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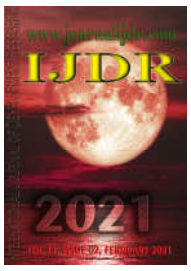

RESEARCH ARTICLE OPEN ACCESS

# RELATIONSHIP BETWEEN THE INJURED HEMISPHERE AND THE FUNCTIONAL SEQUELAE OF STROKE - OBSERVATION AND COMPARISON ACCORDING TO THE FUGL-MEYER AND MOTOR ASSESSMENT SCALE

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**ABSTRACT**

**Introduction:** The Stroke is understood as a neurological deficit of sudden origin, resulting from a vascular injury, which has interaction with the vessels, blood elements and hemodynamic variables. These changes can cause a vessel to obstruct, causing ischemia, but they can also cause a vessel to rupture and an intracranial hemorrhage. **Objectives:** Verify the relationship between the injured hemisphere and the functional sequelae of the stroke, identify the sample profile and evaluate the motor and functional sequelae. **Methods:** Comparative study carried out at the Neurological Physiotherapy Clinic of the Santo Amaro University (UNISA), São Paulo, Brazil. **Results:** The results showed that the average age of the sample was 62.1 years, the predominance of sequelae in the left hemibody (HE) and the majority of the subjects were female. According to the Fugl-Meyer scale, sequelae in the right hemibody (HD) showed a recovery percentage that was more distant from the physiological one, according to the same scale, a 70% predominance of the flexor pattern in the upper limb and the state of motor impairment memorable. According to the Motor Assessment Scale, individuals with sequelae left hemibodies had greater difficulty in carrying out activities aimed at motor coordination and balance control. **Conclusion:** The hemibody most compromised in this sample was the left, despite that, the sequelae on the right are more serious. The flexor pattern of the upper limb was predominant in the evaluated group, as well as the marked motor impairment.



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# INTRODUCTION

It is estimated that the general population will reach 8.5 billion individuals in 2030, consequently, there is a significant increase in chronic non-communicable diseases (NCDs), such as cerebrovascular diseases, the most frequent causes of death (Lima-Costa *et al*., 2004; Garritano *et al*., 2012; Uniric, 2015; IBGE, 2018; Population Pyramid, 2018). In Brazil, approximately 100 thousand deaths from cerebrovascular accident are recorded annually (Directorate of Epidemiological Surveillance, 2014; Almeida e Vianna, 2018). The diagnosis of stroke can be classified as ischemic or hemorrhagic (Pontes-Neto *et al*., 2009; Piassaroli *et al*., 2011; Pavan *et al*., 2015). According to the literature, risk factors for brain injury can be identified as modifiable (hypertension, diabetes, physical inactivity and smoking) and non-modifiable (age, sex, ethnicity and heredity) (Chaves, 2000; Gomes, 2012; Ministry of Health, 2013; Botelho *et al*., 2016). The most frequent clinical picture is the sudden appearance of neurological deficits: decreased sensitivity and/or weakness in the face, in the upper and/or lower limb unilaterally; mental confusion; difficulty seeing with one or both eyes; difficulty walking, dizziness and/or incoordination (Silva *et al*., 2015). These sequelae limit mobility, independence and communication (Pereira *et al*., 2018). Physiotherapeutic treatment is very effective in recovering functional independence after acerebrovascular accident, by stimulating the function of the upper and lower limbs and postural control (Arrais-Júnior *et al*., 2016). The monitoring of a professional physiotherapist is of fundamental importance both in the acute and in the chronic phase (Costa *et al*., 2011; Arrais-Júnior at al., 2016; Pereira *et al*., 2018). Considering the increased frequency of stroke

cases, the functional impact and the varied limitations, the aim of this study was to verify the relationship between the injured hemisphere and the functional sequelae of the stroke, identify the profile of the sample and evaluate the motor sequelae and functional.

# MATERIALS AND METHODS

Comparative study carried out at the Neurological Physiotherapy Clinic of Santo Amaro University (UNISA), approved by the Ethics and Research Committee, Certificate of Presentation of Ethical Appreciation number:97322818.7.0000.0081. The convenience sample consisted of 10 individuals after chronic stroke. A specific questionnaire composed of 9 simple questions was applied to determine the profile of the sample and classified in individuals with left hemibody (LH) or sequelae right hemibody (RH). To assess motor and sensory impairment, the Fulg-Meyer Rating Scale was used, which totals 226 points. It is divided into 6 domains: motor function, range of motion, sensitivity, pain, balance and, coordination and speed21 and used to measure the percentage of sensorimotor recovery (Cavaco, Alouche, 2010; Michaelsen *et al*., 2011). To assess the global motor function: the trunk, upper and lower limbs of the sample, the Motor Assessment Scale (MAS) was used, whose highest score indicates better functioning and the maximum score is 54 points (Carr, Shepherd, 1985;Dean, Mackey, 1992; Conte *et al*., 2009;).

# RESULTS

The sample consisted of 10 individuals, with a mean age of 62.1 years, ranging from 49 to 75 years. According to the national hospital information system, the usual age of diagnosis of cerebrovascular accident is from 60 years old, thus, the average age of the sample corresponds to the literature (Costa *et al*., 2011; Arrais-Júnior *et al*., 2016). The group's average cerebrovascular accident time was 6.8 years, ranging from 2 to 17 years. The time of participation in the physiotherapy group at the University ranged from 1 to 12 years, with an average of 4.9 years.

**Table 1. Descriptive analysis (number and %) of qualitative variables (nominal and ordinal) of patients**

| Variable | N | % |
|---|---|---|
| Sex | | |
| Feminine | 7 | 70% |
| Masculine | 3 | 30% |
| SequelaeHemibody | | |
| Rigth | 4 | 40% |
| Left | 6 | 60% |
| Predominance of Hemiparesis | | |
| Proportional | 5 | 50% |
| Superior predominance | 4 | 40% |
| Lower predominance | 1 | 10% |
| Type of cerebrovascular accident | | |
| Ischemic | 10 | 100% |
| Hemorrhagic | 0 | 0% |
| Probable cause of cerebrovascular accident (riskfactor) | | |
| Arterial hypertension | 4 | 40% |
| Diabetes | 1 | 10% |
| Family history | 1 | 10% |
| Chagas disease | 1 | 10% |
| Hypertension + Diabetes | 1 | 10% |
| Hypertension + Family history | 1 | 10% |
| Didnotknow | 1 | 10% |

Source: Prepared by the authors, 2021.

About the sample, 30% were male and 70% female (Table 1). The most common motor syndromic diagnosis in this sample was proportional left hemiparesis. The ischemic cerebrovascular accident was the subtype presented by the entire sample and the risk factors associated with the cerebrovascular accident were: hypertension (60%), followed by diabetes, family history and Chagas disease.

To assess the motor and sensory impairment of the sample, the Fugl-Meyer Scale was applied. The results showed that the percentage of recovery of the sequelated hemibody was lower than that of the unaffected hemibody (Table 2). However, the difference, in most cases, was not discrepant.

**Table 2. Results after application of the Fugl-Meyer Scale**

| Individual | Sequelated Hemibody | Pontuação na Escala de Fulg Meyer | | | |
|---|---|---|---|---|---|
| | | RH | LH | % recovery | |
| A | Left | 212 | 194 | RH: 93,80% | LH: 86,28% |
| B | Left | 214 | 187 | RH: 94,69% | LH: 82,74% |
| C | Left | 203 | 171 | RH: 89,82% | LH: 75,66% |
| D | Left | 217 | 127 | RH: 96,02% | LH: 56,19% |
| E | Left | 205 | 183 | RH: 90,71% | LH: 81,42% |
| F | Left | 203 | 188 | RH: 89,82% | LH: 83,19% |
| G | Right | 123 | 203 | RH: 54,42% | LH: 89,82% |
| H | Right | 125 | 202 | RH: 57,52% | LH: 89,38% |
| I | Right | 194 | 218 | RH: 85,84% | LH: 96,46% |
| J | Right | 204 | 202 | RH: 90,26% | LH: 89,38% |

Source: Prepared by the authors, 2021.
RH: Right Hemibody; LH: Left Hemibody.

The final score referring only to motor function, totals 100 points, with 66 for upper limbs and 34 for lower limbs, classifying impairment as mild, 96-99, moderate, 85-95, striking, 50-84 or severe, less than 50 points (Cavaco, Alouche, 2010). After applying the scale, it was obtained: 20% of the individuals with sequelae in the RH moderate motor impairment and the other 20% with sequelae on the same side, presented marked impairment; 50% with sequelated LH showed marked impairment and 10% had severe impairment with the left side with sequelae (Table 3).

**Table 3. Classification of patients with cerebrovascular accidents equelae in relationto Motor Impairment**

| Motor commitment | Sequelae Right Hemibody | | Sequelated Left Hemibody | |
|---|---|---|---|---|
| | n | % | n | % |
| Light | 0 | 0% | 0 | 0% |
| Moderate | 2 | 20% | 0 | 0% |
| Outstanding | 2 | 20% | 5 | 50% |
| Severe | 0 | 0% | 1 | 10% |

Source: Prepared by the authors, 2021.

The Motor Assessment Scale (MAS) was applied to assess the global motor function. Its differential is to evaluate the motor function through the observation of the performance of functional activities, emphasizing the quality of the movement of transfers and manual activities (Table 4) (Dean, Mackey, 1992; Hsueh, Hsieh, 2002; English *et al*., 2006; Conte *et al*., 2009; Miller *et al*., 2010; Tucak *et al*., 2010; Wanderley *et al*., 2015).

**Table 4. Relationship between the total MAS score and the affected hemibody**

| Individuals | Affected hemibody | MAS total score | |
|---|---|---|---|
| | | **RH** | **LH** |
| A | Left | 44 | 43 |
| B | Left | 52 | 44 |
| C | Left | 33 | 19 |
| D | Left | 46 | 26 |
| E | Left | 45 | 35 |
| F | Left | 36 | 35 |
| G | Rigth | 38 | 42 |
| H | Rigth | 40 | 40 |
| I | Rigth | 46 | 46 |
| J | Rigth | 37 | 37 |

**Source:** Prepared by the authors, 2021.
RH: Right Hemibody; LH: Left Hemibody; MAS: Motor Assessment Scale.

From the results of MAS, it was noted that individuals with affected LH had greater difficulty in different items in relation to the sequelated HR. After data analysis, it was observed that 5 of the 6 subjects with sequelated HE had a score lower than 3 in at least one of the items. However, among those with sequelated HR, only 1

individual scored low on two items. Analyzing and comparing the results regarding the total scores between the hemibodies, whether sequelated or not, for each individual, it was found that 3 of the 4 individuals with sequelated RH, had MAS scores equal between the hemibodies. However, for 3 (highlighted) of the 6 individuals with sequelated LH, there was a difference between the hemibodies (Table 5).

**Table 5. Relationship between the hemibodies of each individual acquired by MAS**

| Individuals | Affected hemibody | MAS total score | | |
|---|---|---|---|---|
| | | RH | LH | Difference in functionality between hemibodies |
| A | Left | 44 | 43 | 1 |
| B | Left | 52 | 44 | 8 |
| C | Left | 33 | 19 | 14 |
| D | Left | 46 | 26 | 20 |
| E | Left | 45 | 35 | 10 |
| F | Left | 36 | 35 | 1 |
| G | Rigth | 38 | 42 | 4 |
| H | Rigth | 40 | 40 | 0 |
| I | Rigth | 46 | 46 | 0 |
| J | Rigth | 37 | 37 | 0 |

Source: Prepared by the authors, 2021.
RH: Right Hemibody; LH: Left Hemibody; MAS: Motor Assessment Scale.

# DISCUSSION

Immediate physical therapy is essential for the subject's rehabilitation after a cerebrovascular accident and the return to daily activities (Silva *et al*., 2015). However, it was observed that the time of cerebrovascular accident of 5 individuals in the research is greater than the time of the beginning of the physiotherapeutic treatment, which can be considered an aggravating factor for the establishment of the pathological pattern. As for associated diseases, according to the Ministry of Health, it is evident that the most common risk factor in individuals is hypertension and Diabetes Mellitus as the second most common risk factor, similar to the results found in the present study (Chaves, 2000; Pires *et al*., 2004; Silva *et al*., 2015). The results obtained through the Fulg-Meyer Evaluation Scale showed that the percentage of recovery of the sequelated hemibody was lower than that of the unaffected hemibody, however, the latter also demonstrates a reduction in its physiological functionality (Table 2). The human brain is formed by two halves that are connected to each other by the corpus callosum, one of the main functions of which is to allow communication between the two hemispheres, transmitting memory and learning (Voos, Ribeiro-do-Vale, 2008; Bear *et al*., 2017). The information captured is felt as a sensory stimulus in the same way in both hemispheres, but it is interpreted differently in each one (Oliveira, 1984; Voos, Ribeiro-do-Valle, 2008). There are regions in the cerebral cortex that specialize in performing certain functions and, in addition to localization, a function can also be lateralized to a cerebral hemisphere, with one dominating over the Other (Springer, Deutsch, 1998; Moreira, 2017). With differences in information processing between the two hemispheres, studies show that they work in a coordinated manner, playing complementary roles. Thus, an injury in a certain cerebral hemisphere, results in a decrease in the physiological performance of the uninjured hemisphere, which was also observed in the sample results (Springer, Deutsch, 1998; Machado, 2004; Snell, 2010; Moreira, 2017).

According to the results (Table 4), the maximum MAS score was not achieved by any subject, both for the affected hemibody and for the unaffected hemibody. The post-cerebrovascular accident sequelae differ according to the type, location and extent of the lesion, but cognitive, motor, sensory and / or autonomic changes are common (Lundy-Ekman, 2007; Medici, 2013). Cognitive impairments can affect attention, memory and the association of these skills, thus, this fact generates a reduction in the organization of thoughts (Calil *et al*., 2007; Farokhi-Sisakht *et al*., 2019). As for motor dysfunction, contralateral hemiplegia prevails next to the brain injury and, due to the complementary brain activities, there is a decrease in the physiological performance of the uninjured hemisphere (Springer, Deutsch, 1998; Snell, 2010; Oliveira *et al*., 2014; American Heart Association, 2019). Analyzing the distribution of results regarding the difficulty of performing certain items, it was found that actions such as: moving from the supine position to sitting position, hand movements and advanced manual activities stood out, corroborating with the literature regarding the consequences of the injury brain in relation to changes in tone, associated reactions, loss of balance and protection reactions and loss of selective movement (Guyton, Hall, 2011; Schuster, 2011). Muscle tone tends to increase gradually, setting up spasticity, which is associated with the intensification of tendon reflexes, being one of the most common sequelae present in central nervous system injuries (Ministry of Health, 2009; Itaquy *et al*., 2011). In the case of the cerebrovascular accident, there is a propensity for spasticity by the flexor musculature of the sequelated upper limb, thus hampering fine praxis and coordination movements as assessed in the sample (Ministry of Health, 2009). The difficulty of executing the action of moving from supine to sitting position is caused by the limitation of complete trunk mobility, resulting in a body imbalance and greater insecurity, thus generating a greater concentration of attention to the trunk to obtain stability, causing thus, increased spasticity of the muscles and deficits in their motor control.

Recovery is based on the degree of adaptation, plasticity of the uninjured regions and the age of the individual. For example, after childhood, language functions and spatial functions become more and more lateralized and not redundant (Savassini, *et al*, 2019). Studies have concluded that the left hemisphere's way of dealing with new information is best characterized as analytical, contrary to the right hemisphere that processes the information holistically (Springer e Deutsch, 1998). However, many separate areas of the cortical association have overlapping functions. This generally allows one part of the brain to functionally compensate for the other injured parts (Arthur, *et al*., 2010; Savassini, *et al*, 2019). Analyzing and comparing the results obtained with the application of MAS, regarding the total scores between the hemibodies, whether sequelated or not, for each individual, it was found that 3 of the 4 individuals with sequelated HD, had MAS scores equal between the hemibodies. However, 3 of the 6 individuals with sequelated LH showed a significant difference between the hemibodies. Individuals with sequelae in HR, present left brain hemisphere damage and, due to the fact that the tasks of selecting details and motor activities that require planning are more dependent on this hemisphere, in clinical practice, it is common the impression that the functional recovery of individuals with HR is more complicated (Oliveira, 1984; Springer e Deutsch, 1998). However, according to the results (Table 5), there is a greater impairment of the left hemibody in the sample group, corroborating with the results of the Fulg-Meyer Scale. Individuals with sequelae in the LH, presented damage to the right cerebral hemisphere that is composed of the processing mechanism in spatial and non-verbal tasks, such as spatial orientation, postural control and processing of rhythmic movements (Oliveira, 1984; Lent, 2010). Thus, he again agrees with the results of the Fulg-Meyer Scale regarding motor impairment, mainly in relation to changes in muscle and postural tone, motor coordination and balance.

# CONCLUSION

Individuals after chronic cerebrovascular accident did not reach the total score, either in the sequelae and non-sequelae hemibodies, in the global motor and sensorimotor evaluation scales. The results of the application of the Fugl-Meyer Evaluation Scale identified that the hemibody most compromised in this sample is the left, despite that, the sequelae on the right are more serious, being represented by smaller percentages of recovery. With the application of the Motor Assessment Scale, it was observed that individuals with sequelae left hemibodies had greater difficulty in carrying out certain items that involved changes in muscle and postural tone, motor coordination and balance. The flexor pattern of the upper limb is predominant in the group evaluated, as well as the marked motor impairment.

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