foot.

Different sports require the amputee to perform at different levels of activity, and his or her prosthesis should be designed to the level of demand placed on it. The runner requires the prosthesis to attenuate the impact of heel strike, to allow a long stride length and to provide propulsive impulse at the end of stance Golf has different demands. The golfer must be able to endure long period of standing and ambulating over uneven terrain and must be stable when twisting. A basketball player needs significant shock absorption at heel strike. For someone who desires to enter a walking programme and has no intention of running or jogging, shock absorption through heel compression is very important. There are numerous components available that can reduce the shear on the residual limb. One such liner currently available uses a urethane material. Shock absorption can also be increased by use of a telescoping pylon in the prosthesis. Vertical displacement is allowed in the prosthesis to decrease the effect of high impact on the residual limb. This design has a telescoping pylon with adjacent leaf spring.

Some sports generate more torsion and the amputee benefits from rotation within the

prosthesis. Golfers are one group that appreciates this motion when trying to achieve a smooth swing with appropriate transfer of body weight. A rotator allows the amputee athlete to achieve a desired body position with a natural degree of pivot at the toe.

Water sports present a unique prosthetic requirement. Everyday prosthesis do not fare well in water. Prosthesis made of plastic and composite materials can be used; though even these absorb moisture at the molecular level. Covering a prosthesis makes it buoyant, which can make swimming and diving difficult. For underwater use, it is advisable to create a prosthesis that fills with water to compensate for buoyancy and then drains when out of the water.

Special feet for rock climbing have been fabricated that incorporate the specific traits suitable for that sport. These feet must be rigid to the end of the toe to support body weight. Standard prosthetic feet have a flexible toe break to facilitate roll over after mid stance, so are not optimal for climbing.

3C100 C-Leg System by Otto Bock

The C leg is the world's first completely microprocessor controlled prosthetic knee/shin system with hydraulic swing and stance phase control. The product is so revolutionary that amputees who have been fitted with this often state that its most obvious benefit is that they do not have to think about walking any more.

The unique relationship between the microprocessor and the hydraulic pneumatic system enable the C leg to offer amputees the closet possible approximation to their natural gait. Electronic sensors in the C leg collect real-time data that control stance and swing phase movements of the knee, while meeting the full range of stability and functional needs. The electronic systems monitors how the amputee is walking and creates a smooth, harmonious movement of the prosthetic limb, similar to that of the sound leg, immediately adapting to different walking speeds and providing knee stability.

Individual adjustments are optimized during the fitting by interfacing the knee with a personal computer. Unique software algorithms determine the phase of gait, then immediately adjust the knee function to compensate. Multiple sensors in the C leg record this information 50 times per second during a typical gait cycle, greatly reducing the risk of the amputee making a mistake. This is perhaps the most advance knee to date. It samples information on knee position; velocity and strain generated in the pylon and adjusts the hydraulic resistance for proper swing rate and stance control.

The product is designed for a broad spectrum of lower limb amputees. It can be used by extremely mobile individuals as well as those who need additional stance stability. The leg is recommended for amputees weighing upto 220 lbs. who have a moderate or higher functional level.

The lithium-Ion battery in the knee provides 25 to 30 hours of use before needing a recharge.

Book Review

Neurological Rehabilitation Principles & Practice (2nd Edition).

A.B. Taly, K.P. Sivaraman Nair, T. Murali, editors.
New Delhi: Ahuja Book Co. Pvt. Ltd.; 2001. 302 pp. illustrated, paperback. Rs 185.

The editors A.B. Taly, K.P. Sivaraman Nair and T. Murali are amongst the eminent faculty at the prestigious National Institute of Mental Health and Neurosciences (NIMHANS), Bangalore, India. Taly and Murali have been engaged in Neuro-Psycho-Social Rehabilitation at busy institutional setting for over a decade. They roped in a plethora of specialists from India and abroad, coming from different fields viz., Physical Medicine & Rehabilitation, Neurology, Neurosurgery, Psychiatry, Urology etc. to contribute chapters on their special interest topics and came out with first edition of the book in 1998. This was a pioneering effort in the country and welcomed by not only physicians but also by paramedics engaged in neuro-rehabilitation. The second edition is a more than worthy successor to the first edition. There are many additions in this new edition with new chapters on biofeedback, orthotic management, geriatric rehabilitation and neuro-surgical aspect of cerebral palsy rehabilitation.

The first four chapters are introductory in nature. The reader is gradually initiated into details on different aspects of rehabilitation and neurological rehabilitation in particular, specially the concepts and dynamics of neurological rehabilitation. In different chapters psychosocial and vocational aspects of rehabilitation are also elaborated wherever applicable. In keeping with the ever-advancing technological scenario in the field of rehabilitation, chapters on balance rehabilitation and role of functional electrical stimulation (still in experimental labs in India) in neurological rehabilitation are included. Integration of rehabilitation services into community-based rehabilitation has been elaborated upon with traumatic brain injury rehabilitation as model.

The appendices are a very useful source of information, specially the one on benefits for disabled in India. Other appendices depict line diagrams and colored plates explaining different procedures, complications, exercise techniques, adaptive devices and desirable & undesirable postures. At a few places some disparity is found in the description of the diagram but this anomaly will hopefully be corrected in the subsequent reprint or edition. In addition readability can also be improved with two-column format rather than a single column print at present.

Overall a useful quick reference for physiatrists, neurologists, neurosurgeons, psychiatrists in practice and other physicians dealing with patients requiring rehabilitation. It will also be found beneficial for in-training residents in these fields as an adjuvant to larger comprehensive texts. Color plates may also be used to explain different procedures and complications etc to the patients as well.

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Editor's Note

TRUTH SHALL PREVAIL

The Speciality of Physical Medicine and Rehabilitation came into existence about 60 years back and has spread and evolved differently in different countries according to need. In some of the western and developed countries it has developed mainly for life long care of disabled persons but the emphasis every where is still on making patient useful and active component of the society. Compared to other medical spcialities, the development of physical medicine and rehabilitation has not been as radical as it could have been. The trends in other medical specialities have been in the direction of knowledge and skills while we are still sitting as managers and team leaders. It is a known fact that modern world will respect persons with knowledge and skill, not mere managers. We must strive for it.

We have cut our umbilical cord too prematurely. Orthopaedics is the mother speciality from which PMR has evolved and we should continue to develop our skills in the overall management of disabled. There is every reason for us to enter the operative and plaster work in correction of deformities like the ones encountered in polio, cerebral palsy, leprosy, spinal cord injuries (including tuberculosis of spine), peripheral nerve injuries, rheumatoid affections, congenital anomalies, amputations etc. etc. Patients stand to gain from it, and so do we. Local injections, management of pain clinics, phenol and botulinum toxin injections, diagnostic arthroscopy, sports injuries management and training of sports persons, are our natural allies. Orthopaedic surgeons have already started shedding these areas from their routine work and patients do need specialists ready to devote time for this work. A word of caution is essential while undertaking NCV/EMG studies, lest we become "supporting technicians" to the "super specialists". Cardiac Rehabilitation should be done by persons possessing some basic cardiology qualifications, else we get 'blame' and cardiologists get 'name'. Whichever field we tread on, we should be masters of our work.

A thought about nomenclature of the speciality. The word 'physical' has done obvious damage to our identity. Why not shed it? Many specialities have strived for getting their identify by renaming like 'Transfusion Medicine', 'Laboratory Medicine', 'Critical Care Medicine' and so on. We are certainly not experts in rehabilitation of persons affected from supercyclone and earthquake victims or rehabilitation of displaced persons or any other social work. We are practicing medical rehabilitation. Then why not rename our speciality as 'Rehabilitation Medicine"? We need not follow west blindly. We can set trends for them; and certainly they will follow us if our acts are rational. Have we not heard the voices of frustration from foreign faculties visiting our international conferences? The problem is about who will cross the threshold first. Let us!

The standard of teaching and training has remained abysmal in our speciality on the pretext of being new and evolving speciality. Candidates appearing for examinations and interviews clearly reflect the truth. Substandard candidates are awarded qualifications on the ground that ours is a new speciality and we need to build up manpower base. Let us remember that these candidates will form base of the speciality in future and quality of the eventual superstructure cannot be any better.

Bitter truths are difficult to swallow. But we have to face them sometime. Let us face it now, think over it and act in the best interest of the speciality, leaving our marks for the posterity.

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