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Multiple Sclerosis, Corpus Callosum and Bedside Test

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Abstract

Background: The main feature of Multiple Sclerosis (MS) is demyelination which slows down the conduction of Axons in the Central Nervous System. All the signs and symptoms of MS are result of this feature. Corpus Callosum (CC) is one of the biggest myelinated structure in the brain and often involved in the demyelination process.

Objectives: (1) To develop a bedside test that reflects CC involvement in MS and test it on MS patients (2) To determine prevalence of positive CC bedside test in MS sufferers

Methods: Clapping with alternative supination/pronation needs synchronisation of both hemispheres through CC. This will be used as a bedside test reflecting integrity of CC. The speed of clapping is compared with the speed of single hand shakings. 70 consecutive patients, suffering from MS, were seen in clinics and home visits starting from 01 09 2016. Exclusion criteria were Upper limb strength <3/5 MRC scale, Impaired position sense in the upper limbs, Pain including neuropathic sensation, visual impairment, Stroke, Cognitive impairment, intentional tremor, musculo-skeletal conditions affecting hand movement and movement disorder involving upper limb(s).

Results: Out of 70 patients, 31 patients were excluded, 34 patients showed no difference in the speed between the clapping and single hand shaking and 3 patients showed noticeable difference between the clapping and single hand shakings. Comparison of CC thickness on MRI scan between three **positive** patients and three negative matched patients clearly showed marked thinning of CC in the three positive patients.

Conclusions: The study showed at 4.2% of the patients showed dyssynchronisation of the hand movements (clapping) all of whom showed marked thinning on MRI scans.

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Introduction

Corpus Callosum (CC) is the structure that connects both hemisphere in both directions. If there is deficiency in the connection, there will be dyssynchronisation in bimanual and bipedal activities. There is a bedside sensory test for CC developed by Kazuo Satomi [1,2]. Sensory tests are not generally applicable in MS as many of the MS sufferers have variety of sensory impairments. Motor bedside test would be more appropriate and the author has designed the motor test for upper limbs.

Material & Methods

1. Bedside Test It involves the speed of clapping compared with the speed of supination/pronation shaking of each hand separately (Figure 1).
2. 70 consecutive MS Patients (Table 1) seen by the author during clinic and home visits were subjected to the CC motor bedside test after excluding the following:
3. Impaired coordination
4. Impaired vision
5. Severe cognitive problem that could not follow instruction
6. Painful upper limb (including neuropathic pain)
7. Impaired position sense
8. Involuntary movements involving upper limb(s)
9. Stroke
10. Muscle weakness of upper limbs (<3/5 MRC scale)
11. Musculo-skeletal conditions affecting upper limbs

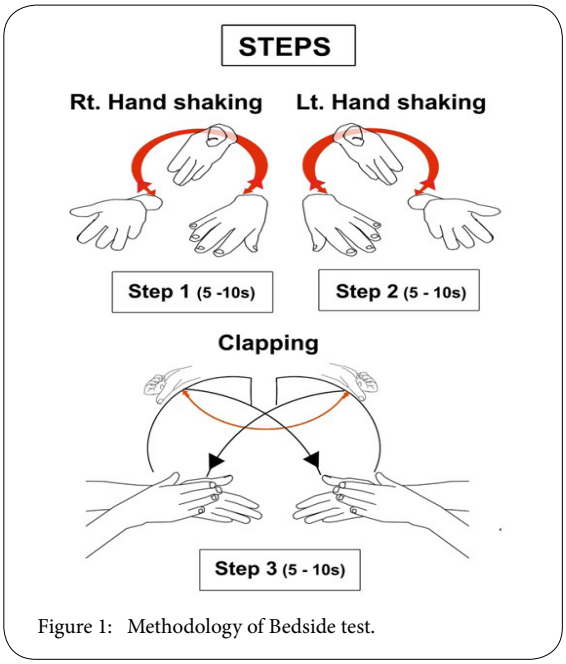

Figure 1: Methodology of Bedside test.

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31 (44%) patients were excluded:

12(17%) patients for weakness, 9(12%) patients for ataxia, 2(3%) patients for impaired vision, 5(7%) patients for cognitive impairment, 2(3%) patients for stroke, 1 (1.5%) patient for Pain [3,4].

Findings

3 (4.2%) patients showed noticeable slowing of speed of clapping and two patients finding were questionable due to functional overlay, 34 (48%) patients showed no noticeable difference in the speed of hand shakings and clapping. It is difficult to determine in 2 patients (3%) due to functional overlay.

MRI images of the three positive patients were then reviewed. Thinnest segmentsof their CC were measured (Figure 2). The three positive patients were then matched with three negative patients from the sample (age & duration of MS) for comparison. The average thickness of CC in positive patients is 2.1mm and for the three matched negative patients is 3.6mm (Table 2). The finding support that there is correlation between thickness of CC and dys-synchrony between the two sides [5].

Representativeness of the Sample

Sample Frame was taken from filing cabinets. There were 367 MS patients under our team caseload which covers North Lincolnshire and Northeast Lincolnshire in UK (Total population 329420 in 2015). There are two outliers (Age 18 & 87) in the Sample Frame and they are excluded to match the Sample. Sample Frame is now 365. Mean age of Sample Frame is 55.56 as shown in the Age Distribution Graph. Maximum Prevalence is between 50 to 59 years. Female to Male ratio of Sample Frame is 2.04 [6,7].

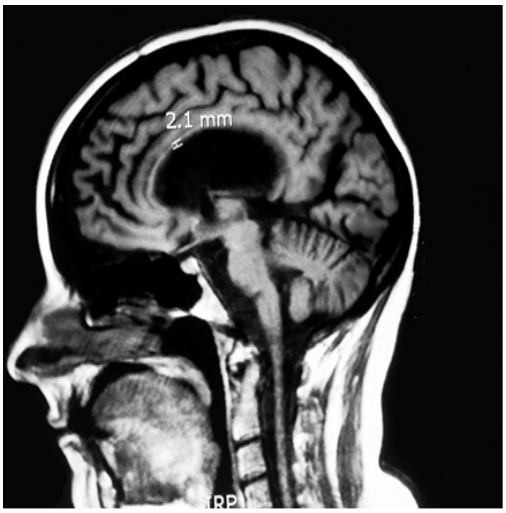

Figure 2: The thinnest CC segment measured in MRI scan.

No.	Name	Age	Sex	Exclusion criteria
1.	J A	45	F	
2.	D l	52	F	
3.	L B	61	F	
4.	D B	55	M	weakness
5.	S B	68	F	
6.	M B	51	M	weakness
7.	J B	73	F	Low cognitive
8.	A B	57	F	
9.	N B	61	F	Low cognitive
10.	C B	59	F	Low cognitive
11.	A C	48	F	
12.	J C	55	F	
13.	J C	53	F	
14.	M	74	M	
15.	R C	32	F	
16.	D	66	M	
17.	C F	67	M	ataxia
18.	A F	54	F	
19.	E F	60	F	weakness
20.	M F	51	F	
21.	W F	47	F	
22.	J G	45	F	
23.	M G	64	F	weakness
24.	G G	65	F	weakness
25.	C G	64	F	
26.	S G	66	F	weakness
27.	A G	49	F	weakness
28.	K G	36	F	
29.	S H	56	M	
30.	P H	61	F	
31.	H H	56	F	Low cognitive
32.	A H	50	F	weakness
33.	T H	40	M	
34.	S I	54	F	
35.	D J	63	F	weakness
36.	K J	57	M	
37.	S J	67	F	
38.	V K	58	F	weakness
39.	S K	67	F	Low cognitive
40.	P L	60	F	ataxia
41.	K L	56	M	
42.	T L	60	M	weakness
43.	M L	40	F	ataxia
44.	S L	50	F	
45.	G M	41	M	ataxia
46.	L M	49	F	
47.	S M	51	F	ataxia
48.	J M	48	M	impaired vison
49.	E M	9	F	ataxia
50.	S O	57	F	
51.	G O	59	M	
52.	K O	54	M	stroke
53.	B P	61	F	
54.	D P	55	F	Impaired vision
55.	G P	65	M	
56.	D P	57	F	weakness
57.	D R	73	M	
58.	S P	46	M	
59.	S R	56	F	ataxia
60.	P S	20	M	
61.	A S	56	F	stroke
62.	L S	60	F	ataxia
63.	B S	68	F	pain
64.	J S	50	M	
65.	S T	54	F	ataxia
66.	T T	64	M	
67.	R V	34	F	
68.	M W	60	M	
69.	S W	42	M	
70.	S W	65	F	

Table 1: Full list of the sample.

Three positive patients
- Duration of MS: 8, 10, 10 years (average 9.33 years)
- CC Thickness on MRI Scan 2.1mm ((2016), 2.1mmm (2008), 2.1mm (2015) average thickness 2.1mm

The three matched patients
- Duration of MS: 10, 10, 7 (average 9 years)
- CC thickness on MRI scan: 3.9mm (2015), 3.6mm (2016), 3.9mm (2015) average thickness 3.8mm

Table 2: The average thickness of Corpus Callosum.

In the sample, Female to Male ratio is 2.18. Age range is from 20 to 74 with the mean age of 55.5. Maximum prevalence is between 50 to 59 years

Both Graphs are Negative Skewed as Maximum Prevalence is between 50 to 59 in both Sample and Sample Frame.

Although Sample size is only 19% of Sample Frame, it is found to be representative of the Sample Frame (Figure 3) [8].

Extension study

As an extension of the above study, further sampling was taken from clinics and home visits in July, August and September 2017. All the exclusion criteria from the first study still applied. In addition, the patients must not be from the first sample and their MRI scans must be accessible and the measurement of thinnest segment must be greater than 2.5mm (the author have arbitrarily chosen 2.5 mm thickness a cut-off point as the average CC of positive patients from the first study is 2.1mm). MRI scans were reviewed the day before the clinic, and bedside clapping test was performed in clinics or home visits the next day [9,10].

Finding of Extension Study

There were 17 MS patients (Table 3) who met the criteria and none of the patients showed dys-synchrony in Bedside Clapping Test .

Conclusion of the Extension Study

The finding showed that if the CC is thick enough (>2.5mm), synchrony of bimanual activity is intact.

Discussion

Dys-synchrony of bimanual activity like clapping reflects dys-synchrony between the two hemispheres which reflects CC deficiency unless proven otherwise. MRI scan measurements support the correlation between the thinness of CC and dys-syncrony of left and right in bimanual activities. The authoralso has video evidence of howthese positive patients struggled to do clapping despite being strong enough upper limbs (at least 4/5 MRC scale) which has never seen before until the author looked for it. The author has experienced with hundreds of neurological patients with a variety of neurological conditions in the last twenty years. Although MS can have complex

	Name	Age	Sex	Clinic/HV	CC in mm	MRI	MS duration (years)
1.	ML	45	M	02 07 2017	6.5	2016	3
2.	MS	41	M	03 07 2017	3.9	2013	10
3.	TC	56	F	03 07 2017	5.9	2014	3
4.	VM	75	F	13 07 2017	4.8	2014	10
5.	LD	31	F	13 07 2017	3.0	2017	4
6.	CP	56	F	18 07 2017	2.8	2017	36
7.	WC	68	F	25 07 2017	3.9	2015	6
8.	LR	57	F	31 07 2017	3.9	2016	9
9.	PM	77	F	31 07 2017	3.4	2013	17
10.	ML	45	M	02 08 2017	4.9	2016	2
11.	RA	51	M	02 08 2017	3.4	2015	
12.	SM	54	F	21 08 2017	3.9	2011	
13.	MF	53	M	06 09 2017	2.7	2013	29
14.	VB	62	F	15 09 2017	4.8	2015	3
15.	JS	54	F	22 09 2017	3.6	2014	
16.	JM	44	M	25 09 2017	4.2	2017	
17.	DV	43	M	20 09 2017	4.2	2013	

Table 3: Patients show dys-synchrony in Bedside Clapping Test.

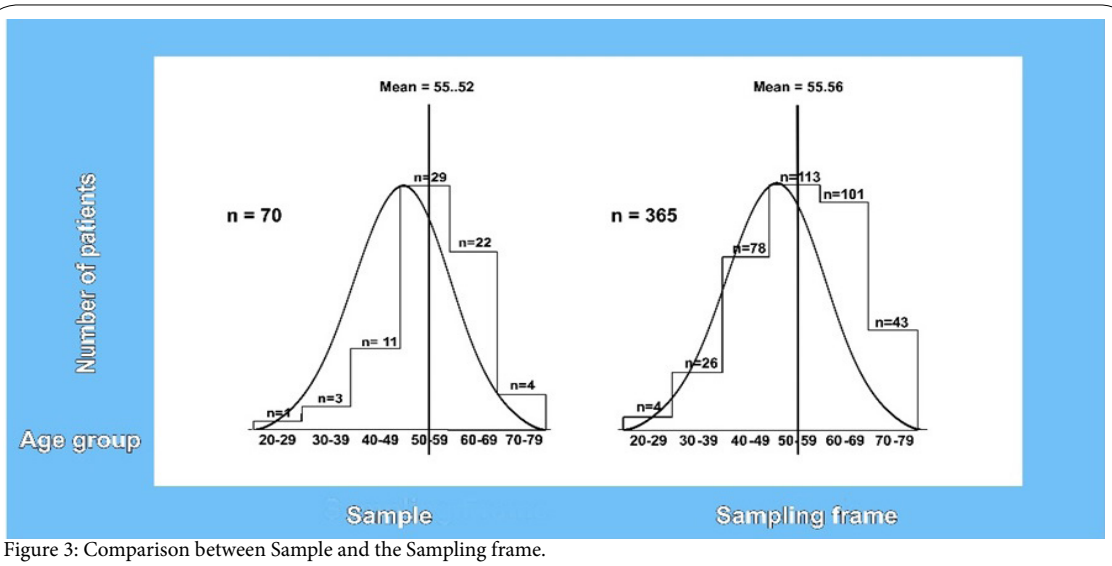

Figure 3: Comparison between Sample and the Sampling frame.

manifestation of signs and symptoms, CC deficiency can cause specific clinical sign (another example of dys-synchrony is observed in Internuclear Opthalmoplegia where the deficiency lies in Medial Longitudinal Fasciculus and this was accepted without Imaging or Neurophysiology evidence) [11].

It will be helpfulif it is possible to measure speed of conduction of CC fibres andviewing CC fibres with Diffusion Tensor Imaging (DTI) [12].

Conclusion

- There is subset of MS patients who showed dys-syncrony in bimanual activity andall of them showed marked thinning of CC on MRI scans.
- DTI can be useful for further research.
- The significance of this finding especially in Neuro Rehabilitation is still unknown.
- Further larger studies need to verify the findings of this study.

Competing Interests

The author declare no competing interests.

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