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Original Research Article

To Find Out the Relation between Hand Impairments and Activity Limitations of Spastic Diplegic Grasp Patterns

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Abstract: Although, spasticity may be one of the features in spastic diplegic cerebral pasly population, children also show atypical hand movements, reduced gross and fine motor skills, which could be because of various other impairments. At the body level, other impairment measurements include, Range of Motion (ROM), muscle tone, muscle strength and sensory integration. Search of literature does not provide any studies that directly relate to these underlying hand impairments and activity limitations in diplegic children. Hence, there is a need to relate the above impairments to activities of hand. The objective of this study is to find the relation between impairments and activity limitations of hand function in spastic diplegic cerebral palsy children. An observational cross sectional study design. 58 subjects were included, both the genders, between the age group of 6 – 12 years, of all the GMFCS levels, with or without splints, with or without surgery for forearm and who can sit independently were included. Children who were visually impaired, hearing impaired and with cognitive impairments were excluded. The study was conducted in the RECOUP neuro musculo skeletal rehabilitation centre, Bangalore. Subjects were tested for their sensory evaluation with Nottingham sensory evaluation chart, muscle tone using Modified ash worth scale , range of motion with goniometer , grip strength with a Jamar Dynamometer, pinch strength with a pinchometer ,pain using NPRS and hand activities with the help of Sollerman Hand Function test, were assessed and correlated and regression was done statistically. The results showed, that there was a moderate positive relation between sollerman hand function test to that of ROM, grip and pinch strength with $p < 0.01$. But, there was a negative relation with hand function test to that of sensory impairment, muscle tone and pain. When multivariant regression was done, it was shown that only grip strength showed a considerable variation of 31.9% with respect to the other variables to the hand function. Thus, there was no significant statistical variation between the relations of the variables.
Keywords: Hand impairments; activity limitations; grasp deficits; correlation; hand functions; spasticity; diplegia; cerebral palsy.

INTRODUCTION

Cerebral palsy is the commonly used name for a group of conditions characterized by motor dysfunction due to non-progressive brain damage early in life. It is defined as an "umbrella term covering a group of non-progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of its development" [1].

In India, about 15 – 20% of the total physically handicapped suffer from CP. The estimated incidence is around 3 per 1000 live births according to the last statistics. 75% out of the approximately 1000 of locomotor disabilities evaluated for the government of Karnataka were found to be CP. There are estimated 25 lakh children, in India with CP, making it the commonest cause of disability[2].

The topographic classification of CP is monoplegia, hemiplegia, diplegia and quadriplegia; monoplegia and triplegia are relatively uncommon. In an analysis of 1000 cases of CP from India, it was found that spastic quadriplegia constituted 61% of cases followed by diplegia 22% [1].

Individuals with spastic diplegia walk with a distinct "scissored" gait. The legs cross over and move stiffly back and forth like a blade of a pair of scissors. The hands of someone with spastic diplegia also move

awkwardly, but are usually not as impaired as in some other forms of CP. People with spastic diplegia generally have normal intelligence. Language skills are usually normal as well [3].

Prevalence of hand impairments

Almost 50% of the children with cerebral palsy (CP) present an arm-hand dysfunction. The marked limitation that is seen in spastic CP is atypical grasping pattern, incoordiantion of hand, impaired anticipatory control and poor dexterity skills [4].

Studies of prehensile action of subjects of cerebral palsy have indicated a general slowness of the more severe impaired arm than the less impaired arm . To a large extent, the grasping deficit of the impaired hand in these subjects may be attributed to the problem, controlling distal hand musculature. It has been shown previously, that children with cerebral palsy, do not develop parallel co-ordination between grip force and load force [4].

During lifting, prolonged durations of force increase(grasping and holding) and of force decrease (releasing) are found in children with bilateral spastic cerebral palsy, this was interpreted as a lack of anticipatory control , within the grip- lift synergy, and this strongly correlates with impairments of manual dexterity [5,6].

Although, spasticity may be one of the features, children also show atypical hand movements, reduced gross and fine motor skills, which could be because of various other impairments. At the body level, impairment measurements include, Range of Motion (ROM), muscle tone, muscle strength and sensibility [7].

Search of literature does not provide any studies that have directly identified the relation between impairments and activity limitations. Hence the aim of this study is to identify the relation between impairments of and activity limitations in Spastic diplegic cerebral palsy.

METHODOLOGY

The study was conducted in RECOUP neuromusculoskeletal rehabilitation centre, Bangalore. Sample size taken was 58 samples with an age group of 6 to 12 years. Both the genders were included in the study. The sampling method was sequential sampling. Children with spastic diplegic cerebral palsy, children with all the GMFCS levels, and who could sit independently, with or without upper limb splints, and children with or without surgery were included in this study. Children who were visually, hearing and cognitively impaired and whose parents did not provide consent were excluded.

Informed consent was taken from the parents and selected kids were assessed for their sensory impairment, muscle tone, range of motion, grip and pinch strength and hand activity function.

Sensory evaluation was done using Nottingham sensory assessment, muscle tone was evaluated using Modified Ashworth scale, range of motion using goniometry. Grip strength was measured by Jamar Dynamometer while pinch strength with Pinchometer. Hand activity was evaluated using Sollerman Hand function test, which includes 20 daily tasks which involves both power grip and prehension. Results were analyzed using SPSS software version 19.0.0. The data obtained was correlated with each of the parameter with hand function and linear regression was done between the above mentioned variables to hand function.

SERIAL NO.	VARIABLE v/s SHF	R- VALUE	+/- CORRELATION	P VALUE
1.	SENSORY v/s SHF	-0.328	Negative correlation	P<0.01highly Sig.
2.	MODIFIED ASHWORTH v/s SHF	-0.149	Negative correlation	p>0.05 not sig
3.	RANGE OF MOTION v/s SHF	0.382	Positive correlation	P<0.01 highly sig
4.	GRIP STRENGTH v/s SHF	0.445	Positive correlation	P<0.01 highly sig.
5.	PINCH STRENGTH v/s SHF	0.260	Positive correlation	P<0.05 sig.
6.	PAIN v/s SHF	-0.205	Negative correlation	p>0.05 not sig

RESULTS

The mean age of the kids was 6 to 12 years. Of which, 30 were females and 28 were males.

The correlation between all the independent variables and dependent variable showed that ROM and grip strength had very strong correlation with SHF p <0.01, while pinch had a good correlation with SHF p <0.05. (Table 2)

Table-1: Showing all the variables with their mean and SD.

	Mean	Std. Deviation	N
SENSORY	2.981111	2.8700392	58
MAS	.945141	.6968705	58
ROM	47.831401	14.6211181	58
GRIP	4.833333	3.5861712	58
PINCH	2.275862	2.0434610	58
PAIN	.84	.951	58
SHF	41.83	20.057	58

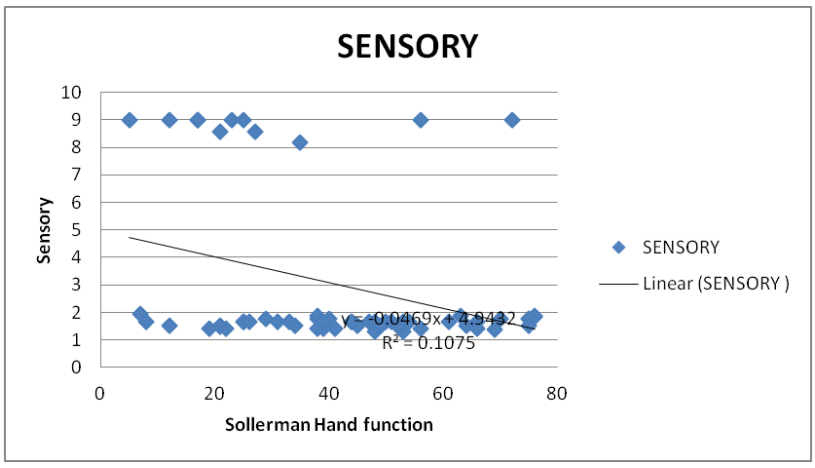
Table 2 showing correlation values with the level of significance.

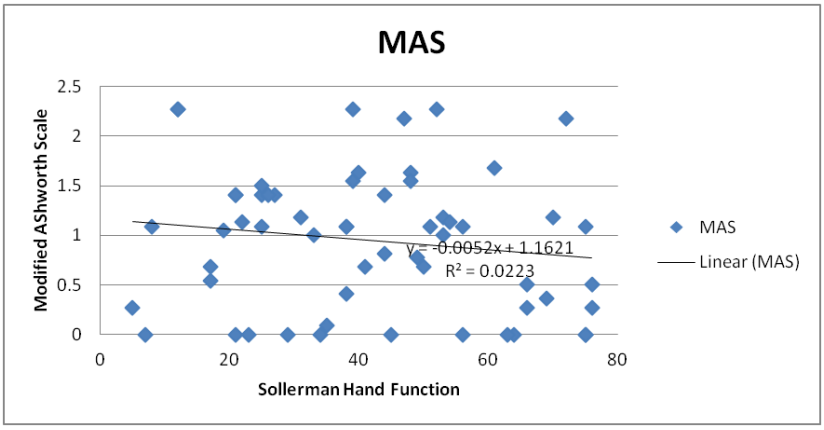
Correlations

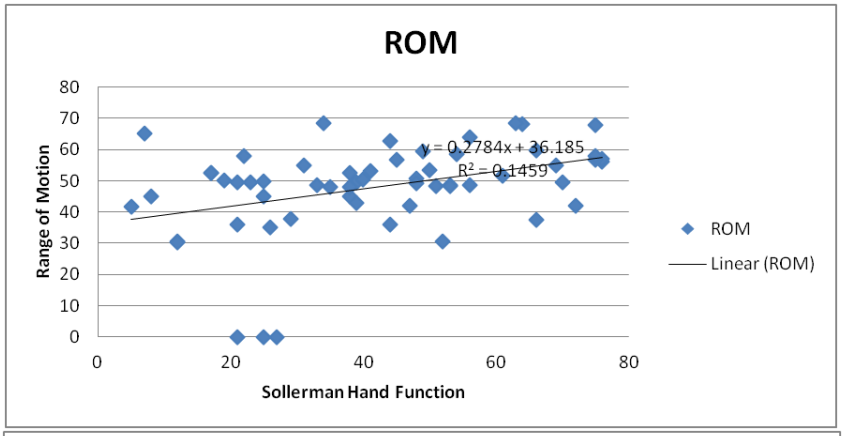
		PAIN	SHF
SENSORY	Pearson Correlation	.117	-.328*
	Sig. (2-tailed)	.382	.012
	N	58	58
MAS	Pearson Correlation	.144	-.149
	Sig. (2-tailed)	.279	.263
	N	58	58
ROM	Pearson Correlation	-.350**	.382**
	Sig. (2-tailed)	.007	.003
	N	58	58
GRIP	Pearson Correlation	.022	.445**
	Sig. (2-tailed)	.868	.000
	N	58	58
PINCH	Pearson Correlation	-.042	.260*
	Sig. (2-tailed)	.753	.049
	N	58	58
PAIN	Pearson Correlation	1	-.205
	Sig. (2-tailed)		.123
	N	58	58
SHF	Pearson Correlation	-.205	1
	Sig. (2-tailed)	.123	
	N	58	58

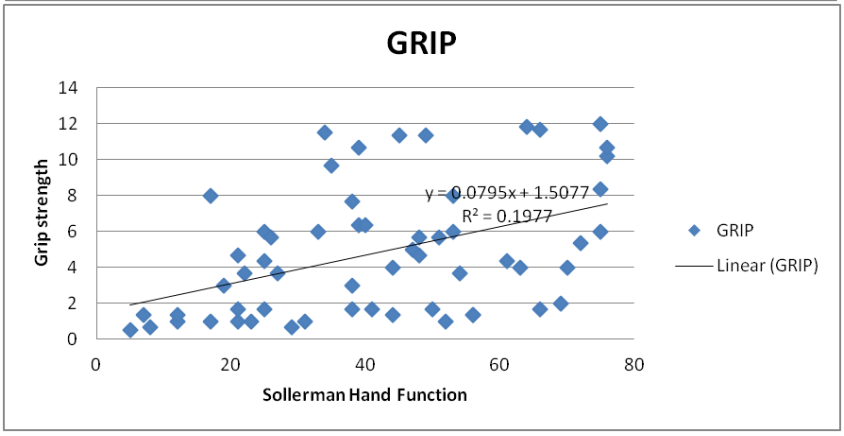
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

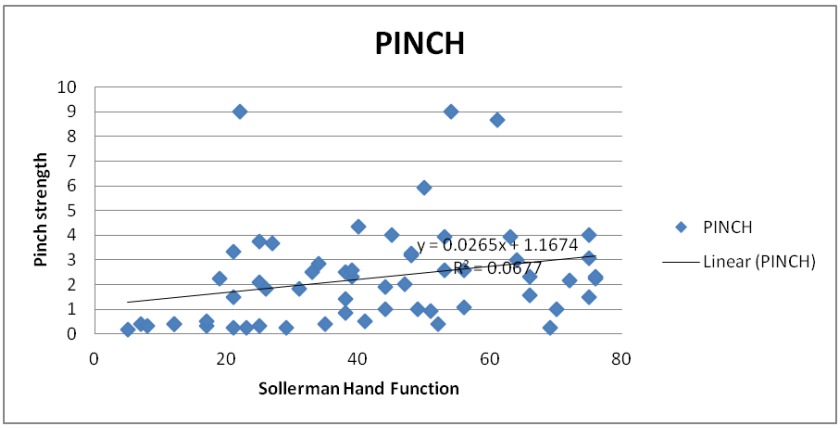
The following are the scatter diagrams between each of the independent and dependent variables.

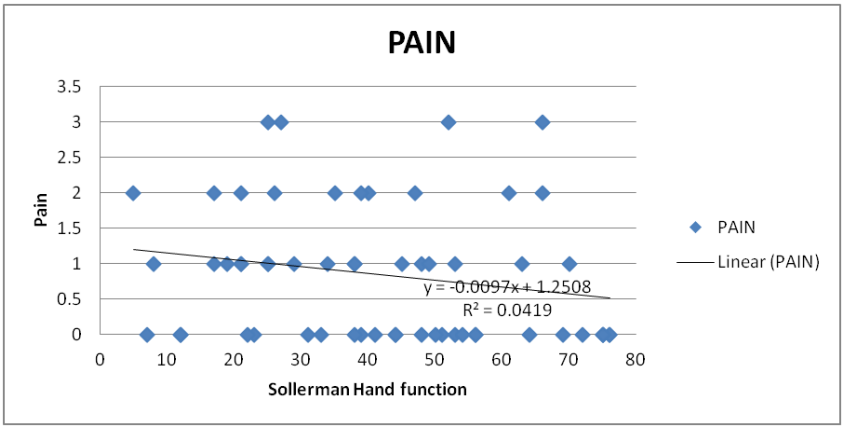



MAS
Modified AShworth Scale
2.5
2
1.5
1
0.5
0
0
20
40
60
80
Sollerman Hand Function
y = -0.0052x + 1.1621
R² = 0.0223
MAS
Linear (MAS)


ROM
Range of Motion
80
70
60
50
40
30
20
10
0
0
20
40
60
80
Sollerman Hand Function
y = 0.2784x + 36.185
R² = 0.1459
ROM
Linear (ROM)


GRIP
Grip strength
14
12
10
8
6
4
2
0
0
20
40
60
80
Sollerman Hand Function
y = 0.0795x + 1.5077
R² = 0.1977
GRIP
Linear (GRIP)


PINCH
Pinch strength
10
9
8
7
6
5
4
3
2
1
0
0
20
40
60
80
Sollerman Hand Function
y = 0.0265x + 1.1674
R² = 0.0677
PINCH
Linear (PINCH)



MULTIPLE LINEAR REGRESSION ANALYSIS

Table 3: ANOVA model for the regression coefficient

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7323.428	6	1220.571	3.989	.002[a]
	Residual	15606.848	51	306.017		
	Total	22930.276	57			

a. Predictors: (Constant), PAIN, GRIP, SENSORY , MAS, PINCH, ROM
b. Predictor: (constant)
c. Dependent Variable: SHF

Table 4: showing multiple linear regression coefficient analysis

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	27.957	15.823		1.767	.083
	SENSORY	-1.181	.956	-.169	-1.235	.222
	MAS	.048	4.102	.002	.012	.991
	ROM	.159	.236	.116	.672	.505
	GRIP	1.977	.709	.353	2.790	.007
	PINCH	1.237	1.208	.126	1.023	.311
	PAIN	-3.100	2.641	-.147	-1.174	.246
2	(Constant)	41.828	2.634		15.882	.000

a. Dependent Variable: SHF

Table 5: Multiple R^2 model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.565[a]	.319	.239	17.493

a. Predictors: (Constant), PAIN, GRIP, SENSORY , MAS, PINCH, ROM
b. Predictor: (constant)

Multiple R2 was found to be 0.319 for the given variables.
Thus, the equation is as follows:
SHF = 27.957 + 1.977 GRIP.

DISCUSSION

The present study was aimed to find out the relation between hand impairments and activity limitations in spastic diplegic grasp patterns of cerebral kids.

Relation between ROM and SHF were found to be moderately positive with 0.382, at 98% CI, and P <0.01. Marc Wishers *et al.;* [8] also explained the same relation, stating that increased tone and range of motion deficits showed a positive relation to the limitations of studied hand activities.

Grip strength and SHF showed a better relation, a moderately positive with 0.445; wish 98% CI, P < 0.01. Pinch strength showed a moderately positive correlation with SHF, of 0.260, at 95% CI, and P < 0.05. Pain parameter showed a negative relation to SHF, with -0.205. Similar analysis was explained by yannick Bleyenheft *et al.;* [9].

Thus, it is seen that around 31.9% of variation was seen in SHF with respect to the variables, when they were compared together, which is a considerable value of variation. The percentage could have been a better value, had it been a larger sample size. The other variables could not be significant, due to under covered minor impairments, which were not included in the study.

Although, three variables, viz. grip strength, pinch strength and range of motion were related positively with the hand function, when they were evaluated together, grip strength showed a significant influence on the hand function. Thus null hypothesis is accepted.

CONCLUSION

The study was done to check the relation between hand impairments and activity limitations. The study concludes that there is a moderately positive correlation between ROM, grip and pinch strength with the hand activity impairment, while sensory, muscle tone and pain showed a moderately negative correlation. Hence, the null hypothesis is proved, that there is no positive correlation between all the impairments and activity limitations in upper limb activities and that the variables are poorly correlated with the hand activity. Thus, all the variables are not related. There is a need for a further authenticated study with data dynamism over a wide range of population at multiple times.

LIMITATIONS

Small sample size is very less. Right and left dominance were not considered. Recordings at multiple points of time were not done. Even more standardized measurement tools should have been taken with a better reliability. Trunk involvement was not considered and checked in the children.Trick movements were not checked in all the activities. Few activities had inherent accessory movements that were done by the children.

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