Impact of Hemorrhagic Stroke on Molar Bite Force: A Prospective Study

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Received February 25, 2022; Accepted August 2, 2022.

Key words: Cerebrovascular disorders – Stroke – Bite force – Record – Stomatognathic system

Abstract: Stroke is a neurological deficit of cerebrovascular origin that promotes physical impairments of adult individuals. The present study is aimed to demonstrate whether hemorrhagic stroke affects the maximum molar bite force. The prospective study carried in Centro Universitario Claretiano de Batatais, Brazil, determined the distribution of the sample into two groups: hemorrhagic stroke group (n=18, median age, 62.5 years) and disease-free group (n=18, median age, 62.0 years), with 10 men and 8 women in each group. Subjects were paired one-to-one (age and body mass index). The dynamometer was used to measure the maximum molar bite force (right and left). All analyses were performed with a significance level of 5% (Student's *t*-test). Differences were found on the right (p=0.048) and left (p=0.042) molar bite force, with lower bite force (both sides) in hemorrhagic stroke group. The study suggests that hemorrhagic stroke negatively affects the maximum molar bite force and necessitates changes in food intake to nutritious and softer consistency foods.

This study was supported by the Fundação de Amparo a Pesquisa do Estado de São Paulo (FAPESP, Brazil), and National Institute and Technology – Translational Medicine (INCT.TM), São Paulo.

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https://doi.org/10.14712/23362936.2022.16

Introduction

Stroke is a pathology of the central nervous system, with important implications on global health, characterized by sudden neurological changes resulting from vascular injuries (Markus and Brainin, 2020). It is classified into two subtypes: ischemic, due to a clot that blocks the flow of blood to the brain, and hemorrhagic, due to the rupture of a blood vessel leading to hemorrhage (Tsai et al., 2018).

When there is an injury to the central nervous system, contraction and relaxation of the skeletal striated muscles may be compromised (Ludwig et al., 2020). This pathology can trigger complications in affected individuals, such as motor deficit, reduced balance, and changes in muscle strength, also affecting the stomatognathic system (Umay et al., 2019).

Muscle hypotonia, associated with weakness of all or some reflexes of the human body, is a characteristic stroke sequel. This hypotonia leads to a progressive and slow decrease in muscle tone, causing a reduction in strength (Al-Hassnan et al., 2008). With functional changes in the musculature, the stomatognathic system, which is an extremely complex system consisting of interdependent static and dynamic structures, can be affected, impacting the quality of life of individuals with stroke (Yılmaz et al., 2020).

The masticatory performance of individuals with stroke is compromised due to the reduced strength of orofacial structures such as tongue, lips and muscles, in addition to molar bite force even though there is no significant difference between the ipsi- and contralesional sides (Schimmel et al., 2017).

This study aimed to determine the maximum molar bite force in individuals with hemorrhagic stroke in order to understand the functional dynamics of the stomatognathic system. The null hypothesis of this study was that the hemorrhagic stroke group would not present changes in relation to the maximum molar bite force when compared to the disease-free group.

Material and Methods

Study design

All procedures followed this prospective and observational study were in accordance with the ethical standards of the responsible committee on human experimentation (School of Dentistry of Ribeirão Preto, University of São Paulo, process # 92222318.8.0000.5419). The informed consent form was signed by the individuals selected to participate in the sample.

Post hoc test (α=0.05) was applied to confirm the sample size of the groups. Sample size calculation indicated that the required number of individuals was 18 for each group (power of 84% and effect size of 0.68). We used the G* Power program (Franz Faul, Kiel, Germany) to validate the sample data.

Following the inclusion and exclusion criteria, eighteen individuals (mean age [SD – standard deviation], 62.5 [3.2] years), out of a total of 40 individuals evaluated, with hemorrhagic stroke that provided problems in the right side of body,

Table 1 – Depicting inter group comparison of anthropometric measurements

Variables	Group	Mean ± std. error	P-value
Body mass index	hemorrhagic stroke disease-free	27.69 ± 0.91 26.91 ± 0.57	0.477
Age	hemorrhagic stroke disease-free	62.5 ± 3.2 62.0 ± 3.2	0.923

diagnosed over a period of more than five years by neurologists at the Centro Universitário Claretiano de Batatais were selected in the case group. The case and disease-free groups (mean age [SD], 62.0 [3.2] years), with 10 men and 8 women in each group, were paired one-to-one by sex, age, and body mass index (Table 1).

The inclusion criteria were individuals with all teeth except the third molars, normal occlusion, and absence of temporomandibular dysfunction according to the Research Diagnostic Criteria for Temporomandibular Disorders. The exclusion criteria were completely and partially edentulous patients, those with a complete and partial prosthesis; diagnosis period of hemorrhagic stroke less than five years; not undergoing clinical treatment; having ulcerations, wounds, or skin hypersensitivity; having cognitive problems; and the presence of chronic-degenerative diseases. Five years of time span were considered because of the available sample, through the survey.

Individuals with hemorrhagic stroke were staged by modified ranking (Wilson et al., 2002), being distributed into degrees 2 and 3 of disability. In addition, all the individuals in the sample presented sensorimotor alterations related to disorders in the somesthetic and primary motor areas.

Bite force analysis

A digital dynamometer (IDDK, Kratos, Cotia, São Paulo, Brazil) with a force load of up to 980.66 N determined the maximum molar bite force. The biosafety protocol was employed for the apparatus using 70% alcohol and latex fingers in rods with Teflon discs (Waripe, São Paulo).

The measurements were made in the region of the right and left permanent first molars. The individual positioned his head in a relaxed and erect, way looking into the horizon, with the Frankfort Horizontal plane kept parallel to the floor. The individual was asked to bite the device three times, with maximum strength, with a two-minute interval between each measurement while alternating the side. This was supervised by a qualified professional (Palinkas et al., 2010; Righetti et al., 2020; Gomes et al., 2022).

Table 2 – Depicting inter group comparison of maximum molar bite force

Molar bite force	Group	Mean ± std. error (N)	P-value
Right	hemorrhagic stroke disease-free	207.9 ± 33.5 310.7 ± 37.3	0.048
Left	hemorrhagic stroke disease-free	192.4 ± 29.7 313.8 ± 49.2	0.042

Method error

Dahlberg's formula was used to calculate the error in the study's methodology with a sample of ten individuals. The interval between two sessions in a week was sufficient to determine the maximum molar bite force error, which was 6.68%.

Statistics

The Shapiro-Wilk test was used to determine the normal distribution of the data. SPSS version 22.0. (SPSS Inc., Chicago, USA) was used to analyse the data obtained (Student's *t*-test, $p<0.05$).

Results

There was significant difference in the right ($p=0.048$) and left ($p=0.042$) maximum molar bite force, between the hemorrhagic stroke and disease-free groups. The hemorrhagic stroke group showed had lower maximum molar bite force (both sides) when compared to the group without the disease (Table 2).

Discussion

The null hypothesis of this study was rejected because there were significant differences between groups for maximum molar bite force. The human body undergoes continuous transformations due to extrinsic and intrinsic factors. This makes it impossible for the motor response to function properly in posture control and body balance, which in turn causes functional impairments (Feger et al., 2019).

Global assessment has shown that the population is increasingly aging, presenting commodities with risk factors for stroke; therefore, knowledge regarding the dynamics of the stomatognathic system and the characteristics of the molar bite force is important in understanding the functional changes resulting from hemorrhagic stroke (Ramírez-Moreno et al., 2015).

In the current study, the null hypothesis was not rejected because the disease had a negative influence on the maximum molar bite force. Individuals with hemorrhagic stroke had a lower bite force than those in the disease-free control group, showing the interaction between the brain and muscle strength after brain injury (Rawson et al., 2018).

Motor sensory disturbances in the stomatognathic system after a hemorrhagic stroke affect the masticatory muscles and the head and neck muscles leading to a decrease in the bite force (Schimmel et al., 2011). When the cells of the nervous system die as a result of a stroke, the individual loses the skills controlled by the affected brain area such as body movement (Stinear et al., 2020).

A hypothesis that could explain the reduction in bite strength in individuals with hemorrhagic stroke would be that the damage and/or injury of the brain resulting from the disease promotes a functional change in the control of voluntary movement. This is because the spasticity, characterized by the interruption of important signals between the nervous system and skeletal striated muscles, promotes functional imbalance with increased muscle activity and muscle tone leading to the appearance of recurrent spasms (Gupta et al., 2018).

These clinical signs favor the weakening of the muscular system, including the muscles used in mastication, triggering a decrease in muscle strength. Literature shows that the masseter muscle is affected by the generalized spasticity in stroke, limiting mouth opening due to trismus (Seo et al., 2012). In this study, the sensation of the resistance of the masticatory muscles or head and neck muscles to passive stretching in individuals with hemorrhagic stroke was not evaluated.

Other factors that could have influenced the decrease in the bite force of individuals with hemorrhagic stroke in this study could be the loss of muscle tone and decreased aerobic capacity, which can increase energy expenditure in daily activities, reducing body strength (Stinear et al., 2020).

Dorsch et al. (2016) evaluated the strength of the lower limbs in individuals with stroke and found a reduction of 48% in strength when compared to that in the disease-free group. The findings of this study demonstrated a reduction in the bite force in the hemorrhagic stroke group. Further, when we transformed the results into percentage data, we observed that the hemorrhagic stroke group experienced a 66.7% reduction in the maximum molar bite force on the right side and 62.3% on the left side when compared to the disease-free group.

Authors report that any disharmony, such as those occurring in the muscle tone in individuals with stroke, may have a negative impact on the dynamics, function, and strength of the human body, resulting in the reduced performance of the skeletal striated muscle, which is responsible for these dynamics (Bovonsunthonchai et al., 2011).

Therefore, the factors reported also have a direct link with poor posture. Often, positioning the head and neck forward affects the functionality of the stomatognathic system structures, especially mandibular movement that involves combined action of the musculature of the neck and cervical spine (Zafar et al., 2000).

Poor posture of the head and neck promotes muscle fatigue because it stimulates the fascia muscle fibers (rapid contraction) that are used for movement, strength, and activity instead of the static muscle fibers that maintain body position (Moccia et al., 2016).

Over time, poor posture causes weakening of the deeper muscles due to lack of use, impairing the functional capacity of the cranio-cervical system. This hypothesis should help clarify the reduction in maximum molar bite force in the group with hemorrhagic stroke. In this study, the postural condition of individuals with hemorrhagic stroke was not assessed.

One of the biggest problems for stroke patients is the difficulty in feeding and swallowing (Nakamori et al., 2021), which can lead to changes in food choices, leading patients to malnutrition. This study proves that even a few years after the hemorrhagic stroke, the stomatognathic system, especially the maximum molar bite force, is still functionally compromised, which is an important clinical report for the knowledge of physicians, nutritionists and speech therapists who work with these patients, seeking an adequate power diet, providing a better nutritional status and quality of life for patients.

Although there are some limitations to this study, such as the inability to evaluate the sensation of resistance of the muscles to passive stretching and the postural position of the head showing a possible increase in muscle tone, a functional change in the stomatognathic system was demonstrated using the maximum molar bite force in the hemorrhagic stroke group.

Conclusion

The results suggest that individuals with hemorrhagic stroke may show a decrease in the maximum molar bite force. Therefore, this study provides basis for future research to improve the function of the stomatognathic system in individuals with hemorrhagic stroke, in addition to confirming our results. Further, there is a need to assess changes in the pattern of food intake, with selection of nutritious and softer consistency foods in such individuals.

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