

Deficits in upper limbs after stroke: influences of functional hemispheric asymmetries

Déficits nos membros superiores após Acidente Vascular Cerebral: influências das assimetrias funcionais hemisféricas

Antonio Vinicius Soares¹, Noé Gomes Borges Júnior², Susana Cristina Domenech², Monique da Silva Gevaerd Loch³

RESUMO

Objetivo. Verificar se as assimetrias funcionais hemisféricas exercem influência sobre os déficits nos membros superiores de hemiparéticos por Acidente Vascular Cerebral. **Método.** Participaram do estudo 42 pacientes destros, 18 mulheres e 24 homens, idade média de 61,7±10 anos, tempo médio de lesão 22±15,1 meses. Os instrumentos de medida foram: Dinamômetro manual, Estesiômetro, Testes da Caixa e Blocos e Nove Buracos e Pinos, Índice de Barthel, Escalas de Movimentos da Mão e de Ashworth Modificada. **Resultados.** Todos os testes apresentaram diferença entre os lados parético e não parético. Entre homens e mulheres houve diferença apenas na dinamometria manual (lado parético p=0,001 e lado não parético p<0,000). Quanto à dominância hemisférica houve diferença no membro parético, sendo o melhor desempenho no teste de caixa e blocos no lado dominante (p=0,016). **Conclusão.** Nos hemiparéticos as alterações contralaterais são globais e mais graves, e as ipsilaterais são relacionadas à destreza manual. A avaliação e o planejamento da reabilitação destes pacientes devem contemplar abordagens globais e não apenas restritas aos déficits contralaterais.

Unitermos. Acidente Vascular Cerebral, Paresia, Avaliação da Deficiência

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Faculdade Guilherme Guimbala, Joinville-SC, Brasil.

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¹Physiotherapist, Master, Center for Research in Neurorehabilitation from the Guilherme Guimbala College, Joinville-SC, Brazil.

²Engineer, PhD, Professor, College of Health and Sport Science, Santa Catarina State University; Florianópolis-SC, Brazil.

³Pharmaceutical, PhD, Professor, College of Health and Sport Science, Santa Catarina State University; Florianópolis-SC, Brazil.

ABSTRACT

Objective. To verify whether the functional hemispheric asymmetries exert influence over the deficits on upper limbs of hemiparetic stroke patients. **Method.** 42 right-handed patients participated in the study, 18 women and 24 men, average age 61.7±10 years, average time lesion 22±15.1 months. The instruments of measurements: Handgrip Dynamometer, Esthesiometer, Box and Blocks Test, Nine Hole and Peg Test, Barthel Index, Movements Hand Scale and the Modified Ashworth Scale. **Results.** All tests showed a difference between the paretic and non-paretic sides. Between men and women there was a difference only in the handgrip (p=0.001 paretic side and p<0.000 non paretic side). As hemispheric dominance was different in the paretic limb, with the best performance in Box and Blocks Test on the dominant side (p=0.016). **Conclusion:** In hemiparetic patients the contralateral alterations are global and more severe, and the ipsilateral are related to the manual dexterity. The evaluation and the rehabilitation planning of these patients have to consider global approaches and not only limited to the contralateral deficits.

Keywords. Stroke, Paresis, Disability Evaluation

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Correspondence:

Antonio Vinicius Soares
Center for Research in Neurorehabilitation
Guilherme Guimbala College,
Joinville-SC, Brazil
Fone: (047) 3026-4000
e-mail: a.vinisoares@yahoo.com.br

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INTRODUCTION

The Stroke represents the greatest cause of death in all Latin America¹. It is the largest public health problem in Brazil, highlighted in the poorest regions in the country¹. Besides the high rate of mortality resulting of this pathology, the Stroke is also the greatest cause of physic and mental incapacity in adults^{2,3}. The predominant age group is between 40 and 69 years old, in which the black and mulattos are the most prevalent having as the main risks factors the systemic hypertension, diabetes mellitus, heart diseases, besides the sedentary, tobacco addiction, alcoholism, obesity, a lot of these elements associated to bad life habits⁴.

The hemiparesis is typical condition caused by Stroke. Due to the great impact on the functionality, great concern has been given to the disorders found in upper limbs of these patients. Thus, it should be investigated not only the contralateral disturbances, usually more severe and easier to clarify, but also, the ipsilateral dysfunction, several times unperceived or neglected by clinical. As the great part of the functional activities of the upper limbs are bimanual, it is important to investigate these alterations and check which impact of those deficits in the functional independence.

Although the contralateral and ipsilateral alterations of the upper limbs of hemiparetic patients have been well documented in the literature⁵⁻¹⁰ it is important to investigate which dominant (preference) manual influences over the motor, sensory and functional aspects of these patients. The objective of this study was to verify if the functional hemispheric asymmetry play an influence over the deficits of upper limbs of hemiparetic stroke patients, as well as if these possible alterations are different between men and women.

METHOD

Sample

The study was conducted in the Ambulatory of Neurological Rehabilitation from the Guilherme Guim-bala College and at the Association of Handicapped of Joinville. This study was approved by the Committee of Ethics and Research of the Lutheran Education Association (number 006). After clarification and orientations

all the participants gave their written informed consent.

Forty-two hemiparetic survivors of Stroke participated in the study, being 18 women (42.9%) and 24 men (57.1%) in average age 61.7±10 years, average time of lesion of 22±15.1 months. All patients were right-handed, in which 25 (59.4%) presented right-sided hemiparesis and 17 (40.5%) the left-sided hemiparesis. As the inclusion criteria, the patients should present of hemiparesis by Stroke (ischemic and hemorrhagic), with function at least partial of the more injured upper limb (able to perform the reach and grip) regardless the age and sex. The established criteria to the exclusion were: any other causes of hemiparesis, visual and/or auditory deficits, severe cognitive deficits and aphasia.

Procedure

For more reliability of the research the tests were always carried out by the same examiner. A card with the personal and anamnesis data was fulfilled. All the tests were carried out firstly with the less injured upper limb, following by the more injured upper limb (paretic).

To evaluate the muscle strength, it was used a Manual Dynamometer TKK 5401 GRIP-D® TAKEI – Scientific Instruments – Japan (measurement capacity between 5 and 100 kg; resolution 0.05 Kg; precision ±0.5%). The patient was positioned seated comfortably, with the shoulder forward and flexed elbow in 90o, forearm and wrist in a neutral position¹¹⁻¹³. Four measurements were performed in each limb, being the first one used only to get familiar with the equipment and with the method; therefore, this first measure was discarded; with the other measures the arithmetic average was calculated.

To the application of the Hand Movements Scale (1-6), the patient was requested to perform extension followed by fingers flexion, extension of the index finger, as he was pointing, and pincer between the first and the other fingers until the opponency with the little finger^{13,14}.

To the evaluation of the muscle tonus through the Modified Ashworth Scale, the flexor muscle of elbow, wrist and fingers were chosen. The obtained was found by calculating the average muscle spasticity of the upper limb all itself. As a way to facilitate the tabulation and

analysis of data, a scale of 0 to 5 was used^{15,16}.

In the manual dexterity there were used the Nine Hole and Peg Test-9HPT, composed by nine pegs (9 millimeters of diameter and 32 millimeters of length, a wood board with dimension of 100x100x20 millimeters containing nine holes of 10 millimeters of diameter and 15 millimeters of depth^{17,18}. The patient was oriented to take all the pegs out of the board and after putting them back, the patient was allowed to get familiar with the test for 15 seconds, and then, the total time to complete the task was timed, considering that it could not surpass 300 seconds to finish; and the Box and Blocks Test that is composed of a wood box (53.7 centimeters) with a taller dividing wall, separated in two compartments with same dimensions and 150 cubes of 2.5 centimeters^{17,18}. The patient transported the blocks from one side to the other side of the box, as well as the criteria of 15 first seconds, to get familiar with the test. In the sequence, one minute was timed and the number of transported blocks was counted. For both tests a verbal command, there was used instructing the patient to accomplish the task as fast as he could.

The sensibility by Esthesiometry was evaluated using a set of six nylon monofilaments (Monofilaments Sorri-Baurú®), these ones exercise a specific strength in the tested area that corresponds to the variety of weight between 0.05 and 300g. The monofilaments were applied perpendicular to the skin according to the distribution map of the ulnar, median and radial nerves at specific points by the protocol of the test. With eyes closed the patient related the perception of the touch and located it^{19,20}. The amount recorded was the average (in grams) of seven tested places, which six of them were in the palm region and one in dorsal region of hand.

The Barthel Index was used to evaluate de functional independence of the individual, for whom there were included aspects of feeding, personal hygiene, clothing, among others; the same was applied to the patient and/or caregiver. The maximum score was 100 points, which was a suggested of total independence²¹.

Statistical Analysis

The collected data were tabulated and analyzed in the software GrapfPad Prism 4°. Besides the descriptive statistics to obtain the averages and the standard deviation to the analysis of the differences between the measurements averages between the right and left sides, the Test t in pairs was applied; and for the unpaired data as an analysis between men and women and hemiparetic the right and left, there was used a Welch Correction. In the analysis of relations there was used the Sperman Correlation Test with significant level of 95% (p<0.05).

RESULTS

Forty-two hemiparetic stroke patients were evaluated at subacute or chronic stages, in which 18 women in average 62.3±11.7 age and 24 men in average 61.3±8.8 age. There was not a difference among these groups (p=0.776). All patients were right-handed.

The Table 1 presents the results of the general evaluation by both upper limbs of all patients involved in the study. Remarking that the contralateral upper limb is the most injured, usually considered as paretic, and the ipsilateral upper limb, in general, the less injured.

It was observed that all the results (Table 1) of the comparison between the sides are significant. The

Table 1. Comparison between the Upper Limbs Contralateral (CL) versus Ipsilateral (IL).

	HMS (CL)	HMS (IL)	EST (CL)	EST (IL)	DYN (CL)	DYN (IL)	9HP (CL)	9HP (IL)	BBT (CL)	BBT (IL)	MAS (CL)	MAS (IL)
Average	4.9	5.9	29	3.4	17.4	28.5	117	35	26	42	0.7	0
SD	1.2	0.3	80	19	10	9.4	102	16	14	15	0.6	0
p-value	<0.000		0.042		<0.000		<0.000		<0.000		<0.000	

HMS= Hand Movements Scale (1-6); EST= Esthesiometry (g); DYN= Dynamometry - Grip Strength (kgf); 9HP= Nine Hole and Peg Test (time in seconds); BBT= Box and Blocks Test (blocks/minute); MAS= Modified Ashworth Scale (0-5).

best performance was on the non paretic side. Remarkable that, in fact, it is evident the greatest contralateral exposure. From the 42 patients, 30 were spastic and were evaluated through the Modified Ashworth Scale, expressed on the Table 1.

On Tables 2 and 3 the results displayed are due to the comparison between men and women, that on Table 2 the results of the contralateral upper limb evaluation are expressed, and on Table 3 the data related to the ipsilateral upper limb.

To emphasize on Tables 2 and 3 that in this comparison between men and women it occurred just a difference on dynamometric tests for the evaluation of grip strength, as well as contralateral ($p=0.001$ paretic side) and ipsilaterally ($p<0.000$ non-paretic side).

On Tables 4 and 5 the results displayed are due to the comparison between patients that were stricken on the dominant sides and not dominant sides that on Table 4 are expressed from the evaluation results of contralateral upper limb (paretic), and on Table 5 the data referred to the ipsilateral upper limb.

When it comes to the evaluation quality of life through Barthel Index, the comparison between patients with right and left hemiparesis it was not observed a difference between them ($p=0.961$).

The relation between tests the measure instruments that were used are presented in the research. The Nine Hole and Peg Test was used as the parameter of reference by the fact of the dexterity is a common deficit in both upper limbs.

It is possible to observe that on the contralateral upper limb (paretic) there was from moderate to strong negative correlation with the dynamometry (grip strength;

$r=0.49$), the Hand Movements Scale ($r=0.64$) and with the Box and Blocks Test ($r=0.76$). There was no correlation with Esthesiometry. Yet on the ipsilateral upper limb, the best correlation to the Nine Hole and Peg Test was with the Box and Blocks Test ($r=0.67$). A weak correlation was found with the Esthesiometry ($r=0.33$) and with the Dynamometry ($r=0.35$). Yet, ipsilaterality there was no correlation with the Movement Hand Scale and with Barthel Index.

DISCUSSION

Some studies have demonstrated that alterations occur in both upper limbs after a unilateral stroke affecting the frontal and/or parietal lobes of brain^{22,23}. Undoubtedly, the greatest focus is given to the contralateral alterations due to the severity of the deficits that cause important functional impacts. As in previous studies, our results confirm that the most important alterations are on the contralateral upper limb (paretic)²⁴. In all the applied tests there was a difference between both sides. This is easily understandable, as the influence of the cortical-spinal tract is predominantly crossed²⁵. Reinforcing these aspects these patients used 5 to 6 times more their ipsilateral members comparing to the contralateral members²³.

When the influence of the hemispheric dominance was compared to the contralateral influences, in other words, on the paretic side, it could be observed that the only difference was on the performance of the Box and Blocks Test. Considering that all the patients were handed people, it was observed a better performance in right hemiparetic patients. Besides the spontaneous use of the dominant limb (preferred) to execute the most

Table 2. Comparison between women (W) and men (M) – Contralateral Upper Limb (Paretic).

	HMS W	HMS M	EST W	EST M	DYN W	DYN M	9HP W	9HP M	BBT W	BBT M	BI W	BI M
N	18	24	18	24	18	24	18	24	18	24	18	24
Average	4.9	4.9	46.2	15.5	11.9	21.4	111	121	23.7	28	88.1	87.9
SD	1.3	1.2	98.1	61.4	5.9	11.2	93	110	12.5	14.2	15.5	13.1
p-value	0.972		0.252		0.001		0.754		0.306		0.961	

HMS= Hand Movements Scale (1–6); EST= Esthesiometry (g); DYN= Dynamometry - Grip Strength (kgf); 9HP= Nine Hole and Peg Test (time in seconds); BBT= Box and Blocks Test (blocks/minute); BI= Barthel Index (0–100).

Table 3. Comparison between women (W) and men (M) – Ipsilateral Upper Limb.

	HMS W	HMS M	EST W	EST M	DYN W	DYN M	9HP W	9HP M	BBT W	BBT M	BI W	BI M
N	18	24	18	24	18	24	18	24	18	24	18	24
Average	5.9	6	0.9	0.6	20.7	34.3	36.4	33.9	39	43.9	88.1	87.9
SD	0.2	0.5	2.8	0.7	5.2	7.4	14.5	17.4	16.2	13	15.5	13.1
p-value	0.565		0.725		<0.000		0.628		0.286		0.776	

HMS= Hand Movements Scale (1–6); EST= Esthesiometry (g); DYN= Dynamometry - Grip Strength (kgf); 9HP= Nine Hole and Peg Test (time in seconds); BBT= Box and Blocks Test (blocks/minute); BI= Barthel Index (0–100).

complex component of the task, it was already observed that those patients with lesion on the left hemisphere use twice more the upper limbs bilaterally, what could contributed to a better performance in this dexterity test²³.

In the case of ipsilateral alterations, the disturbs linked to the dexterity of the upper limb are often described in the literature. According to the results, there were used two tests to evaluate this aspect of the motricity, the Nine Holes and Pegs Test and the Box and Blocks Test. In general, good performances in these tests permit to take into consideration the functionality of the upper limb of these patients and are predictors of the upper limb motor function²⁶.

Regarding the influence of the hemispheric dominance in the ipsilateral alterations, no significant difference was observed in the dexterity tests. These findings are supported by other studies that used the Jebsen-Taylor Test to evaluate this variable^{8,9}.

However, in the study where thirty patients were evaluated, which 15 with lesion on the right hemisphere and 15 with lesions on the left hemisphere, the authors observed that the ipsilateral alterations in the upper limb

are more frequent in lesions on the left hemisphere, because they are associated to the cognitive alterations, as the ideomotor apraxia¹⁰. These findings are in conformity with relate the deficits of ipsilateral dexterity to different reasons, where they observed that the lesions on the left hemisphere cause apraxia of the member, and the lesions on the right hemisphere cause spatial disturbances²². The patients with lesions on the right hemisphere use the ipsilateral upper limb four times more than the patients with lesions on the left hemisphere²³. This can be explained due to the majority are handed people, so, the spontaneous use can contribute decisively to this behavior.

Although it has not been found any difference on the ipsilateral member between the brain hemispheres, the alterations in the group as a whole are evident when compared to the rates suggested for the same group age. In the Nine Holes and Pegs Test, the average time is 19.4 ± 2.7 sec²⁷. Our patients obtained the average time of 35 ± 16 sec. According to the Box and Blocks Test, the patients of the study reached the average performance of 42 ± 15 blocks/min, considering that the normative rates suggest at least 54 blocks/min¹⁸.

Table 4. Comparison between the non-dominant (ND) and dominant (D) sides (Contralateral Upper Limb – Paretic).

	HMS ND	HMS D	EST ND	EST D	DYN ND	DYN D	9HP ND	9HP D	BBT ND	BBT D	Age ND	Age D
N	17	25	17	25	17	25	17	25	17	25	17	25
Average	4.5	4.8	23.8	32	15.2	18.8	140	101	20.1	30.2	59.5	63.3
SD	1.6	1.2	72.9	85.2	12.1	8.9	111	93.6	12	13.2	8.6	10.8
p-value	0.392		0.748		0.274		0.227		0.016		0.231	

HMS= Hand Movements Scale (1–6); EST= Esthesiometry (g); DYN= Dynamometry - Grip Strength (kgf); 9HP= Nine Hole and Peg Test (time in seconds); BBT= Box and Blocks Test (blocks/minute).

Table 5. Comparison between the non-dominant (ND) and dominant (D) sides (Ipsilateral Upper Limb).

	HMS ND	HMS D	EST ND	EST D	DYN ND	DYN D	9HP ND	9HP D	BBT ND	BBT D	Age ND	Age D
N	17	25	17	25	17	25	17	25	17	25	17	25
Average	5.9	6	0.4	5.4	30	27.5	31.5	37.4	39.4	43.4	59.5	63.3
SD	0.5	0.2	0.6	24.5	10.8	8.4	8.3	18.9	15.7	14.5	8.6	10.8
p-value	0.477		0.406		0.405		0.235		0.391		0.231	

HMS= Hand Movements Scale (1–6); EST= Esthesiometry (g); DYN= Dynamometry - Grip Strength (kgf); 9HP= Nine Hole and Peg Test (time in seconds); BBT= Box and Blocks Test (blocks/minute).

Comparing men and women the only difference that was found, was the grip strength evaluation in the dynamometer tests in both sides. These findings can be explained by the fact that men present more muscular strength in all stages of life development²⁸, maintaining this difference even when brain lesions occur, independently of the injured hemisphere²⁹.

CONCLUSION

This present study confirms the reports in the literature of bilateral disability of upper limbs after a unilateral Stroke. In contralateral side the alterations are global and ipsilateral related to the dexterity. That is something easily detected in clinic tests that were used in this study.

However, the ipsilateral alterations are usually neglected by clinicians also need detailed investigation, so they can represent important dysfunctions that reflect on the functional performance of daily activities, which are most of the time bimanual⁵⁻⁹. So, identifying these deficits and understand which influence of the hemispheric asymmetries can contribute to the appropriate and realistic planning of these patients' rehabilitation.

Therefore, the clinicians should pay attention during the evaluation process to the possible bilateral dysfunctions on the upper limbs and select strategies of treatment that consider the global rehabilitation, not only restricted to the contralateral side.

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