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CONTENTS

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Structured Rehabilitation Exercise Program in Parkinson's Disease

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Abstract

Title of the article: A Study of structured rehabilitation exercise program in Parkinson's disease

Context: There is a growing need to address rehabilitation issues to supplement medical therapy.

Aims: To assess the impact of rehabilitation intervention in the functional status and quality of life in patients with Parkinson's disease.

Settings and Design: Prospective follow-up study in a teaching hospital

Materials and Methods: Twenty-eight cases with Parkinson's Disease on a stable pharmacological regimen and moderately disabled participated in this study. All patients were given the same set of exercises. During the first month, patients performed exercises under supervision at the hospital and rest of the days at home. In the second and third month, patients continued the same exercises at home. During the fourth month, patients maintained their usual level of physical activity but discontinued the exercises. All patients were evaluated at 0, 1, 2, 3 and 4 months. Outcome measures used were Unified Parkinson's Disease Rating Scale (UPDRS) version 3.0, Webster step seconds product, and Parkinson's Disease Quality of Life Questionnaire (PDQL)

Results: Significant improvements were observed in UPDRS section 1 (Mentation, behavior and mood), sections 2 and 6 (Activities of Daily Living), PDQL subscales (parkinsonian symptoms, systemic symptoms and social functioning), and Webster step-seconds product.

Conclusions: Systematic program of physical therapy is beneficial in patients suffering from moderately disabled Parkinson's disease. Activities of daily living like dressing, turning in bed and walking respond favorably to exercises. Quality of life improves considerably following exercises leading to increased social participation

Key Words: Activities of Daily Living, Exercise therapy, Parkinson Disease, Quality of life, Rehabilitation.

Introduction

An estimated seven million Indians are affected with Parkinson's disease (PD), a progressive neurological disorder. As the life expectancy of the general population increases, there is a large pool of at risk population and with better medications, patients with PD have increased life expectancy.[1] Hence the patient pool of PD is bound to increase and there is a growing need to address their rehabilitation issues to supplement medical therapy.[2] The strategies that are developed in rehabilitation are directed toward assisting patients with PD to manage activities of daily living (ADL), to remain as much independent as possible in home environment and to improve quality of life.[3] As early as in 1956, Bilowit[4] reported improvement in range and initiation of motion following exercise. Scientific studies to substantiate these issues are lacking in India and this study was initiated to fill this gap and gather preliminary observations which will be helpful in planning future studies.

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Material and Methods

Patients of any age and either gender diagnosed with PD by the UKPD Society Brain Bank Criteria, on a stable pharmacological regimen during period of study and for six months before entry into study and able to ambulate and function independently were included in the study. Patients having Hoehn and Yahr (HY) Stage 4/5 PD, dyskinesia, Parkinsonism variants, neurosurgical intervention, cognitive deterioration, psychiatric disturbances, head trauma, other neurological diseases and medical contraindications to exercise were excluded from the study. The procedures followed were in accordance with the ethical standards of the institutional committee. The program was of a 4-month period. All patients were taught the same set of exercises as described below for a period of 45 minutes to 1 hour.

Supine: Five repetitions of passive range of motion and stretching exercises for each major joint.

Sitting: 1.Neck exercises: Five repetitions each of flexion, extension, rotation and lateral flexion. 2. Breathing exercises.3. Stretching of the thigh muscles: Patients instructed to place one foot at a time on a chair in front and hold the knee with hands for a count of 10. Exercise to be repeated three times for each leg. 4. Knee extension: Sitting on chair, patient instructed to extend knees one at a time and hold at full extension for a count of 10. Exercise to be repeated five times for each leg.

Standing: 1. Stretching exercises: Standing with back up against a wall, making sure heels, shoulders and back of head all touch the wall for 1 minute, repeated five times in the morning. Standing facing the wall, raising both hands and placing the palms of hands on the wall. Slowly the hands are pushed up the wall as far as they can reach. The stretch force should be maintained for at least 15 to 30 seconds. This exercise is repeated 5 times in the morning. 2. Five repetitions of active flexion-extension of hip, knee and ankle joints holding a rail. 3.Balance training: In self induced responses, the patient displaces his or her own center of gravity outside the base of support by reaching upward and outward in various directions, focusing on counter-balancing motions of the upper and lower extremities and on protective responses. In externally induced balance responses, the therapist or care-giver gradually shifts the patient's center of gravity while eliciting normal righting responses. Exercise to be practiced for 5 minutes. 4. Rotation of trunk: Standing with feet slightly apart, arms are put out at shoulder level, then swung to the left and then to the right for 5 times. 5. Marching in place with swinging of the arms for 5 minutes.

Walking: Patient instructed to walk for 5 minutes with long steps, broad base of support and arm swing.

During the first month, patients performed exercises under supervision twice a week at the hospital and rest of the days at home. In the second and third month, patients continued the same exercises at home. During the fourth month, patients maintained their usual level of physical activity but discontinued the exercises. All patients were evaluated at 0, 1, 2, 3 and 4 months. During follow-up, the patients were evaluated at about the same time of the day and about the same duration after drug intake to decrease clinical fluctuations that may hamper evaluation. All patients were evaluated with UPDRS version 3.0 and a timed activity test described by Webster[5]. In the timed activity test patient was required to rise from a chair, walk 15 feet, turn around, and return to the chair. This time was multiplied by the number of steps taken with the right foot to provide a "step seconds" product. Additionally, the patients were evaluated with PDQL questionnaire at 0 and 3 months.[6] It has 37 items in four sub-scales: parkinsonian symptoms, systemic symptoms, social functioning and emotional functioning.

Results

Twenty eight patients (23 males and 5 females) with mean (±SD) age of 55.18 (±11.47) years satisfying the inclusion criteria participated in the study. Of the 28 patients enrolled into the study, only 20 completed the 4-month follow-up. The reasons for drop-out were change in medications (2), difficulty in transport (2), loss of health due to other causes (1) and loss of interest (1). Two cases were lost to follow-up and could not be contacted. Descriptive statistics including mean and standard deviation distribution were found out for each quantitative variable. To compare each of the quantitative parameters (UPDRS section 1) over a period of time, two way analysis of variance / Friedman's test was used. In case of significant result, multiple comparison test (Post hoc test / Bonferroni) was carried out to identify pairs of time-points when the parameters [UPDRS section 2, UPDRS section 3, UPDRS total (of sections 1, 2, & 3), UPDRS section 6 and Webster step seconds] had significantly different levels. A result was considered significant at 5% level of significance, that is, $P<0.05$. Results are tabulated in table 1. Significant improvement was observed in the first month and this was maintained through the rest of the study in UPDRS section 1 (mentation, mood and behavior), section 2 (activities of daily living), section 6 (Schwab and England activities of daily living scale) and Webster step-seconds product. No significant improvement was observed in section 3 of UPDRS (motor examination).

To compare scores related to quality of life between baseline and 3 months, paired t-test was used. Significant improvement was observed in three subscales of PDQL

			Baseline	1 month	2 month	3 month	4 month
UPDRS Section 1 (Mentation)	Mean		2.80	2.30	2.30	2.30	2.30
	SD		1.58	1.22	1.22	1.22	1.22
	P			*	*	*	*
UPDRS Section 2 (ADL)	Mean		10.30	7.55	7.55	7.55	7.55
	SD		3.15	2.67	2.67	2.67	2.67
	SE		0.70	0.59	0.59	0.59	0.59
	95% CI	Lower	8.83	6.3	6.3	6.3	6.3
		Upper	11.77	8.79	8.79	8.79	8.79
	P			*	*	*	*
UPDRS Section 3 (Motor)	Mean		22.35	21.60	21.60	21.60	21.70
	SD		8.79	8.66	8.66	8.66	8.66
	SE		1.96	1.94	1.94	1.94	1.94
	95% CI	Lower	18.24	17.55	17.55	17.55	17.65
		Upper	26.46	25.65	25.65	25.65	25.76
	P			†	†	†	†
UPDRS Section 6 (Schwab & England ADL)	Mean		80.00	86.00	86.00	85.50	84.50
	SD		3.24	5.98	5.98	6.05	6.05
	SE		0.72	1.34	1.34	1.35	1.35
	95% CI	Lower	78.48	83.20	83.20	82.67	81.67
		Upper	81.52	88.80	88.80	88.33	87.33
	P			*	*	*	*
Webster step seconds	Mean		153.28	135.57	136.62	136.52	139.30
	SD		41.58	38.06	37.73	38.79	41.10
	SE		9.29	8.51	8.44	8.68	9.19
	95% CI	Lower	133.82	117.76	118.96	118.36	120.06
		Upper	172.74	153.38	154.27	154.67	158.54
	P			*	*	*	*

Table 1: UPDRS Sections 1, 2, 3 & 6 and Webster step seconds (N=20). (N-number of cases, SD-Standard deviation SE-Standard error, CI-Confidence interval, *- Significant at 5% interval between baseline and the corresponding month, †- Not significant at 5% interval between baseline and the corresponding month)

		Mean	SD	SE	P value
Parkinsonian symptoms	Baseline	50.09	5.49	1.17	.000*
	3 month	53.59	5.23	1.12	
Systemic symptoms	Baseline	25.55	2.84	0.61	.000*
	3 month	28.36	2.49	0.53	
Social functioning	Baseline	21.05	5.55	1.18	.000*
	3 month	22.68	5.47	1.17	
Emotional functioning	Baseline	35.68	3.34	0.71	.104†
	3 month	35.86	3.33	0.71	
PDQL total	Baseline	132.32	14.20	3.03	.000*
	3 month	140.63	13.62	2.90	

Table 2: PDQL (Parkinson's disease quality of life) (N=22). (N-number of cases, SD-Standard deviation, SE-Standard error, *-Significant between baseline and 3 month, †- Not significant between baseline and 3 month.)

namely, in parkinsonian symptoms, systemic symptoms and social functioning. Emotional functioning subscale however showed no significant improvement. Results are tabulated in table 2.

Discussion

The results of our study show that moderately disabled PD patients (HY stages 1 to 3) show objective improvement following regular physical exercise, the improvement being significant in many of the standardized measures of PD severity. Exercise programme was kept to the minimum taking into consideration the fact that strenuous exercises may induce muscle stiffness which in turn may lead to deterioration of function.[7] The benefits of exercise were helpful in overcoming some physical limitations, which may be due to the disease or due to the inactivity and disuse following the disease. The improvements following exercise may not be considered as improvement in neurological condition but may be improved residual potencies left in the parkinsonian patient. However, animal experiments by Sutoo[8] et al found that exercise increases the dopamine level in brain.

Significant improvement in mentation subscale (section 1) of the UPDRS was observed as due to the improvement in motivation section. Improvement in motivation could be due to the self-realization of the patients about their exercise and mobility potential. There were no improvements in intellectual impairment, thought disorder, and depression sections of this sub-scale. Absence of use of separate depression scores (like Geriatric depression scale or Beck's depression inventory) may have been a drawback in this study. In normal persons, physical activity ameliorates mood which in turn improves motor performance.[9] Psychological factors are likely to influence motor performances in parkinsonian patients.[10,11] It is not possible to exclude the placebo effect of exercise but the insignificant outcome in the emotional functioning subscale of PDQL adds credence to the non-psychological benefits of exercise.

Improvements in ADL section of UPDRS (sections 2 and 6) were significant in spite of insignificant improvement in motor section (UPDRS section 3). Nieuwboer[12] et al found improvement in the UPDRS ADL section, but not in the motor examination, similar to our study. However, Comella[13] et al found that there was significant improvement in the UPDRS ADL and motor scores. Ellis[14] and Formisano[10] have reported similar improvements in ADL. Most of the improvements in our study were observed in dressing, hygiene, turning in bed and walking. Speech, swallowing, handwriting and tremor showed poor or no improvement. This could be due to the structure of exercise programme where occupational therapy and speech therapy were not incorporated. This could become the scope of future studies.

In this study there was no significant improvement in motor scores (section 3), but there was some improvement from baseline. Most of these improvements were observed in leg agility, arising from chair, gait and postural stability. Very little or no improvements were noticed in tremor, rigidity, speech, and bradykinesia. The reason for improved symptoms in lower limb when compared with upper limb may be due to the exercise program, which was more focused on lower limb mobility. Poor response of rigidity[7] and tremor[15] to exercise has already been recorded. Comella[13] et al reported significant changes in bradykinesia and rigidity, but they were short-lived and lost at follow-up. In this section of UPDRS, impairments where changes are seen following exercises are given less importance. It gives more importance to tremor and rigidity (48 points out of 108) which might be the reason for insignificant outcome reported in this study. The limited benefit may also be because of the fact that the patients were already well managed (since they were recruited from specialist neurology clinic) and hence a limited scope for further improvement. Maybe this sub-scale could have reached levels of significance if more patients had been studied.

Absence of change in modified HY staging (UPDRS section 5) is not surprising. This staging is accepted as a rough estimate of disease severity and may not be sensitive enough to detect changes in symptoms. Similarly much attention was not paid to section 4 of UPDRS since it evaluates complications of drug therapy, which was immaterial to the purpose of our study. However no new onset of complications or worsening of persisting complications was observed during the course of the study.

Improvement in gait was assessed through Webster step-seconds product. The improvement could have been due to increase in stride length or speed or both. More objective studies using sophisticated gait analysis machines may throw some light in this field. Similar improvements in gait have been reported by Fisher[16], Palmer[7] and others.[14,17,18] Though significant improvement was noted, the assessment was conducted at level ground in controlled environment and hence may lose significance when generalized to an external environment like a house or street where the grounds may not be leveled and several impediments in the form of steps, crowd or furniture may be present.

Significant improvements were noted in PDQL total and PDQL subscales (parkinsonian symptoms, systemic symptoms and social functioning). Improvement in quality of life following exercise therapy is evidently

documented.[19,20] The improvement in parkinsonian symptoms was observed as due to improvements in walking, getting up from chair and turning in bed. The improvement in systemic symptoms was observed as due to improved feeling of well-being and lessened feeling of exhaustion. The patients were better able to participate in social functions and recreational activities leading to significant outcome in social functioning subscale. However they still scored poorly in the question related to difficulties with transport which was possibly due to poor access for the disabled provided by the public transport system in the city. Insecurity, embarrassment, depression, concentration and memory were not improved by exercise programme and hence the insignificant outcome in emotional functioning subscale. The patients' acceptance of the fact that they suffer from an incurable progressive disease with uncertain course could be a reason for this. The effects of exercise program were specifically perceived by the patients as improvement in the quality of life in the domain of physical mobility leading to increased participation in their social roles. This confirms the specificity of the exercise program and the need to incorporate additional rehabilitative protocols to improve the quality of life in other domains like speech, swallowing and handwriting. The improvement in PDQL could also mean that the benefits of exercise programme are not limited to controlled environments (improvement in UPDRS), but can be extended to community dwelling patients.

In almost all parameters studied, there was no significant improvement after the first month, though the levels of performance were significantly better when compared with the baseline. Although patients received instructions to continue exercises regularly, some of them missed their regularity which might explain the mild loss of benefit in the second and third months. Failure to exercise in spite of preserved higher motivational status (UPDRS section 1) during the second and third months is but unexplainable. More loss was recorded in the fourth month when the patients stopped exercising as instructed. However the scores reflecting patients' performance at the end of the fourth month were still significant when compared with the baseline. This means that there is some carry over effect of the benefits of exercise over a period of one month. The duration of this extended benefit needs further study; probably a long term follow-up at 6, 9 and 12 months may be helpful in answering this question. Previous studies indicate loss of improvement around sixth month.[13]

Since no significant improvement occurred beyond the first month, it is advisable to limit the duration of treatment to this period. Exercise regimens are not easily integrated into a patient's lifestyle and hence regular follow-up visits may have to be arranged, preferably every 4 months as deterioration start setting at around this time as seen in our study. The disease being chronic and progressive, and the patients' being old and forgetful, it is imperative that follow-ups are stringent. Regular weekly exercises were sufficient to maintain fitness levels in parkinsonian patients comparable with age matched controls.[21] Need based house visits and community based programmes could be strengthened to cover a wider range of patients who may find it difficult to travel long distances and attend tertiary health care centers. Context (hospital / home) and content (physical therapy / occupational therapy / speech therapy) specificity of the rehabilitative interventions should be further studied. Cost-effectiveness of treatment strategies (group therapy / individualized / home-based / hospital-based) must also be studied in future.

Conclusions

Systematic program of physical therapy is beneficial in patients suffering from moderately disabled Parkinson's disease (HY stage 1 to 3). Activities of daily living like dressing, turning in bed and walking respond favorably to exercises. Improvement in gait is the most successful outcome observed in this study, though the generalization of this outcome in community dwelling PD patients is done with caution. Quality of life improves considerably following exercises leading to increased social participation. Further studies are needed to evaluate individual components of physical therapy (benefits of strengthening, balance training, etc.), speech therapy (for speech, swallowing, and drooling), occupational therapy (for handwriting), to quantify improvements in gait in terms of speed, stride length and other parameters using sophisticated gait analysis machines, to examine the cost-effectiveness of different treatment modalities or strategies, to evaluate the efficacy of exercises in delaying the initiation of drug therapy in early PD, and the benefit of exercises in slowing the progression of PD.

What we learn from this article

A minimum of one month of individualized exercise sessions conducted twice a week (under supervision) is necessary to have outcome oriented benefits in most of the co-operative and cognitively unimpaired PD patients. Exercise regimen done daily in the first month and at least thrice a week for the next two months provides benefits which are carried over another one month period, at the end of which some deterioration starts setting in. Follow-up every 4 month is recommended. Activities of daily living like speech, swallowing, and handwriting do not have favorable response from exercises. Occupational therapy and speech therapy may have to be incorporated in the rehabilitation intervention to have favorable

outcome in these areas. There is only a limited scope for improvement from exercises in motor symptoms of PD, like tremor, rigidity, and bradykinesia.

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Profile of Reconstructive Surgery Cases in Leprosy in Central UP - India: Experience of PPP Model

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Abstract

109 cases of leprosy were identified in the camps using private public partnership (PPP) between non-governmental and governmental organizations. The patients were admitted and operated free in the Department of Physical Medicine and Rehabilitation and Plastic Surgery, Chhatrapati Shahuji Maharaj Medical University, Lucknow during 2007-08. 75.2% were males and 24.8% females. Maximum cases (81.7%) were between 11 to 40 years. Overall illiteracy was 68.8%. 89.9% were having hand lesions with equal distribution in either hands in 32 cases each. Clawing of both hands was observed in 28 cases. Foot lesions were seen in 18 cases out of which nine cases each were of foot drop and plantar ulcer. In 84 cases (77.1%) Dermolipectomy with or without Zancolli procedure was performed. Tibialis Posterior transfer was done in nine cases of foot drop. The nine cases of plantar ulcer were treated by proper local dressing followed by below knee Plaster of Paris cast with walking iron (weight relieving) followed by PTB calliper with MCR padded open shoes. PPP helped identify more patients and get help to avail free treatment including surgery done at the government hospital including travel and food expenses paid by the non-governmental organization.

Keywords: Leprosy, Reconstructive surgery.

Introduction

With the introduction of multi-drug therapy (MDT) in 1982, followed by progressive implementation of short, fixed duration drug therapy gradually reduced the number of leprosy cases registered for treatment. However, it is estimated that out of nearly 500,000 existing leprosy cases, nearly 100,000 (20%) are in need of reconstructive surgery, some of them may require more than one surgery. The disability rate in one study was 16.23%[1]. In another study of 514 leprosy cases 229 (44.56%) had disability. Disability was most commonly seen in lepromatous leprosy. There was an increasing trend in disability with increasing age of patient and duration of disease. Disability rate was higher in males as compared to females[2].

There are a large number of leprosy cured patients in the rural areas who require reconstructive surgery to minimize the impact of deformity leading to reduced social stigma and rehabilitation. Reconstructive surgery has been done in camps successfully in various parts of the country. The reconstructive surgery also helps in functional improvement which is necessary for their activities of daily life. Due to many unavoidable reasons like poverty, illiteracy lack of awareness regarding reconstructive surgery, lack of transportation and lack of basic facilities even in Medical Colleges/District Hospitals, a majority of leprosy cases do not come forward voluntarily for reconstructive surgery even if it is provided to them free of cost.

An experiment of private public partnership (PPP) between Rotary International (RI), UP State Government and Chhatrapati Shahuji Maharaj Medical University (CSMMU), Lucknow was initiated. Experience from this approach are presented here on the work undertaken during 2007-2008.

Material and Methods

All three stake holders of PPP were invited to participate in a meeting which included representatives of Rotary

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International, State and District Leprosy Officers and consultants from two departments of CSMMU (Physical Medicine and Rehabilitation and Plastic Surgery). The meeting was aimed at finding out the means to mobilise the leprosy cured cases for reconstructive surgery at CSMMU. It was decided to have a camp approach in four stages.

Stage I. Capacity building by training of doctors and field workers engaged in National Leprosy Education Programme (NLEP) in three districts namely Lucknow, Barabanki and Hardoi, in UP, India. Lectures and case demonstrations of six hours each was done.

Stage II - The team of experts from CSMMU, District Leprosy Officer and member of Rotary international visited the rural areas for identification and selections of cases that required reconstructive surgery at different PHC/District Hospitals on specified dates and time.

Stage III- Preoperative physiotherapy and exercises were given to the patients for two weeks before undertaking hand and foot surgery. Admission of such cases in Department of Physical and Medicine Rehabilitation (PMR) was done followed by reconstructive surgery in Department of Plastic Surgery, CSMMU on a prefixed date.

Stage IV Immediate follow up of all operated cases, including proper supervised post-operative physiotherapy.

All the patients requiring reconstructive surgery along with one attendant were given free transportation from and to their home district to Lucknow. The patients were not charged the costs for admission, food, surgery, surgical supplies and medicines. Even for followup, the patients were reimbursed the transportation costs by Rotary International (RI). Average total cost of reconstructive surgery for each patient was approximately Rs.6500/-.

Fifteen rural leprosy camps were conducted in different PHCs and District Hospitals of Lucknow, Barabanki and Hardoi, with the help of health personnel. Nearly 250 leprosy cured cases were screened by the team of experts from the Departments of PMR and Plastic Surgery, CSMMU. Out of which 116 cases were found suitable for reconstructive surgery and all cases were called for admission in batches of 15 to 20 cases. Finally 109 cases were admitted in PMR, CSMMU. All admitted cases were subjected to routine hematological investigation i.e. hemoglobin, total and differential leucocyte counts, bleeding time, coagulation time, blood sugar, Australia antigen, HIV tests and routine urine examination. The cases having local infection, abscess and upper respiratory tract infection, were excluded at the time of screening.

Criteria for patients selected for reconstructive surgery were as follows:

1. Course of MDT completed.
2. Flexible deformity.
3. No local infection.
4. Willing and motivated for reconstructive surgery.
5. Prefererably younger age group.

Observations and Discussion

Out of 109 cases admitted, males (75.2%) out numbered females (24.7%). Maximum cases were in their 3rd and 4th decade of life (Table 1), that is the age of maximum productivity. Hence, it is important to do screening to pick out cases for surgery and making them more able to earn their living.

Level of literacy in relation to gender was also studied. 75 cases (68.9%) were illiterate followed by 26 cases (23.8%) who had studied up to class 8th class. Out of 27 female cases, 23 were illiterate (85.5%) whereas out of 82 males, 52 were illiterate (63.4%) (Table 2).

Still illiteracy is a major constraint among people of rural area which is solely responsible for lack of awareness regarding benefit of health related programmes.

A majority of cases came from Hardoi district followed by cases from Barabanki and Lucknow (Table 3). This can be explained due to the simple fact that cooperation, motivation and sincerity of the leprosy staff involved in NLEP and also the leadership quality of District Leprosy Officer, Hardoi. It is quite surprising to note that a very small number of leprosy cases (16 out 109 cases) came for reconstructive surgery from Lucknow, the capital of Uttar Pradesh. It may be noted that the prevalence of Leprosy affected patients in each area was not taken into account.

The study of incidence of occupation versus education and gender showed that out of 27 females 21 were housewives. Nearly half the males were working as farmers (Table 4). Six were students out of 20 cases below 20 years. This again shows that a lot needs to be done to improve “education for all” programme.

Hand lesions were found in 98 cases (89.9%). Clawing of one hand was seen in 32 cases, whereas bilateral claw hand deformity was found in 28 out of which 22 were males and six females (Table 5).

Foot lesions were found in 18 cases, out of which nine each had foot drop and plantar ulcer (Table 6).

Various techniques of reconstructive surgery were done in 100 cases of leprosy. Nine cases of plantar ulcer were treated by closed plaster technique. The types of reconstructive surgeries done are listed in Table 7.

Age	M	F	Total
0-10	1	0	1
11-20	13	06	19
21-30	22	10	32
31-40	29	09	38
41-50	16	1	17
51-60	1	1	2
Total	**82**	**27**	**109**

Table 1. Age and sex distribution.

Literacy	M	F	Total
Nil	52	23	75
Up to 8th	22	4	26
9th -12t	5	0	5
Above 12th	3	0	3
Total	**82**	**27**	**109**

Table 2. Literacy and sex distribution.

District	M	F	Total
Barabanki	19	5	24
Lucknow	12	04	16
Hardoi	51	18	69
Total	**82**	**27**	**109**

Table 3. Geographical distribution by sex.

Occupation	Sex		Education (Standard)			
	M	F	Nil	< 9	9-12	> 12
Housewife	0	21	18	3	0	0
Student	6	-	01	4	0	1
Farmer	40	0	30	10	0	0
Service	14	0	05	4	4	1
Non working	22	6	21	5	1	1
Total	**82**	**27**	**75**	**26**	**5**	**3**

Table 4. Sex wise education and occupation

Hand Lesion	M	F
None	10	1
Right Claw	25	7
Left Claw	21	11
Nerve	1	01
Bil. Claw	22	6
Nerve + Claw	3	1
Total	**82**	**27**

Table 5. Types of hand lesion.

Foot	M	F
Normal	64	27
Foot Drop	09	0
Plantar Ulcer	09	0
Total	**82**	**27**

Table 6. Types of foot lesion.

Technique of Surgery	M	F	Total
Dermolipectomy	50	16	66
Zancolli Lasso	10	08	18
Tendon Transfer for hand	01	01	02
Tendon Transfer for foot	09	00	09
Contracture Release	01	01	02
Tarsorraphy	01	00	01
Opponensplasty	00	01	01
Neurolysis	01	00	01
Total	73	27	100

Table 7. Types of surgeries done.

In a majority of cases dermolipectomy with or without Zancolli technique was performed which gave static correction. Foot drop was successfully corrected by tibialis posterior transfer and results were satisfactory. Proper post operative care was provided to each case in the indoor ward. The patients were discharged after seven days of surgery and were admitted again after 3-4 weeks for removal of stitches and for physiotherapy. Post reconstructive surgery cases were given exercises in groups and individualy for another four weeks. The final outcome was reviewed in the follow-up camps at the primary health centres or district hospitals.

Conclusion

PPP model worked successfully in the rural areas for patients with leprosy to avail advantage of free expertise at their doorstep. Confidence gained in the rural population helped sensitize more to come forward to get reconstructive surgery done at a specialized centre. This initiative of private public partnership where a tertiary health care service provider (CSMMU) provided their infrastructure, time, manpower and skill; with financial support from a non-governmental organisation (Rotary International) and field support from the state government (UP). Individually, for any one of the organizations it would not have been possible to have the patients be sensitized, be able to afford the treatment or be operated at the peripheral health facility without the expertise. To help more leprosy cured persons, such kind of partenership approach should be encouraged.

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Assessment of Cross Talk Between Fine Wire EMG from Soleus and Surface EMG from the Gastrocnemius

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Abstract

Objectives: To assess the extent of cross talk between deep and superficial muscle using fine wire electromyography (EMG) and surface EMG and to assess the correct location of the inserted fine wires in the targeted muscles.

Design: Observational.

Setting: Movement analysis laboratory, Department of Physical Medicine and Rehabilitation (PMR), Christian Medical College (CMC), Vellore.

Participants: 12 healthy volunteers

Main Outcome Measures: (i) timing of the EMG from the fine wires and surface electrodes during different functional tasks, (ii) movement in response to stimulation through the fine wires, (iii) cross-correlation of the fine wire EMG with the surface recorded EMG.

Methods: EMG sampling was done with fine wire electrodes in the soleus and with surface electrodes on the gastrocnemius from healthy subjects. Cross correlation and fine wire stimulation was done to assess the extent of cross talk between the two groups and assess the accuracy of fine wire placement.

Results: In 9 out of 12 subjects, the EMG timing (method 1) and cross-correlation (method 2) strongly indicated that the fine wires were in the Soleus when compared to the surface electrodes which were over the Gastrocnemius. In the remaining three subjects (subjects 1, 3 and 4) the fine wires were probably in the Gastrocnemius.

Conclusions: The Gastrocnemius and the Soleus muscles perform almost the same actions of plantar flexion but there are differences in their temporal and spatial firing patterns, as shown in the results above. These differences and the location of the fine wire electrodes have been determined using cross correlation and stimulation through the fine wire.

Key Words: Fine wire electrodes; Surface electrodes; Soleus Muscle; Gastrocnemius Muscle; Cross correlation.

Introduction

Electromyography (EMG) is a record of the electrical activity of the muscle tissue. The amplitude, spatial and temporal firing patterns of muscle is used clinically for the diagnosis of neurological and neuromuscular problems. In movement analysis laboratories, it is used to measure dynamic muscle activity. EMG can be recorded with the help of surface electrodes or intramuscularly with the help of needle electrodes or fine wires. The main advantage of surface EMG is that it is a non-invasive procedure therefore it is used more widely than needle or fine wire EMG. Needle electrodes are used for motor unit analysis recording using only low levels of contraction. While the needles provide stable and fixed locations of recording, they do not allow higher levels of contraction due to the risk of fiber tearing and related damage. On the other hand, fine wires are preferred for higher intensity activity as will occur during normal muscle activity, because the needles, being rigid, cause a lot of discomfort.

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The EMG signal picked up by the surface electrodes is the sum of the muscle action potentials of many motor units within the sampled muscle. Most of the recording comes from within 25mm of the skin surface and hence cannot be used for recording from deeper muscles.[1] Disadvantages of surface electrodes include inability to record activities from specific muscles without cross talk from neighboring muscles and inability to record muscle activity from deep muscles.[2,3] In order to avoid cross talk and study different muscles individually, it is necessary to use fine wires or needles. Fine wire or needle EMG may give a more detailed view about individual muscles and even motor units.

The extent of cross talk between adjacent muscles cannot be determined by simple visual inspection of the EMG. In signal processing, cross correlation tells us the similarity between two waveforms and any time delay between them. The cross correlation function will peak at the particular time shift when the two signals are similar. Li and Caldwell used cross correlation to compare between patterns and detect alterations[4], Loeb, Lee et al. found synchronization of motor units during slow movements, using cross correlation[5], Wren, et al, used cross correlation for comparing dynamic EMG signals during gait[6]. If the surface electrodes and fine wires are placed in the same muscle, there is a strong cross correlation between the two signals and the function peaks at the phase lag/lead at which the two signals are similar. If the electrodes are placed on different muscles, cross correlation yields no significant result. The Soleus lies beneath the Gastrocnemius in the calf, these muscles cause plantar flexion of the foot. They generate significant torque and while performing these complex tasks, the Gastrocnemius and Soleus co-contract with differences in timing and amplitude. The purpose of the present study is to show the extent of these differences and the methods by which this differentiation can be made.

Materials and Methods

Two silver discs of 15mm diameter were used as bipolar surface electrodes with an inter electrode distance of 35mm.

Fine wire electrodes used were made from stainless steel (SS316) wire of 0.075 mm thickness and insulated with a Teflon coating. These were manufactured by Grass Instruments, USA. Two fine wires (SS316), 100mm long were used and 3mm of the insulation was stripped off from the ends to be inserted in the muscle and about 5mm from the ends that were to be connected to the preamplifier. The two fine wires were inserted into of a 26 G, 1.5" long intramuscular needle and sterilized by the

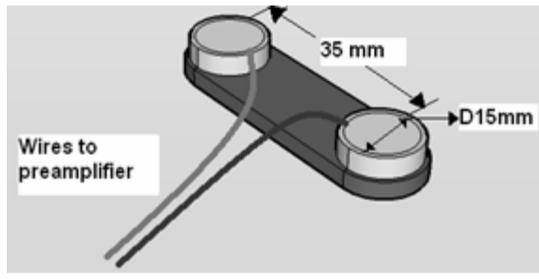

Fig 1. Surface electrodes.

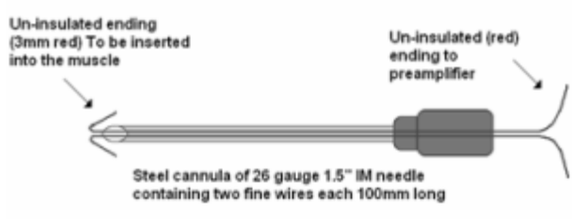

Fig 2. Fine wire electrodes.

STERRAD sterilization system. The ends that were to be inserted into the muscle were bent behind to form hooks as shown.

Permission for the study was granted by the Institutional review board for research.

Subjects: Twelve healthy subjects volunteered and signed the informed consent form according to the guidelines established by the institution.

The non-dominant leg was assessed during the study. The surface of the skin into which the electrodes were to be inserted was cleaned with surgical spirit; the fine wires were inserted in the Soleus muscle near the postero-lateral aspect of the mid leg. The preamplifier with the spring connectors attached to the fine wires were taped onto the skin close to the location of the fine wires and the ground electrode was placed below the knee joint. The surface electrodes were placed on the belly of the Gastrocnemius on the same side, in parallel to the muscle fiber direction. EMG was recorded from the surface and fine wire electrodes while the subject was asked to perform tasks like standing, leaning forward and backward with knees extended, standing on toes (heel raise), going down and single limb stance.

For Stimulation the fine wire electrodes were connected to the stimulator and the subjects seated with their legs hanging were stimulated with pulses of maximum amplitude 80mA and pulse duration of 0.2ms. If stimulation caused only plantar flexion, the wires were in the Soleus, plantar flexion along with knee flexion meant that the wires were in the Gastrocnemius. Two 3-axis accelerometers were placed, one of the accelerometers was placed on top of the big toe and the other one was placed at the lower end of the shank of the leg in order to

quantify the amount of plantar flexion and knee flexion. Stimulation of the muscle through the fine wire electrodes caused plantar flexion, and the resulting acceleration was picked up in the Z-axis by the accelerometer that was placed on the toe. Acceleration resulting from knee flexion was picked up in the Z-axis by the accelerometer on the shank of the leg.

Following the experiment the fine wires were pulled out and examined under magnification to see whether they were intact at the tip.

The instrumentation consisted of two EMG pre-amplifiers, two accelerometers, and main amplifier box. The preamplifiers were designed with a gain of 500, and filters between 30Hz to 500Hz for the surface electrodes and 30Hz to 1 KHz for the fine wire electrodes. Stainless steel springs were used as connectors for the fine wires. EMG data was acquired using the CMC Data Acquisition Software (DAQ-a suite of software and associated hardware for data acquisition). The raw EMG obtained could be further filtered offline. All data were sampled at 2000Hz and stored on the hard disk for later processing and analysis.

A program was written in Matlab to determine the normalized cross correlation of the data obtained from the two different types of electrodes.

Results

Three methods were used to identify the location of the fine wires using as reference, the surface EMG recorded from the Gastrocnemius, namely, (i) timing of the EMG from the fine wires and surface electrodes during different functional tasks, (ii) movement in response to stimulation through the fine wires, (iii) cross-correlation of the fine wire EMG with the surface recorded EMG. The results obtained from the experiments are described below and tabulated.

Distinguishing EMG in two muscles by independence of timing

During standing; The Soleus was more active than the Gastrocnemius. Fig 3 shows the averaged EMG of a subject while standing. There is more activity recorded by the fine wires during standing, suggesting that the wires were in the Soleus which is predominantly a stance phase muscle.

Subject no	Method 1 (EMG timing)	Method 2 (Twitch movement)				Method 3 (Cross-correlation of raw EMG)			
	Qualitative assessment of simultaneity of activity	Accelerometry response to **mild** Stimulation		Accelerometry response to **strong** Stimulation		Uncorrelated background values		Peak value	Significance of peak
		Plantarflexion at Ankle (soleus+gastroc) $g*10^{-3}$	Flexion at Knee (gastroc) $g*10^{-3}$	Plantarflexion at Ankle (soleus+gastroc) $g*10^{-3}$	Flexion at Knee (gastroc) $g*10^{-3}$	Mean μ	SD σ	P	
1	yes	89.6	0	198.6	41	0.0098	0.0160	0.1200	6.8000
2	no	85.6	0	200.4	13.4	0.0175	0.0246	0.0500	1.3200
3	yes	-	-	-	-	0.0100	0.0150	0.1100	6.6000
4	yes	90.4	0	152	62.6	0.0120	0.0160	0.1300	7.3750
5	no	106.4	0	156	25	0.0150	0.0199	0.0600	2.2610
6	no	0	0	46	0	0.0158	0.0217	0.0800	2.9580
7	no	-	-	-	-	0.0099	0.0150	0.0600	3.3400
8	no	70.4	0	159.6	35.2	0.0091	0.0136	0.0450	2.6390
9	no	63.8	0	162.6	32.4	0.0188	0.0196	0.0800	3.1220
10	no	0	0	159	33.2	0.0158	0.0237	0.0622	1.9500
11	no	-	-	-	-	0.0109	0.0169	0.0670	3.3100
12	no	0	0	166.2	-	0.0112	0.0178	0.0300	1.0000

Table 1: Summary of results obtained by the three methods.

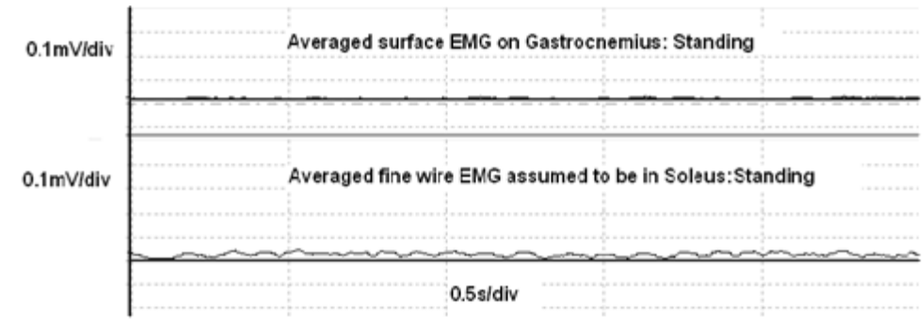

Fig 3. Averaged EMG while standing

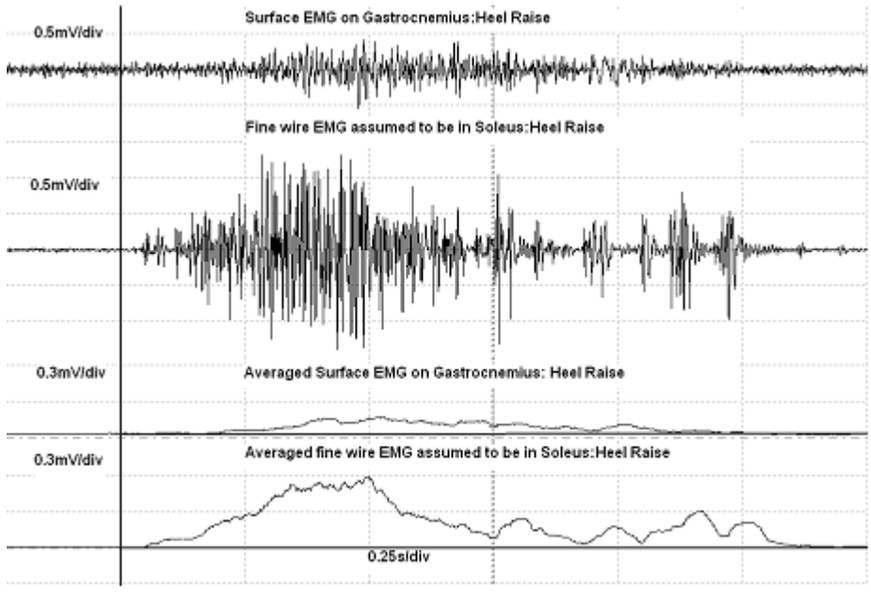

Fig 4. Raw and Averaged EMG during Heel rise.

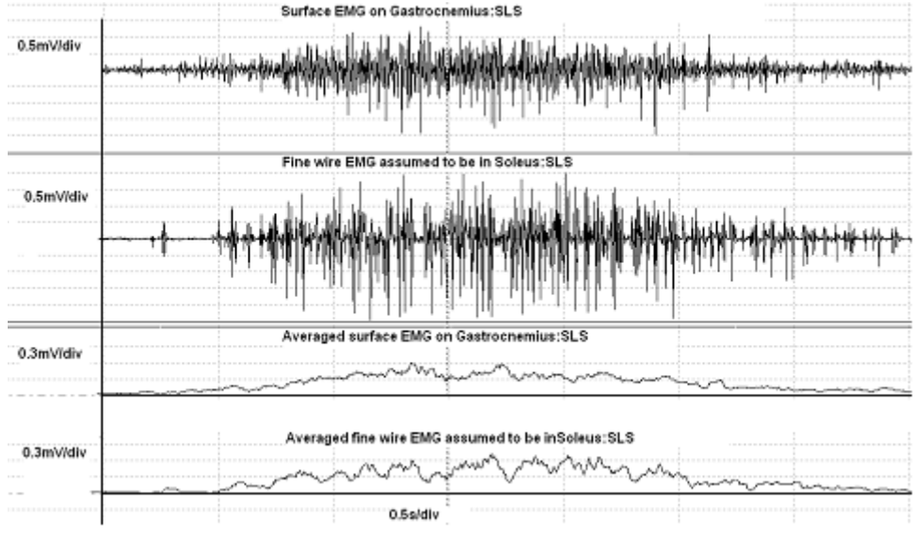

Fig 5. Raw and Averaged EMG during Single Limb support

Heel Raise: Both Soleus and Gastrocnemius muscles are active during plantarflexion. The subjects were asked to do a heel raise and the difference in timing and firing showed that the two electrodes were recording from different muscles. The raw and averaged data obtained for a heel raise in a subject is shown in Fig 4. Gastrocnemius was more active during heel raise as compared to the stance phase Soleus. The difference between the timing and amplitude was observed from the averaged data.

Single limb support: The whole body weight was applied on the foot under investigation, hence activating the Gastrosoleus complex as a whole. The graph below shows the raw and averaged EMG data when a subject was loading the leg under investigation.

Leaning forward and backward: The subjects were asked to lean forward and backward to activate the calf muscles. It has been shown that the swaying of subject by even as little as 5^0 caused reflex activity of the posterior as well as the anterior muscles.[7] By asking the subject to lean forward it was noted that the Soleus which is a stance phase muscle had more discrete activity than the Gastrocnemius.

Different movement elicited by stimulation: Though the timing and amplitude analysis of the averaged EMG data could show the difference between the two EMG data, stimulation and directional movement detection by accelerometers was used to confirm the location of the fine wires. If the wires were located in the Soleus, mild stimulation through them gave clear plantar flexion with no knee flexion. As the amplitude of stimulation was

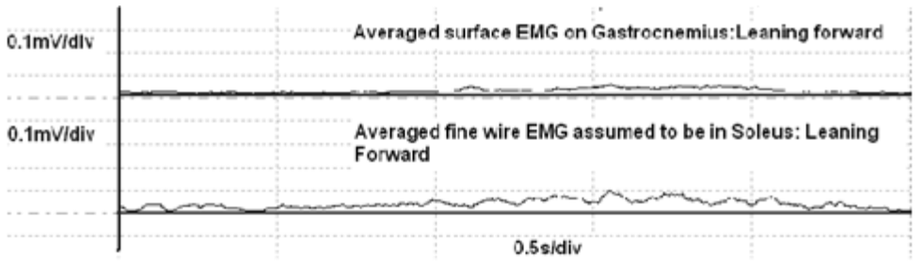

Fig 6. Averaged EMG while Leaning Forward

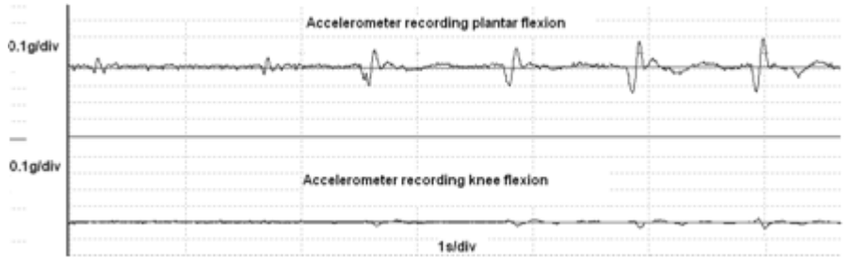

Fig 7. Accelerometer Readings for mild, moderate and strong stimulation

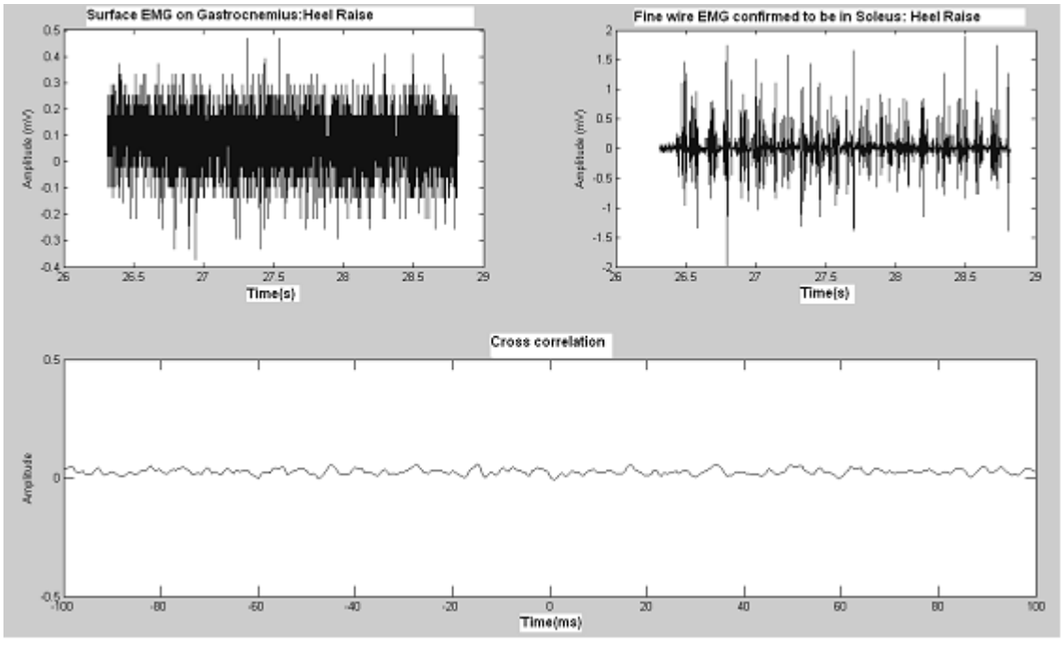

Fig 8. Cross correlation of EMG obtained from different muscles.

increased from moderate to maximum, slight amount of knee flexion was observed. This observation led to the conclusion that at high amplitudes of stimulation, fibres from the surrounding muscles (the Gastrocnemius in this case) were also being stimulated. In three subjects, (subject 3, 7 and 11) stimulation was stopped due to expressed discomfort, therefore, no response was obtained from them. The accelerometer readings from the foot and the shank in the rest of the subjects showed that the fine wires were in the Soleus muscle.

Distinguishing EMG in two muscles by cross-correlation: Normalized cross correlation was done between the surface and fine wire raw EMG data. The maximum amplitude and time of correlation were noted down for each subject. An amplitude (P) of 1.0 meant prefect correlation. The following formula was used to quantify the correlation between the two channels of EMG:

$S= (P-\mu)/\sigma$

Where P is the peak value of the cross-correlation, μ is

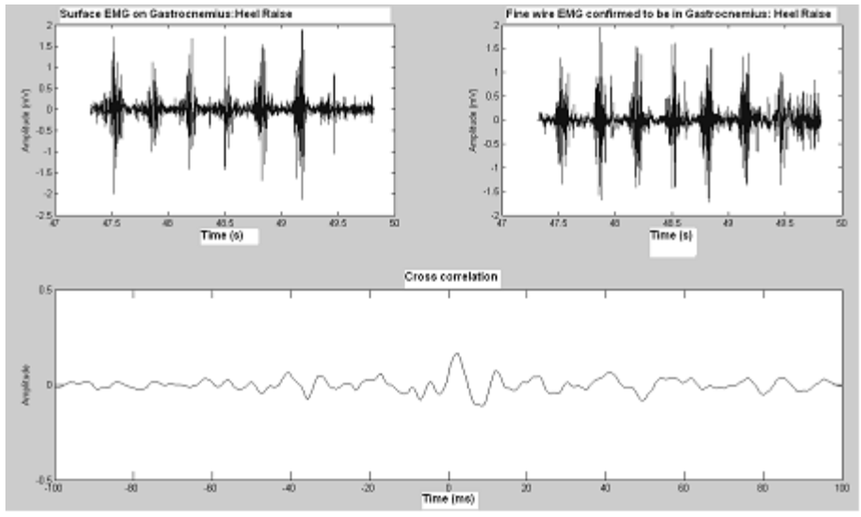

Fig 9. Cross correlation of EMG from the same source.

the mean of the absolute value of the cross-correlation and σ is the standard deviation. The calculated value S gives the number of standard deviations by which the peak is different from the mean. The values from the 12 subjects are tabulated in Table 1, which showe that the cross-correlation is highest in three subjects, (subjects 1, 3 and 4), being well above 5 which meant that there was some cross talk between the two different types of electrodes. In the other 9 subjects the cross correlation peaks were not significant proving that the wires were recording from the Soleus and not the Gastrocnemius muscle.

None of the subjects had any complications during and after the experiment, in all individuals the fine wire was removed full and intact.

Discussion

The Gastrocnemius and the Soleus are usually treated to be a single muscle. Though they perform almost the same actions of plantar flexion, there is a significant difference between their spatial and temporal firing pattern, as demonstrated in our study. When muscles under observation are overlapping each other, it is difficult to predict from which muscle the EMG is being recorded. This can be overcome by using stimulation, to prove the location of the wires. To further confirm the location, cross correlation of the signals obtained can also be done. The normalized cross correlation gives a quantitative measure of the amount of similarity or cross talk between raw data obtained from the two different types of electrodes and could therefore be used to confirm the location of the fine wires. Lesser the value of the cross correlation peak means that the fine wires are in the targeted muscle and vice- versa. This is the most efficient method to prove the location of the wires. The spacing of the wires within the muscle can be determined by checking the mean frequency. If the wires are too close to each other, the mean frequency will be very high. To increase the recording area between the two electrodes, each wire can be placed separately with two hypodermic needles. The impedance of the fine wires was determined for seven subjects. It was seen that the impedance values did not change with electrode placement. This was verified by inserting wires both closely spaced and spaced about 3cm apart. Therefore, impedance is not a useful way of determining electrode spacing and orientation.

In three subjects stimulation was stopped due to expressed discomfort before any noticeable movement, therefore, no response was obtained from them. This observation led to the conclusion that at moderate to maximal stimulation, fibers from the surrounding muscles (Gastrocnemius) were also being stimulated, thereby giving rise to knee flexion as well as plantar flexion. In subjects 1 and 4, the knee flexion was highest suggesting that the fine wires were very close to or within the Gastrocnemius itself.

In movement analysis, EMG data is acquired from a group of agonists or antagonists muscles. Individual muscles in the group have a specific function, and during walking it is essential to see in which part of the gait cycle each of these are active. In the present study, fine wire EMG has been tested and shown to be fairly easy to acquire from a target muscle by contrasting with the EMG from a nearby muscle. Compared to needle EMG, the discomfort with fine wire EMG during strong contractions is very less. Tasks like writing involve the small muscles of the hand, forearm, arm and the shoulder girdle. It is difficult to place surface electrodes on the small muscles, especially on the hand. The contribution of the deeper muscles of the hand, involved in writing is not taken into

consideration. Multichannel EMG with surface and fine wire EMG could overcome this problem. Surface EMG could be placed on large muscles of the hand and fine wires could be inserted into deep and small muscles of the hand. This would give a clearer picture of the underlying muscle function.

Conclusions

Fine wire EMG has been usually avoided as it is invasive, painful and targeting the desired muscle is difficult. A few wires and minimal movement bring little discomfort. Fine wire is often used in sports injuries, since the muscles of interest are covered by other muscles especially around the shoulder girdle and are not accessible with surface electrodes. Dynamic and real time EMG data can be acquired for analysis of complex and high speed motor tasks.

The EMG obtained with the fine wires was devoid of noise and was easier to record than the surface EMG. We suggest that instead of studying a group of agonist or antagonist muscle involved in a particular task, it is better to do a complete analysis of individual muscles with the help of multi channel recordings from surface and fine wire electrodes.

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F-Wave Parameters of Normal Ulnar and Median Nerves

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Abstract

Twenty healthy volunteers (17 males) aged 19–46 years (Mean 28±6.8) without any history of previous numbness and pain in the hands or any other neurological disorder were included in this study. The normal median nerve F-wave parameters studied were: minimum latency 24.8±1.7 ms; maximum latency 29.8±2.8 ms; mean latency 26.8±1.4 ms; chronodispersion 5±2.8 ms; FM ratio 2±1, manual and computerized persistence mode 10. Persistence varied from 4 (40%) to 10 (100%) measured both manually and by computer.

The normal ulnar nerve F-wave parameters studied were: minimum latency 24.5±1.7 ms; maximum latency 28.2±1.8ms; mean latency 26.2±1.7 ms; chronodispersion 3.6±1.4 ms; FM ratio 3±5.2, persistence (mode) 10. Persistence varied from 5 (50%) to 10 (100%) measured both manually and by computer.

In both the median and ulnar nerves, difference between the right and the left F-waves parameters values were insignificant. There was significant difference between median and ulnar nerve F-waves maximal latency, chronodispersion and mean latency ($t=3.28$; $p<0.05$: $t=2.92$; $p<0.05$: $t=2.42$; $p<0.05$ respectively).

In conclusion, it was observed that there was increased median and ulnar nerves F-wave chronodispersions and significant difference was found between median and ulnar nerves' F-wave maximal latency, chronodispersion and mean latency in comparison to the previous studies.

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Key Words: F waves normal parameters, Ulnar nerve, Median nerve.

Introduction

Following the original description[1] and early clinical studies[2,3], the F wave has found a wide application in the assessment of peripheral nerve lesions. Consecutively recorded F waves vary in latency and amplitude, necessitating comparison of a train of responses. Most laboratories use persistence and minimum latency as the only practical measures[4,5,6]. Some advocate mean latency[7] and others chronodispersion, which is defined as the difference between minimum and maximum latencies, or the range of conduction time among all motor fibers[8,9,10].

The normative data described in the literature were mostly based on the analysis of only some aspects of the F waves. In our study various F-wave parameters were analyzed in healthy subjects, including some uncommonly studied aspects, such as F-waves FM ratios and manual persistence.

Methods

This study was performed in Physical Medicine and Rehabilitation Department, Prince Abdul Rahman Al-Sudairy Central Hospital, Sakaka, Al-Jouf, Kingdom of Saudi Arabia. A total of 20 (17 men) healthy volunteers (40 ulnar and 40 median nerves) aged 19–46 years (mean 28±6.8) without any history of previous numbness or pain in the hands or any other neurological disorder, gave a written consent to participate in this study. Nerve conduction studies were performed by Schwarzer Myos Plus EMG machine (Schwarzer GmbH Medical Equipment for Diagnosis, Baermannstr.38, D-81245, Munich) with filter setting at 20 Hz- 10000Hz, in a warm room, maintaining the skin temperature above 32 degree centigrade. A gain of 5000µV per division was used for all M response latency measurements. For the F-wave, amplifier gain was 200µV per division and a sweep speed of 5 ms was used.

F-wave studies consisted of applying ten supramaximal stimulations to the ulnar nerve with the cathode proximal to the anode at the wrist and recording F-waves from the abductor digiti minimi with active disk electrode placed over the belly and reference disc electrode over the tendon

of the muscle. Ground electrode was placed on the dorsal aspects of the wrist between the stimulation point and active electrode. Stimuli were delivered to relaxed subjects lying supine on a bed. Same procedures were applied for median nerve for the recording of F-waves with active disk electrode placed over the belly and reference disc electrode over the tendon of the abductor pollicis brevis muscle[11,12,13].

Chroni, Taub and Panayiotopoulos[14] studied the peroneal nerve F waves in 20 healthy subjects and 20 patients with neuropathy to assess the effect of sample size on the accuracy of measurements of the following F wave latency parameters: F wave minimum latency, mean latency, median latency and F chronodispersion. The values obtained from a large sample (65-110 F responses) were compared with the corresponding values from smaller samples of 10, 20 and 40 responses. The results indicated that equally accurate measurements for all parameters were provided by larger F wave samples in patients, compared with healthy subjects. A sample of 40 fulfilled the requirements for all F wave latency parameters of the peroneal nerve in almost all subjects, a finding which is in good agreement with that of a similar study for the ulnar nerve. Hence, 40 ulnar and 40 median nerves were studied in 20 volunteers.

Minimum latency, maximal latency, mean latency, chronodispersion, manual and automated computerized persistence and FM ratios of F-waves were measured and analyzed. Data were analyzed to study the difference between the right and the left sides within the same nerve and between the two nerves by applying Wilcoxon Signed Rank Test for persistence and t-test paired for other F-waves parameters.

Results

The normal median nerve F-wave parameters were: minimum F-wave latency 24.8±1.7 ms; maximum F-wave latency 29.8±2.8 ms; mean F-wave latency 26.8±1.4 ms; chronodispersion 5±2.8 ms; FM ratio 2±1 (Table 1). The median nerve persistence was measured in mode and not in mean because of the nature of the data was 10 for both manual and computerized persistence. Persistence varied from 4 (40%) to 10 (100%) both manually and by automated computer (Table 2).

The normal ulnar nerve F-wave parameters were: minimum F-wave latency 24.5±1.7 ms; maximum F-wave latency 28.2±1.8 ms; mean F-wave latency 26.2±1.7 ms; chronodispersion 3.6±1.4 ms; FM ratio 3±5.2 (Table 1).

In both the median and ulnar nerves the difference between the right and left F-waves parameters values were insignificant. There was significant difference between median and ulnar nerve F-waves maximal latency, chronodispersion and mean latency ($t=3.28$; $p<0.05$: $t=2.92$; $p<0.05$: $t=2.42$; $p<0.05$ respectively).

Table1. Normal F-waves Parameters of median and ulnar nerves. All measurements in ms.

	N	Min	Max	Mean	SD
RMFMIN	20	18.67	27.27	24.4570	2.24082
RMFMAX	20	24.22	33.28	29.7890	2.37171
RMDISP	20	2.03	12.97	5.3320	2.84071
RMMEAN	20	23.13	29.50	26.8095	1.50972
RMFM	20	0.56	4.55	1.9735	1.23856
LMMIN	20	23.52	27.42	25.2075	1.04416
LMMAX	20	25.23	36.95	29.9990	3.23236
LMDISP	20	0.85	11.33	4.7915	2.87056
LMMEAN	20	24.88	29.44	26.9495	1.42201
LMFM	20	0.62	3.54	2.1945	.89069
RUMIN	20	22.34	27.66	24.3210	1.68161
RUMAX	20	25.47	31.95	28.3905	1.96729
RUDISP	20	1.72	8.44	4.0695	1.68256
RUMEAN	20	23.98	29.98	26.1890	1.74189
RUFM	20	0.50	29.79	3.2150	6.32124
LUMIN	20	22.27	29.38	24.7585	1.85183
LUMAX	20	24.92	31.56	28.0270	1.80098
LUDISP	20	1.01	5.71	3.2685	1.03411
LUMEAN	20	23.99	30.36	26.2855	1.72366
LUFM	20	1.11	19.58	2.9090	4.00526
MMIN	40	18.67	27.42	24.8323	1.76687
MMAX	40	24.22	36.95	29.8940	2.80032
MDISP	40	0.85	12.97	5.0618	2.83208
MMEAN	40	23.13	29.50	26.8795	1.44933
MFM	40	0.56	4.55	2.0840	1.07068
UMIN	40	22.27	29.38	24.5398	1.75995
UMAX	40	24.92	31.95	28.2088	1.87071
UDISP	40	1.01	8.44	3.6690	1.43691
UMEAN	40	23.98	30.36	26.2373	1.71114
UFM	40	0.50	29.79	3.0620	5.22553

RMFMIN- Right median F waves minimum latency
RMFMAX -Right median F waves maximum latency
RMDISP- Right median F waves chronodispersion
RMMEAN- Right median F waves mean latency
RMFM- Right median F waves FM ratio
LMMIN- Left median F waves minimum latency
LMMAX- Left median F waves maximum latency
LMDISP- Left median F waves chronodispersion
LMMEAN- Left median F waves mean latency
LMFM- Left median F waves FM ratio
RUMIN- Right ulnar F waves minimum latency
RUMAX- Right ulnar F waves maximum latency
RUDISP- Right ulnar F waves chronodispersion
RUMEAN- Right ulnar F waves mean latency
RUFM- Right ulnar F waves FM ratio
LUMIN- Left ulnar F waves minimum latency
LUMAX- Left ulnar F waves maximum latency
LUDISP- Left ulnar F waves chronodispersion
LUMEAN- Left ulnar F waves mean latency
LUFM- Left ulnar F waves FM ratio
MMIN- Median nerve F-waves minimum latency
MMAX- Median nerve F-waves maximum latency
MDISP- Median nerve F-waves chronodispersion
MMEAN- Median nerve F-waves mean latency
MFM- Median nerve F-waves FM ratio
UMIN-Ulnar nerve F-waves minimum latency
UMAX- Ulnar nerve F-waves maximum latency
UDISP- Ulnar nerve F-waves chronodispersion
UMEAN- Ulnar nerve F-waves mean latency
UFM- Ulnar nerve F-waves FM ratio

Table 2. Normal F-waves persistence of Median and Ulnar nerve. All values in ms.

	N	Min	Max	Mode
RMMP	20	9.00	10.00	10
LMMP	20	8.00	10.00	10
MMP	40	8.00	10.00	10
RUMP	20	10.00	10.00	10
LUMP	20	9.00	10.00	10
UMP	40	9.00	10.00	10
RMCP	20	4.00	10.00	10
LMCP	20	6.00	10.00	10
MCP	40	4.00	10.00	10
RUCP	20	8.00	10.00	10
LUCP	20	5.00	10.00	10
UCP	40	5.00	10.00	10
Valid N (listwise)	20			

RMMP- Right median manual persistence
LMMP- Left median manual persistence
MMP- Median manual persistence
RUMP- Right ulnar manual persistence
LUMP- Left ulnar manual persistence
UMP- Ulnar manual persistence
RMCP-Right median automated computerized persistence
LMCP- Left median automated computerized persistence
MCP- Median automated computerized persistence
RUCP- Right ulnar automated computerized persistence
LUCP- Left ulnar automated computerized persistence
UCP- Ulnar automated computerized persistence

Table 3. Difference in median and ulnar nerves F-waves parameters.

		Paired Differences 95% CI Lower	of dif. Upper	t	Sig2tld
Pair 1	RMFMIN-LMMIN	-1.8367	0.3357	-1.446	0.164
Pair 2	RMFMAX-LMMAX	-1.7705	1.3505	-0.282	0.781
Pair 3	RMDISP-LMDISP	-1.2681	2.3491	0.626	0.539
Pair 4	RMMEAN-LMMEAN	-0.8568	0.5768	-0.409	0.687
Pair 5	RMFM-LMFM	-0.8939	0.4519	-0.687	0.500
Pair 6	RUMIN-LUMIN	-1.1793	0.3043	-1.234	0.232
Pair 7	RUMAX-LUMAX	-0.5044	1.2314	0.877	0.392
Pair 8	RUDISP-LUDISP	-0.1605	1.7625	1.744	0.097
Pair 9	RUMEAN-LUMEAN	-0.5358	0.3428	-0.460	0.651
Pair 10	RUFM-LUFM	-3.1466	3.7586	0.186	0.855
Pair 11	MMIN-UMIN	-0.3352	0.9202	0.943	0.352
Pair 12	MMAX-UMAX	0.6477	2.7228	3.285	0.002
Pair 13	MDISP-UDISP	0.4281	2.3574	2.920	0.006
Pair 14	MMEAN-UMEAN	0.1059	1.1786	2.422	0.020
Pair 15	MFM-UFM	-2.7338	0.7778	-1.127	0.267

Abbreviation used: 95% CI of dif: 95% confidence interval of differences; Sig2tld: Sig 2 tailed; rest of them are as explained below the Table 1.

Table 4. Difference between ulnar and median manual persistence performed by Wilcoxon Signed Rank test.

	Ulnar Manual Persistence – Median Manual Persistence
Z	-1.414
Asymp. Sig. (2-tailed)	0.157

Table 5. Difference between ulnar and median automated computerized persistence performed by Wilcoxon Signed Rank test.

	Ulnar automated persistence – Median automated persistence
Z	-1.368
Asymp. Sig. (2-tailed)	0.171

Discussion

In the reported literature the upper limit in the normal adult for minimal F latency is 31 ms for hand[15] and in this study it was 29.38 ms. Right to left asymmetry of minimum F latency exceeding 2 ms in hand is considered abnormal[15]. In this study the difference between the right and the left median mean minimum latency was -0.75 ms and the difference between the right and the left ulnar mean minimum latency was -0.43 ms which were well within normal limits. Alavian, Samadzadeh and Alavian-Ghavanini[16] studied that the maximum normal difference in F wave latency between right and left upper extremities with stimulation at the wrist for total group was 2.2 ms for median nerve and 2.4 ms for ulnar nerve. Maximum normal difference in F wave latency between median and ulnar nerve in an extremity with stimulation at the wrist for total group was 2.7ms. In this study the difference between the right and the left median nerve maximum F-wave latency was -0.21ms and difference between median and ulnar nerve maximum latency of F wave was 1.69ms.

The highest reported normal values for F wave chronodispersion (mean ± SD) for the median nerve (abductor pollicis brevis) are 3.6 ± 1.2 ms[17], for the ulnar nerve (abductor digiti minimi) 3.3 ± 1 ms[8]. In this study median nerve (abductor pollicis bravis) chronodispersion was 5±2.8ms and Ulnar nerve(abductor digiti minimi) chronodispersion was 3.6±1.4ms, both were higher than the previous reported values.

The upper limit of F amplitude is 5% of M wave[7]. Normal F/M ratios based on mean F-wave amplitudes reported were 2.2 ± 1.0 percent for the abductor pollicis brevis[18].

In this study it was 2.08±1.07 for abductor pollicis brevis and 3.06±5.22 for abductor digiti minimi.

The F-wave persistence was 8.3 ± 1.9 of ulnar nerve[19]. Another study[7] showed that the persistence of F wave for abductor digiti minimum and abductor hallucis were about 8 to 9 respectively. In this study the median nerve manual persistence minimum was 8 and maximum was 10 when mode was 10 and for ulnar nerve manual persistence minimum was 9 and maximum was 10 when mode was 10.

Puksa, Stalberg and Falck[18] observed no significant differences in any of the parameters except for the median nerve F-wave minimum latency and F-wave mean latency, which was 0.2 ms longer on the right than left. In this study the difference between the median and the ulnar nerve F-wave maximal latency, chronodispersion and mean latency was significant ($t=3.28$; $p<.05$: $t=2.92$; $p<.05$: $t=2.42$; $p<.05$ respectively). There was no significant difference between median and ulnar nerves F-waves minimum latencies, FM ratios and persistence.

Conclusion

In this study it was found that there was increased median nerve and ulnar nerve F-wave chronodispersions and there was significant difference between median and ulnar nerves F-wave maximal latency, chronodispersion and mean latency in comparison to previously reported studies.

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Levetiracetam and Speech Therapy in Aphasia from Penetrating Brain Injury. Could it be the Way To Recovery?

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Abstract

A previously healthy 26 years old right-handed man sustained a penetrating brain injury (PBI) from gunshot wound to the head. The bullet entered the right parieto-occipital junction, traveled diagonally through the occipital pole and ended in the left fronto-temporal lobe. He developed right hemiparesis and global aphasia. He was enrolled in speech therapy (ST), and was started on levetiracetam (LEV) 500 mg twice daily (BID) for seizure prophylaxis, then LEV was increased to 750mg BID. After 8 days on LEV 750 mg BID the patient pronounced the names of his children and answered questions appropriately with verbal "yes" and "no". At discharge, FIM scores in comprehension, expression, memory, and social interaction had all improved from 2 to 4. He was able to respond verbally at the 1-3 word level with 50% accuracy and had shown improvement in auditory comprehension and verbal expression. The patient was kept on LEV 750 mg BID for 7 months. He had 50 outpatient ST sessions. At 9 months, he was able to read a paragraph he had written, and used a paper guide to scan lines. His comprehension of the written language improved to the sentence level, and his money management skills improved to modified independent. Conclusions: LEV appears to improve aphasia and cognitive outcomes of PBI patients treated with ST. Large prospective randomized trials are needed to confirm this clinical observation and to establish treatment protocols for PBI-induced aphasia that will incorporate ST and LEV.

Key words: Levetiracetam, aphasia, speech therapy, penetrating brain injury, rehabilitation.

Introduction

Language and cognitive disorders are extremely common complications following stroke and traumatic brain injury. When they do not resolve, they become indicators for poor long-term functional outcome [1-4]. Acquired aphasia, apraxia of speech and dysarthria often result in significant disability and handicap [4]. Full recovery from aphasia is uncommon and limits patients' chances to live independently in the community or rejoin the workforce [2-4].

Aphasia is marked by an impaired ability to comprehend or express language in its written or spoken form. General categories include receptive, expressive, and mixed or global aphasia. Aphasia affects about 1 in 250 Americans (more than one million). More than 100,000 Americans acquire the disorder each year. The majority of cases result from stroke, and the remainder are due to severe brain trauma, brain tumors, and neurodegenerative disease[5]. About 33% of surviving severe traumatic brain injury patients develop aphasia[5]. In the penetrating brain injury (PBI) population, this incidence ranges between 24% and 31% [6].

Treatment for aphasia is controversial. Several published reports suggest that spontaneous biological recovery may explain most of the improvement in speech and verbal fluency seen in aphasics[2, 7-11]. Here, we present the case of a patient with PBI induced global aphasia, and we discuss the improvement of his language and cognition after treatment with intensive speech therapy and adjunct pharmacotherapy with levetiracetam (LEV). To the best

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of our knowledge, this is the first report about the impact of LEV on recovery from aphasia following PBI.

Case Report

A previously healthy 26 years old right-handed Hispanic man sustained a civilian gunshot wound to the head. The bullet entered the right parieto-occipital junction, causing significant brain damage, and traveled diagonally through the occipital pole toward the frontal pole to become lodged in the left fronto-temporal lobe. He was initially intubated and treated with entrance wound debridement, continuous intracranial pressure monitoring and intravenous mannitol. He also was treated with intravenous antibiotics for acinetobacter pneumonia. The patient developed right hemiparesis, and impaired cognition, in addition to severe receptive and expressive aphasia. When he became stable for rehabilitation, he was admitted to our comprehensive rehabilitation center. As part of his treatment program, the patient received daily 1-hour sessions of speech and physical and occupational therapy 6 days a week, for 3 weeks. There was no evidence of seizure activity throughout the first 2 weeks after the PBI, and during the 21 days spent in the rehabilitation unit. However, in view of the patient's restlessness and agitation, an electroencephalogram (EEG) was performed. It demonstrated mild-to-moderate diffuse slowing of brain activity, more prominent in the left frontal lobe. Because of the penetrating nature of the brain injury, the patient was started on progressively increased dose of LEV for seizure prophylaxis. He initially received 500 mg twice daily (BID) by mouth for one week, which was well tolerated. Subsequently LEV was increased to 750 mg BID.

On examination, the patient was alert but unable to communicate in any modality, or to complete a review of systems. He had a right hemiparesis with a motor strength of 1-3/5 in the major muscle groups, worse in the upper extremity. A head computed tomography scan (CT) without contrast showed large bullet fragment with metallic artifact in the left fronto-temporal lobe, with edema surrounding the left periventricular region (Fig. 1A), in addition to an extended band-shaped hypodensity in the right postero-parietal region representing the bullet trajectory (Fig. 1B).

Review of patient's premorbid condition indicated he had 12 years of relatively successful education (11th grade of the US educational system) without any significant academic problems. However, he dropped out of school at the age of 16 to begin working in the construction field to support his family. He also has a history of illicit drug use, in addition to many years of alcohol abuse. He was married and had 2 children. His preferred language was English.

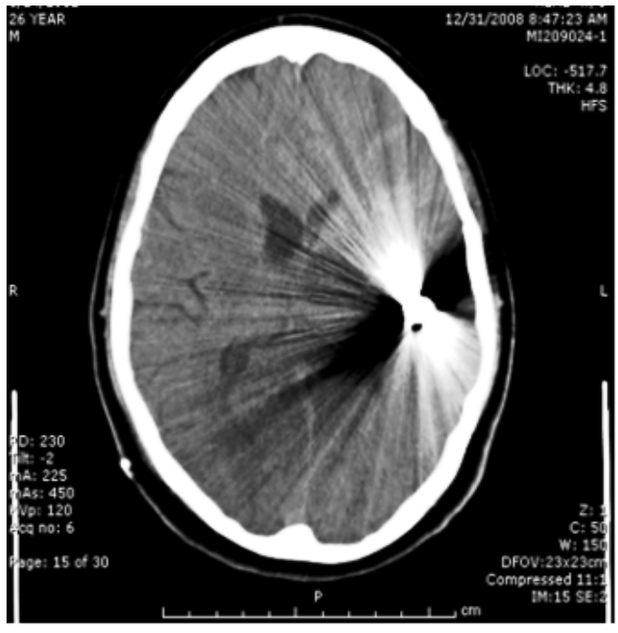

Fig 1A. Head computed tomography scan without contrast showing large bullet fragment with metallic artifact in the left fronto-temporal lobe with edema surrounding the left periventricular region.

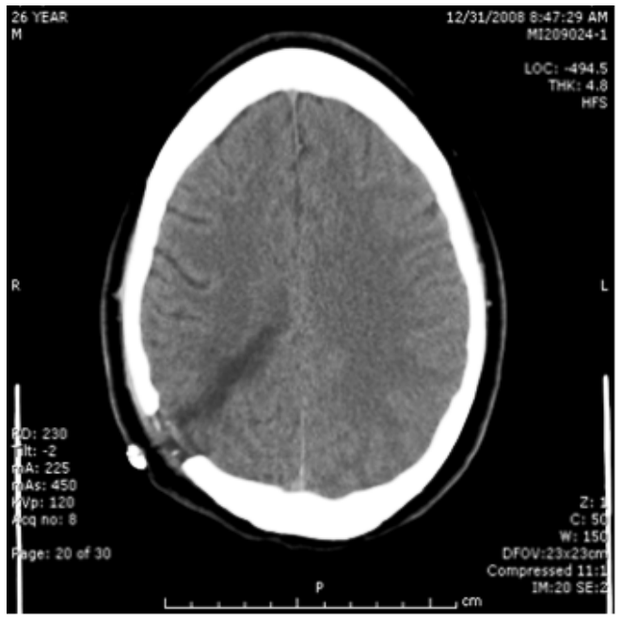

Fig 1B. Head computed tomography scan without contrast showing an extended band-shaped hypodensity in the right postero-parietal region representing the bullet trajectory.

During the first few days in rehabilitation, the patient was consistently aphasic and demonstrated minimal comprehension when asked about his strength, mood and general well-being. Initial functional independence measure (FIM) scores for comprehension were 2, indicating need for maximal assistance. For expression, memory and problem solving he had FIM scores of 1,

indicating need for total assistance. After 5 days on LEV 500 mg BID, the speech therapists noted that the patient was responding more accurately with head nodding and shaking, however he remained non-verbal. FIM scores for comprehension and social interaction remained at 2. However, 8 days after increasing the LEV dose to 750 mg BID, the patient began to say the names of his wife and children and started to answer questions appropriately with verbal "yes" and "no". He also showed improved accuracy with responses regarding his mood and general well-being, production of some simple words and increased smiling and laughing. FIM scores for comprehension and social interaction increased from 2 to 3. On his 9th day on LEV 750 mg BID, the patient accompanied his family and his therapists to a local park as part of the treatment program. Upon return he was able to verbalize that he "had a good time". Within 11 days of the increased dose of LEV, the patient was able to convey verbally that he wanted to resume sexual relations with his wife. At discharge from rehabilitation, the patient had been on LEV 750 mg BID for 14 days. At that point, his FIM scores in comprehension, expression, memory, and social interaction had all improved to a score of 4, indicating need for only minimal assistance. The patient demonstrated an ability to respond verbally at the 1-3 word level with approximately 50% accuracy and had shown steady improvement in auditory comprehension and verbal expression.

From a motor standpoint, the patient's initial FIM scores for locomotion and transfers were 2 and 3, respectively. They improved to 5 and 5 respectively at discharge, indicating only need for supervision or set-up for safety. The patient was able to ambulate at variable speeds, and demonstrated appropriate balance and equilibrium reactions. He was able to feed himself independently, and only needed setup and some verbal cues for hygiene and grooming and body dressing. The patient was discharged to his home with his wife and children, and was advised to continue taking LEV 750 mg twice daily.

Two weeks later, the patient scored 14/33 on the CASI-S mini-mental status exam, demonstrating problems with fluency, orientation and memory. Meanwhile, he was enrolled in outpatient speech therapy 2 times per week for a total of 50 sessions. At follow-up 9 months post-injury, the patient's memory, reading, and writing ability have improved significantly. As part of his therapy, he was able to read a paragraph he had previously written. He spontaneously used a paper guide to help him scan lines. His comprehension of the written language improved to the sentence level, and his money management skills improved to modified independent in functional settings.

Discussion

Currently, the key treatment for aphasia is conventional speech and language therapy. However, the efficiency of this approach has not been decisively established and the need for additional treatment options is there[2, 7-13]. Pharmacotherapy of aphasia had been discussed for the last two decades. However, of all the products used, only a few drugs like piracetam, donepezil, and amphetamine have shown some limited efficacy[2, 3, 7, 12-16].

On the other hand, 30% to 50 % of patients with PBI develop seizures. Of those, 4-10 % develop the seizure during the first week after injury, 80% within the first 2 years, and about 18% will only have seizures after 5 years post injury or later[17, 18, 19]. Seizure activity in the early post-traumatic period following head injury may cause secondary brain damage as a result of increased metabolic demands, raised intracranial pressure and excess neurotransmitter release[20]. It is therefore imperative for patients suffering from PBI to receive early seizure prophylaxis with drugs such as phenobarbital, valproate or with the newer product LEV[20, 21, 22].

Levetiracetam is an S-enantiomer which derives from piracetam. Both are cyclic pyrrolidone products that derive from gamma-aminobutyric acid. LEV was initially studied in animal models of cognitive impairment with the primary objective of finding a drug more effective than piracetam. However LEV was initially considered to be more effective in preventing seizures[23]. Investigations into the effect of LEV on fluency and cognition have been performed in several studies, all of which focused on patients with an established diagnosis of epilepsy. Most comprehensively studied by Piazzini et al[24] 70 patients with diagnosed partial epilepsy were divided into two groups of 35 patients. Both groups underwent a battery of neuropsychological tests twice, at a 7 week interval, with one group testing before and after receiving 7 weeks of a therapeutic dose of LEV. The LEV group demonstrated improved cognitive function and oral fluency which did not correlate with seizure frequency. This observation has lead to the hypothesis that the antiepileptic mechanism of LEV is distinct from its effect on speech and attention. It has been suggested that LEV may have an influence on the brain's metabolism in areas devoted to attention and language similar to what has been suggested with piracetam, the other pyrrolidone derivative found to be associated with improved learning, memory and attention. In fact, there is some evidence that piracetam enhances glucose utilization and cellular metabolism in the brain[15, 24]. Sechi and colleagues[25] prospectively examined the effects of LEV on 5 patients with partial epilepsy and disfluent speech and found that verbal fluency and speed of oral reading improved but

also found that seizure frequency did not correlate with this improvement. Furthermore, Hannon[26] had suggested LEV appears to posses newer properties which differentiate it from older anticonvulsant drugs. He speculated LEV may prevent extensive neuronal loss and associated axonal reorganization, known as fiber sprouting, which is thought to be epileptogenic and lead to additional neuronal death. Therefore, LEV seems to play a dual neuroprotective role, probably relevant to its anticonvulsant and antiepileptogenic action. This role is similar to that of conventional antiepileptic drugs like phenobarbital and valproate; however it comes with less frequent and less severe side effects[27]. Additionally, LEV does not require titration or drug level monitoring and it has demonstrated rapid onset of action[28].

The long-term effect of LEV on cognition and quality of life was examined by Lopez-Gongora et al[29]. Twenty-seven epileptic patients were found to have improved memory, verbal fluency and quality of life at one year on 2000 mg of LEV daily. Our patient was initially started on LEV for seizure prophylaxis and not with the intention to treat his aphasia. However our clinical observation suggested an improvement in patient motor speech, fluency, and cognition after starting him on LEV, and more precisely after increasing the dose to 750 mg BID (about 22 mg/kg of patient's 70 kg body weight). At present, the guidelines for management of PBI do not recommend prophylaxis of late post-PBI epilepsy[30], however in view of the considerable improvement observed of our patient's aphasia and cognitive function, which was thought to be due in part to LEV, we kept the patient on LEV during the whole length of the outpatient treatment program; about 7 months. The idea of dose-effect correlation of LEV and piracetam has been previously described in animal studies[23]. In fact, while piracetam improved the learning and memory of the studied mice at 10 mg/kg, LEV was only effective at higher doses (17-54 mg/kg). However, prospective research is needed to characterize this relationship in more detail and to establish disease-specific therapeutic ranges.

Finally, the excellent functional outcome of our patient could be due in part to the limited extent of cerebral injury and to the limited total brain volume loss from the low velocity civilian missile, as shown on the CT scan images (Fig 1A, B), and as reflected on the EEG results, which did not show any anterior temporal or central spike foci, or any significant focal slowing. The latter anomalies are more frequently seen in war casualties from very high velocity military ammunition, and are almost always associated with more severe brain damage, post PBI seizures, Broca's aphasia, and focal neurologic deficits, in addition to rare motor and cognitive recovery rates[31]. The type of diffuse EEG slowing that was seen in our patient is very common in the first few weeks after PBI, and its incidence usually drops rapidly within the next six months following the injury[31].

Conclusion

While LEV was shown to improve the cognition and fluency of epileptic patients, LEV also appears to improve aphasia and cognitive outcomes of PBI patients treated with intensive speech therapy. Whether this effect is the result of metabolic changes in the injured brain tissue, and whether this role depends on the dose of LEV used, is beyond the scope of this report. However, large prospective randomized trials are needed to confirm this clinical observation, and to establish treatment protocols for PBI induced aphasia that will incorporate intensive speech therapy and LEV.

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Congenital Absence of All Four Limbs A Rehabilitation Challenge

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Abstract

A child with congenital limb deficiency is best managed by an interdisciplinary rehabilitation team with full cooperation of the family members and active participation of the child himself. It is important to understand the changing needs of the growing child. Different aspects of a normal human development, mobility, acitivities of daily living (ADL), cognitive and psychosocial skills are to be considered while planning the management. We report a case of an eight months old male child with almost absence of all four limbs that was rehabilitated by providing custom made aids.

Key Words: Congenital Limb Deficiency, Phocomelia, Meromelia.

Introduction

Congenital limb deficiencies present a wide range of abnormalities from the absence of a single digit to the complete absence of the limb with an approximate incidence of 0.3 to 1.0 per 1000 live births[1]. But complete absence of all four limbs is far more uncommon. WL Wong et al[2] cited 13 such cases from the literature to which they added 2 more similar cases. A vast majority of congenital limb deficiencies are sporadic and non-transmissible. A study from the Medical Birth Registry of Norway showed that children born to a mother with a limb deficiency relatively have about 5.6 times the risk[3].

Various classification systems have been devised to describe congenital limb deficiencies. The International Standards Organization / International Society of Prosthetists and Orthotists (ISO/ISPO) system have given the accepted standard classification, although its clinical application is inconsistent, and older classification systems are frequently used[4]. Older systems of classification are: Saint-Hilaire (1837), Frantz O'Rahilly (1951) and Frantz O'Rahilly revised (1961)[5].

Phocomelia, term introduced by Geoffery Saint-Hilaire (1832)[6], is defined as a type of meromelia characterized by absence of the proximal portion of a limb or limbs, the hands or feet being attached to the trunk of the body by a single small, irregularly shaped bone[7]. In extreme cases there is absence of proximal bones of both the upper and lower limbs so that hands and feet appear attached directly to the body (tetraphocomelia). Thalidomide, when taken during pregnancy, remains the only drug proven to have caused a large number of congenital limb deficiencies[8]. The familial form is transmitted as an autosomal recessive trait where mutation occurs on chromosome no. 8 (8 p 21.1)[9].

Case Report

An 8 months old male child presented with a rudimentary right upper limb stump (humerus) of about 5cm, complete absence of left upper limb (Amelia), four small toe buds as the right lower limb and a foot with four digits attached to a rudimentary tibia to the pelvic girdle as left lower limb. For ambulation, the child used serpentine movements and log rolling movements. Head, neck and trunk movements were adequate and the child could manipulate toys with his left partial foot and right upper limb stump. The child's cognitive level was age appropriate and he was active and cooperative. Psychosocially, the child was affected in his limited interaction with his environment. There was no significant antenatal history (Fig 1).

The aims, objectives and sequence of the management program were sorted out with group discussions. Utmost part was the counseling of the parents. The management

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plan was directed to achieve independence of the child with mobility aids, self help assistive devices, early training and adaptation to the present condition and to get the maximum possible function.

A multifunctional seat was fabricated with resin (epoxy) and reinforced with glass fiber mat and multiple layers of cotton stockinet, which supported the child on three sides. Anteriorly, the child was secured with Velcro and canvas straps. The seat was mounted on an aluminum frame with four small casters to provide mobility. The right side wall of the seat was extended with an attachment made of the simple door cleat and latch. Over the cleat a tray was fitted (removable) that acted as a table. The tray

Fig 1. Child with tetraphocomelia.

Fig 2. Multifunctional seat with a hinged tray.

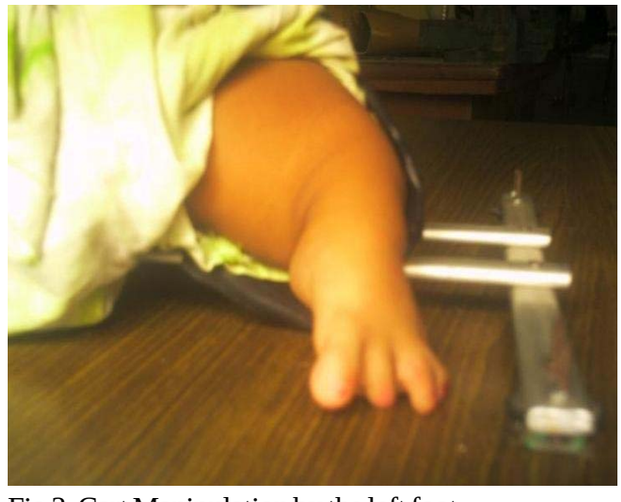

Fig 3. Cart Manipulation by the left foot

Fig 4. Above elbow prosthesis made by parts of a doll.

Fig 5. Training of the child.

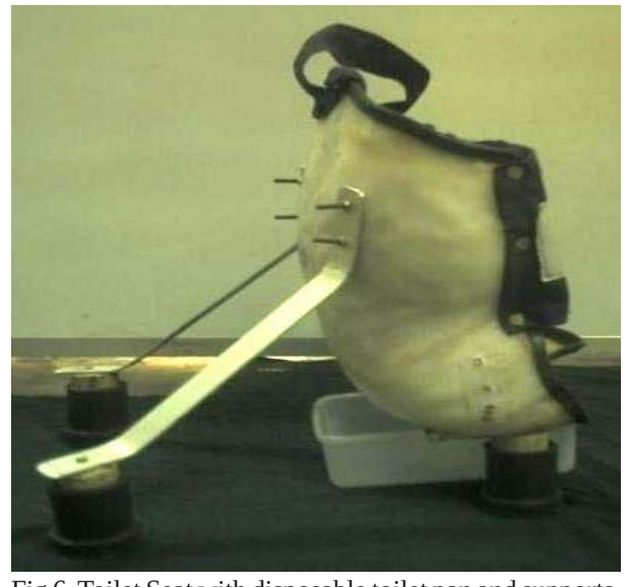

Fig 6. Toilet Seat with disposable toilet pan and supports.

could be rotated side to side (Fig. 2). The child used his left foot to manipulate the cart (Fig.3).

Prosthetic fitment was considered for early prosthetic adaptation. The upper limb portion of a doll made of light weight plastic (polyethylene) was fitted to a custom made socket with a single strap suspension system across the axilla of the other side was used. The distal end of the prosthesis was fitted with a modified universal cuff to hold a pen, pencil and spoon etc. (Fig.4,5).

A toilet seat was fabricated similar to the cart seat but with a hole at the bottom and supported with four stable posters. Disposable toilet pan was used (Fig.6).

Discussion

For children with phocomelia, most adaptive devices have been designed on temporary basis and battery powered. Zazula and Foulds described an electric cart designed for a child with multiple limb deficiencies. Three separate double-pole, double-throw switches controlled the device which was operated by the child's partial left foot (to go forward) and his head (for side movements)[10].

Hart designed six adaptive aids to improve classroom activities of a 7 years old boy with severe upper limb deficiencies (a typing aid, a reading aid, a chalk board aid, a dressing stick, a pull over shirt aid and a ball thrower)[11].

Weiss-Laubrau et al designed a device to aid for bilateral high level upper limb amputee in independent toileting[12]. Nelson et al highlighted a self-directed learning module in making a decision in prosthetic management of pediatric and adult patients[4].

In the literature, phocomelia described is either of a single limb or both upper limbs. It is very rare to have all four limbs involvement (tetraphocomelia). It is important to know the mental status and learning ability of the child. From time to time new aids are required to promote the developing brain. The natural adaptations that this child acquired (serpentine movement) should not be discouraged, as these adaptations are helpful.

While discussing about the assistive and adaptive devices, sophisticated machines like motorized wheel chair as designed by Zazula et al[9] were considered but due to socio-economic reasons the idea was dropped. It was also difficult but important to counsel the family members who were not well educated and belonged to a rural area.

The motive of reporting this case is to highlight how a totally dependent but otherwise mentally alert child could be made to ambulate to some extent with minimal possible cost using locally available resources.

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ICF in Physical Medicine and Rehabilitation

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Introduction

The International Statistical Classification of Disease (ICD 10) and related health problems focuses on diagnosis, disorders, morbidity and mortality. The International Classification of Functioning, Disability and Health by World Health Assembly (ICF) augments and enriches the ICD 10 in a way of a multipurpose classification for description and measurement of a person's functional status and associated health condition. Together the ICF and ICD 10 form the WHO Family of International Classifications and provide a meaningful picture of health. In May 2001, the world health assembly ratified and approved the ICF for implementation in various fields.

Aims of ICF

(i) To provide a scientific basis for understanding health, health-related states, outcomes and determinants. (ii) To establish a common language for describing health and health-related states, thereby improving communication between health care professionals, legislators, and the public. (iii) To allow comparison of data across countries, health care services, and time. (iv) To provide systematic coding scheme for health information systems.

Applications of ICF

At the individual level: ICF helps in assessment of the individual level of functioning, intervention planning to maximize his functioning and further evaluation of the intervention itself to see how effective it was. At the institutional level: ICF helps in resource planning, quality assurance and outcome evaluation of the services needed. At the social level: ICF is useful in assessment of the environment, socioeconomic analysis, and compensation systems.

ICF is a universally accepted framework to describe functioning, disability and health in persons with all kinds of diseases or conditions. Realizing that ICF's significance and power lies in its conceptualization of functioning and disability, there is an urgent call for creating ICF-based instruments that are more appropriate to clinical information needs.

Structurally, the ICF is based on three levels of functioning (body functions and structures, activities, and participation) with parallel levels of disability (impairments, activity limitations and participation restrictions). These are classified in terms of domains appropriate to each level, and can be seen in Table 1.

Table 1. Notice that the term 'disability' in the ICF refers to all three dimensions taken together.

Dimensions of Functioning	Dimensions of Disability
Body Functions & Structures	Impairments
Activities	Activity limitation
Participation	Participation Restrictions

Spinal cord injury (SCI) rehabilitation is an important area in which almost every physical medicine department across the country has been actively involved, and doing extensive work in bringing the best out of the persons with disability.

There may be similar protocols but no common outcome to measure the consequences of spinal cord injury. To describe, qualify and quantify consequences of SCI, a wide range of outcome measures has been used. Various functional independence measures have been used to assess the person's progress with intense rehabilitation programs. Many issues relating to the large variation in currently available measures need to be sorted out. There are also problems in comparing data of different persons at different stages of their recovery and rehabilitation process and after community reintegration

SCI is one chronic condition in which one faces limitations and challenges in physical, psychological and social domains of functioning, the more proximal the level of lesion, the greater the difficulty in functioning with the given personal factors in a specific environment.

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To facilitate a systematic and comprehensive description of an individual's functioning, ICF core sets have to be developed. A core set is a list of selected categories relevant for the specific health condition that serves as minimal standards for assessment and documentation of functioning and health in the related case.

A Brief ICF core set for a specific condition includes as few categories as possible for ideal and minimal health information system.

A longer Comprehensive ICF core set for a specific condition is a list of categories that are necessary to describe the limitations and challenges in functioning of the individual. All multidisciplinary team members will be required to be involved in the assessment of the various domains.

A stepwise approach explaining the use of ICF tools in the rehabilitation process of a spinal cord injured person in the various phases of the rehabilitation program is described below.

Case Example

History and background: A 23 year male mason, hailing from a village, sustained injury after a fall from a height, following which he had complete loss of movement and sensations below his chest. He was initially shifted to the near-by government medical college where he was diagnosed to have thoracic spine 8/9 fracture dislocation compressing his spinal cord, causing complete paraplegia (T8 ASIA A). He was operated and the spine fracture was stabilized. Postoperatively there was no significant improvement in his neurological condition. After four weeks he was referred to a spine injury rehabilitation centre for further management. At the time of admission into the rehabilitation center, Gopi was completely dependant for all activities, with his mother and sister caring for him.

Step 1: The initial assessment: Based on history, the patient's perspective of his body structure, function, activity and participation are tabulated.

Step 2: Go to the ICF core set for spinal cord injury. If no corset is available, formulate a corset using the available ICF resources such as the ICF browser http://apps.who.int/classifications/icfbrowser/

Choose ICF categories from this core set relevant to a patient's case and make a profile of the patient's body structure and functioning.

Step 3: Rate each category using the ICF qualifiers, all categories in the classification should be quantified using the same generic scale (scored 0 - 4 and 8):

Table 2: Perspective of body structure, function, activity and participation and personal factors.

Patient's Perspectice:

Body-Functions/Structures	**Activity and participation**
Legs don't work	I can't walk,transfer
No sensations below chest	I can't return to work
Tightness in my legs	I can't be an earning member
Bladder bowel no control	I can't do my daily activities
Sleep is affected by pain in legs	

Physician's Perspective:

Body-Functions/Structures

s12004	Thoracic spinal cord
b265.4	Touch functions
b525.4	Defaecation functions
b620.4	Urination functions
b710.2	Mobility and joint functions
b730.4	Muscle power functions
b735.3	Muscle tone
b755.3	Involuntary movement reactions
b770.4	Gait pattern functions
b810.4	Protective functions of the skin

Activity and participation

d410.4	Changing basic body functions
d415.4	Maintaining body posture
d420.4	Transferring oneself
d450.4	Walking
d465.4	Moving around using equipment
d510.4	Washing oneself
d520.4	Caring for body parts
d530.4	Toileting
d540.4	Dressing
d550.1	Eating
d560.1	Drinking
d850.4	Remunerative employment
d870.4	Economic self sufficiency
d910.4	Community life

Environmental factors

e1559.3-	Living in a thatched hut
e115.4-	Assistive devices

Personal factors

23 years old, male
Living with mother and sister
Has accepted his disability
Wants to be independant
Unemployed
Disability pension
Needs family and for support

0 -	No problem (none, absent, negligible)	0-4%
1 -	Mild problem (slight, low)	5-24%
2 -	Moderate problem (medium, fair)	25-49%
3 -	Severe problem (high, extreme)	50-95%
4 -	Complete problem (total)	96-100%

8 - not specified

9 - not applicable

Environmental factors are quantified with a negative and positive scale that denotes the extent to which an environmental factor acts as barrier or a facilitator:

0 - No barrier	+0 - NO facilitator
1 - Mild barrier	+1 - MILD facilitator
2 - Moderate barrier	+2 - MODERATE facilitator
3 - Severe barrier	+3 - SUBSTANTIAL facilitator
4 - Complete barrier	+4 - COMPLETE facilitator

We now have an illustration of the functioning status of a patient at the time of initial assessment. Various categories are assigned to the rehabilitation team for further intervention. Each health professional sets a goal to be achieved within a specified time. Interventions, treatments, therapy are carried out. At the end of that specified time each team member rates the patient again to see whether the assigned goals were achieved or not. In the pre discharge meeting the team then goes on to decide whether the person is to be given more time, change certain goals or conclude the rehabilitation program.

Discussion

The Central Bureau of Health Intelligence, DGHS, Ministry of Health and Family Welfare, India, had organized a workshop in 2008 for designing the strategy for Advocacy and implementation of International Classification of Functioning, Disability and Health (ICF) in which major recommendations included promotion of ICF in Medical colleges and National institutes of various disabilities and Needs-assessment to formulate a social policy or legislation which intern will be useful for state entitlements.

At the outset, the ICF as a tool may seem very intimidating and lengthy for clinicians and other allied health professionals, this is probably an important factor behind the slow progress in its implementation. Once ICF core sets are decided upon (a few are already available and validated), choosing the categories and rating them by the specific team members does not take much time. An ICF Core Set was developed to guide health professionals through rehabilitation management in clinical practice and scientists in the research of functioning and disability. This approach is an ongoing and worldwide process that will result in more and more ICF Core Sets in the future. ICF is a health and health-related classification system thus there is tremendous scope for its use by sectors like insurance, labor, education, economics, social policy, general legislation, development and environment modification. ICF provides an appropriate instrument for the implementation of stated international human rights mandates as well as national legislation. ICD as a tool is inadequate to predict service needs, level of care, functional outcomes, health planning and management. ICF is a tool, which measures and describes how people function with their health condition, applies to all decrements of health and disability.

Table 3. Comprehensive Core Set for Spinal Cord Injury Rehabilitation in the Long Term Context

b	**Body Functions**
b126	Temperment and personality
b130	Energy and drive function
b134	Sleep function
b152	Emotional function
b260	Proprioceptive functions
b265	Touch function
b270	Sensory function related to temperature and stimuli
b28010	Pain in head and neck
b28011	Pain in chest
b28012	Pain in stomach or abdomen
b28013	Pain in back
b28014	Pain in upper limb
b28015	Pain in lower limb
b28016	Pain in joints
b2803	Radiating pain in dermatome
b2804	Radiating pain in a segment or region
b420	Blood pressure functions
b440	Respiration functions
b445	Respiratory muscle functions
b455	Exercise tolerance function
b525	Defecation tolerence function
b530	Weight maintenance function
b550	Thermoregulatory functions
b610	Urinary excreatory functions
b6200	Urination
b6201	Frequency of urination
b6202	Urinary incontinence
b640	Sexual function
b660	Procreation function
b670	Sensations associated with genital and reproductive fns.
b710	Mobility of joint functions
b715	Stability of joint functions
b720	Mobility of bone functions
b730	Muscle power functions
b740	Muscle tone functions Muscle endurance functions
b750	Motor reflux functions
b760	Control of voluntary movement functions
b770	Gait pattern functions
b780	Sensation related to muscle and movement function
b810	Protective functions of the skin
b820	Repair functions of the skin
b830	Other functions of the skin
b840	Sensation related to the skin
s	**Body Structures**
s12000	Cervical spinal cord
s12001	Thoracic spinal cord
s12002	Lumbosacral spinal cord
s12003	Cauda equina
s1201	Spinal nerves
s430	Structure of respiratory system
s610	Structure of urinary system
s720	Structure of shoulder region
s7300	Structure of upper arm
s7301	Structure of fore arm
s7302	Structure of hand
s7500	Structure of thigh
s7501	Structure of lower leg
s7502	Structure of ankle and foot
s760	Structure of trunk
s8102	Structure of upper extremity
s8103	Structure of pelvic region
s8104	Structure of lower extremity
s8105	Structure of trunk and back
D	**Activity and Participation**
d155	Acquiring skills
d230	Carrying out daily routine
d240	Handling stress and other psychological demands
d345	Writing messages
d360	Using communication devises and techniques
d4100	Lying down
d4102	kneeling
d4103	Sitting

d4104 Standing
d4105 Bending
d4106 Shifting the bodys centre gravity
d415 Maintaining bodys position
d420 Transferring oneself
d430 Lifting and carrying objects
d4400 Picking up
d4401 Grasping
d4402 Manipulating
d4403 Releasing
d4450 Pulling
d4451 Pushing
d4452 Reaching
d4453 Turning or twisting the hands or arm
d4454 Throwing
d4500 Walking short distances
d4501 Walking long distances
d4502 Walking on different surfaces
d4503 Walking around objects
d455 Moving around
d4600 Moving around within the home
d4601 Moving around within building other than home
d4602 Moving around outside the home and other buildings
d465 Moving around using equipment
d470 Using transportation
d475 Driving
d510 Washing oneself
d520 Caring for body parts
d5300 Regulating urination
d5301 Regulating defecation
d5302 Menstural care
d540 Dressing
d550 Eating
d560 Drinking
d570 Looking after ones health
d610 Acquiring a place to live
d620 Acquisition of goods and servises
d630 Preparing meals
d640 Doing house hold work
d650 Caring for house hold objects
d660 Assisting others
d720 Complex interpersonal relationships
d750 Informal social relationship
d760 Family relationship
d770 Intimate relationship
d810 Informal education
d820 School education
d825 Vocational training
d830 Higher education
d840 Apprenticeship(work prepration)
d845 Acquiring, keeping and terminating a job
d850 Remunirative employment
d870 Economic self sufficiency
d910 Community life
d920 Recreation and leisure
d940 Human rights

e Environment Factors

e110 Products and substances for personal consumption
e115 Products and technology for personal use in daily living
e120 Products and technology for indoor and outdoor mobility and transportation
e125 Products and technology for communication
e130 Products and technology for education
e135 Products and technology for employment
e140 Products and technology for culture, recreation and sport
e150 Design, construction and building products and technology of buildings for public use
e155 Design, construction and building products and technology of buildings for private use
e160 Products and technology of land development
e165 Assets
e310 Immediate family
e315 Extended family
e320 Friends
e325 Acquaintances, peers, collegues, neighbours and commmunity members
e330 People in position of authority
e340 Personal care providers and personal assistants
e355 Health professionals
e360 Other professionals
e410 Individual attitudes of immediate family members
e415 Individual attitudes of extended family members
e420 Individual attitudes of friends
e425 Indivdual attitudes of Acquaintances, peers, collegues,neighbours and community members
e440 Individual attitudes of personal care providers and personal assistants
e450 Individual attitudes of health professional
e455 Individual attitudes of health related professional
e460 Societial attitudes
e465 Social norms, practices,and ideologies
e510 Service systems and policies for the production of consumer goods
e515 Architecture and construction services systems and policies
e525 Housing servises systems and policies
e530 Utilities services systems and policies
e535 Communication sevices, systems and policies
e540 Transportation services systems and policies
e550 Legal services systems and policies
e555 Associations and organisational services systems and policies
e570 Social security services systems and policies
e575 General social support services systems and policies
e580 Health services systems and policies
e585 Education and training services systems and policies
e590 Labor and employment services systems and policies

Issues for consideration for the effective implementation of ICF: (i) Workshops to sensitize and train health professionals within departments, then district and state levels. (ii) Training of postgraduate in the field of Physical medicine and rehabilitation on ICF. (iii) Include ICF in the teaching schedule and syllabus of MBBS, and all postgraduate courses. (iv) Encourage research and multicentric studies on the use of ICF.

Our challenge ahead is to develop ICF core sets and categories specific for individuals in our country with SCI, ABI (acquired brain injury), neuromuscular disorders, chronic pain disorders, arthritis, amputations, and the list is never ending in our specialty!

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Hand on Head Sign: A New Clinical Sign

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Introduction

Neck pain is one of the commonest ailments to bring people of working age to the doctors. Neck pain that involves the adjoining unilateral shoulder and arm is often found to be confounding. Some times it is only the pain around the scapula and shoulder without any pain in the neck.Common disorders with this presentation mentioned above can be: myofascial pain syndrome or myofibrositis, cervical disc prolapse with radiculopathy, periarthritis of shoulder (with minimal restriction of the range), injury or strain of the shoulder, malignancy of apical part of the lung, malignancy – secondary deposit in the brachial plexus especially from thyroid, lung, and upper gastrointestinal tract.

Many a times pain syndromes do not occur with the characteristic features and often present with overlapping signs. Clinical isolation is important because the management is always different even sometimes diverse. This is more important in case of the pain present at the lateral aspect of neck and adjoining shoulder area. Most common overlapping cases are cervical radiculopathy because of cervical disc prolapse and myofascial pain syndrome.

Cervical radiculopathy appears as a symptom of shoulder pain or arm or forearm pain with or without radiation. There may be tenderness in the adjoining shoulder area including trapezius.

There are conditions like myofascial pain syndrome where patients present with the similar pain symptoms and differentiating features like loss of tendon jerks or sensory deficiency may not be prominent enough to give a lead to diagnose specifically.

In this situation radiology may bring a solution like MRI of the cervical spine confirming the radicular compression or excluding it. But is it worthwhile to go for the expensive investigation like MRI for every neck and shoulder pain?

A clinical test or feature, if available can be a best answer to differentiate cervical radiculopathy from other causes of neck and shoulder pain.

Procedure to elicit this sign of cervical radiculopathy

Ask the patient affected with the neck and shoulder pain to put the hand of the affected upper limb on the head and and ask him if the patient feels anyrelief. If it is a positive sign patient will report relief within seconds.

Discussion

Positive sign means patient has cervical radiculopathy not other pain like myofibrositis. In case of other etiology there will be either no change or aggravation.

In case of positive sign patient will even sometime come to clinic with the upper limb holding up on the head.

If we look at the anatomy of the roots exiting through inter-vertebral foramina the mechanism of this sign will be evident. In a narrow space in the foramina space is compromised with the bulge of the disc. Root makes a compromised curved course in the spinal canal and vertebral foramina. This curved course can be maintained if the nerve root is kept loose. This looseness is possible if the upper limb is hold up on the head. This is the mechanism of the sign. When the limb is allowed to hang downwards root is pulled taught over the bulging disc and pain starts.

Three cases who could afford to complete the MRI of the cervical spine showed paracentral disc prolapse of the same side of the symptom.

This sign may be helpful in early and easy identification of cervical radiculopathy and ward off expensive investigations like MRI or NCV to an extent.

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Adieu !

"I have full sympathies with you," he said after finding out what I was engaged in with this journal. I was wondering why. Isn't it something great that I was doing, making me proud. But the learned consultant to WHO, an author of many books and the past editor of a reputed journal in Europe continued with "My wife was almost about to leave me when I was in your shoes. I was being envied in my peer and they felt as if I had snatched away the glory which they deserved. They never realized that I was envious of all those who were not doing what I did." He kept pouring in "That is the reason I chose to write books. There are no deadlines. You have finished one issue of the journal and instead of rejoicing you worry. You worry for those whose papers could not be included, for the little mistakes that still crept in despite your best efforts, for those where you included someone else's paper that came in much later than theirs, even if there was no queue system here but the pricks can't stop their hurt. And the bigger worry is not that, it is whether you have enough for the next issue, whether the reviewers have given you what you wanted at that time and there are many with the free advice 'why can't you let someone else do the corrections and you just do the management' but you are worried if the next issue would have adequate number of papers with a reasonable quality. Above all, would you still have the funds coming in." That made me open the channels in my brain to think.

I did not realise that until the birthday of my son two years ago. While he was wanting to spend time with his friends, as parents we wanted to enjoy with him. He traveled five hours to reach home only to find me struggling to finish the 'next issue' of the journal saying 'I won't be long' without realizing that it really took me a good time late into that evening just to be able to squeeze a quick dinner at a place which was just about to close. There went all the fun into resentments in everybody's mind it would have been better "if only we could have..." How true our learned friend from WHO was, I realised.

There have been good times: taking up the responsibility, learning how to do the proofs, how to do the nitty gritty of publication software and learning how to be even on the pages and then squeezing the bleed of two lines into the new page or not to leave 'orphans' at the end of a column or a page, getting good resolution photos or be able to get good quality papers. Then the best things that happened was the thoughts of putting the journal on the web even though just for the heck of putting it when India was relatively naive in doing so, not thinking that one day the readership would go so high that we got over 10,000 hits a month and it is not stopping at that, and get papers not just from India but practically from all continents. I can't forget the days when we used to 'beg' the presenters of good papers in the conferences to contribute to the hungry journal. The scenario has changed a lot. We are now choosy and also have a 'reasonable' rejection rate. Even though personally, I don't feel comfortable to reject the work of someone but one also has to have a reasonable standard being answerable to the scientific world and a lot of responsibility of what is published. When I started, the biggest challenge was to have two publications a year, if we were not choosy about what to publish, we could easily bring four provided we have finances and the influx of quality work from our native land.

On one hand we have tried to keep the basic motto of spreading the knowledge to the world by making the journal available to most libraries in India free but costs have been increasing many folds making us find the way through the electronic versions rather than the print versions. We also found like minded people on the web: Directory of Open Access Journals, who also make freely available the scientific knowledge. I am proud to say that our journal is a part of that and hopefully shall remain there in the future too.

Having kept the journal alive and growing was not without the usual pains of growing since 1993. It was entrusted upon me not by choice. Like it was entrusted I was nicely relieved too a couple of years later but with a few missing issues, it was thrust back on me. We limped back to regularity and frequency to the present and are ready to embark into the future with the help of each one of the contributors, readers, the critics, the friends and specially my dear editorial team. I shall be failing in my duties if I don't mention the contributions made by my dear friends assisting me in all the possible ways in fulfilling the editorial responsibilities: Dr VS Gogia, Dr Gita Handa and Dr Ak Joy Singh. They have shared my burden along with Dr SY Kothari and Dr R Sharma, who have stood by me in the difficult times through this journal. I bid adieu to the journal's editorship, perhaps the last issue I shall be editing. While thanking all of you for what you did, I also beg your pardon for any misses on my part. I sincerely hope that our dear journal into which have gone my heart and soul besides my time, goes into better hands.

'Adieu' (*French*) also means 'To God' to whom I salute to have made me do this.

Dr U Singh, Editor