Effect of Dental Characteristics of Stroke Patients on the Masticatory System*

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Abstract

Aim: The aim of this study was to assess the interplay between central facial paralysis and dental characteristics for impaired mastication in sub-acute or chronic-stage stroke patients.

Method: 20 stroke patients and 27 healthy individuals were included in the study. Oral health, oral hygiene, masticatory efficiency, central facial paralysis, and forward head posture of the participants were assessed by OHIP-14 questionnaire, a self-prepared questionnaire, a two-colored chewing gum test, labial commissure, and craniocervical angle measurements. Stroke characteristics and dental characteristics were also assessed.

Results: The sociodemographic and physical characteristics of both groups were similar (p>.05). The dental characteristics of the stroke patients were significantly poor compared to healthy individuals (p<.05). Masticatory efficiency of the stroke patients was nearly half that of the healthy individuals (p<.05). The forward head posture and facial paralysis values of both groups were similar (p>.05).

Conclusion: Our study showed that central facial paralysis gradually loses its effect on impaired mastication in stroke patients and gives its place to dental characteristics. Masticatory muscle activation and increasing postural adaptations like forward head posture may not be preferred by stroke patients. The preferred mastication side might be used to assess the severity or existence of central facial paralysis in stroke patients.

Keywords: Facial paralysis, mastication, oral hygiene, stroke rehabilitation

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İnmeli Bireylerin Dental Karakteristiğinin Çiğneme Sistemine Etkisi

Öz

Amaç: Bu çalışmanın amacı subakut ve kronik inme hastalarındaki yetersiz çiğnemede rol oynayan santral fasiyal paralizi ve dental karakteristik arasındaki dinamik ilişkiyi değerlendirmektir.

Yöntem: Çalışmaya 20 inme hastası ve 27 sağlıklı birey dahil edildi. Katılımcıların oral sağlık, oral hijyen, çiğneme etkinliği, santral fasiyal paralizi ve baş anterior tilti OHIP-14 anketi, birey odaklı anket, iki renkli sakız çiğneme testi, labial kommissür ve kranioservikal açı ölçümüyle değerlendirildi. İnme karakteristiği ve dental karakteristik de değerlendirildi.

Bulgular: Her iki grubunda sosyodemografik ve fiziksel karakteristiği benzerdi ($p>0,05$). Sağlıklı bireylere oranla inme hastalarının dental karakteristiği anlamlı derecede kötüydü ($p<0,05$). İnme hastalarının çiğneme etkinliği sağlıklı bireylerin neredeyse yarısı kadardı ($p<0,05$). Her iki grubun da baş postürü ve fasiyal paralizi değerleri benzerdi ($p<0,05$)

Sonuç: Çalışma, santral fasiyal paralizinin inme hastalarında yetersiz çiğnemedeki etkisini kademeli olarak kaybettiğini ve yerini dental karakteristiğe bıraktığını gösterdi. Baş anterior tilti gibi çiğneme kas aktivasyonunu arttırıcı postüral adaptasyonlar inme hastaları tarafından tercih edilmeyebilir. İnme hastalarında tercih edilen çiğneme tarafı santral fasiyal paralizinin varlığının ve şiddetinin değerlendirilmesinde kullanılabilir.

Anahtar Sözcükler: Fasiyal paralizi, çiğneme, oral hijyen, inme rehabilitasyonu

Introduction

Mastication is a rhythmic opening and closing movement of the mandibular and maxillar arcs under the control of the brainstem central pattern generators[1]. This rhythmicity is aroused by the coordination of lingual and perioral muscles and the teeth that form the occlusal surfaces in the dental arcs[2,3]. Dental arcs, masticatory muscles, and lingual and perioral muscles contribute to this harmony by hosting the teeth, generating the bite force and jaw movement, transporting the food to the occlusal surface, and sealing the lip during the mastication[3-5]. Mastication is like a symphony orchestra, as the central pattern is conductor, muscles are musicians, teeth and dental arcs are scene and musical instruments. Let us imagine one of the components of the orchestra is missing, grating sound takes place in this harmony. Stroke is one of the diseases that result in disruption of this harmony[5-9].

Stroke affects the masticatory efficiency by the orofacial dysfunction, which is seen in half of the patients with stroke[10]. Losing strength and coordination in lingual and perioral muscles characterizes masticatory efficiency impairment due to orofacial dysfunction[4,11]. Thus, the mentioned muscle groups could not completely fulfill their role during the mastication, leading to impaired masticatory efficiency[8,12]. Impaired masticatory efficiency results in mastication and eating problems in nearly three-quarters of the patients with stroke[6].

Although orofacial dysfunction is blamed primarily for impaired masticatory efficiency in stroke patients, the World Health Organization and World Dental Federation highlight the necessity of adequate teeth[13,14]. Similarly, it was stated that dental prosthesis use due to tooth loss causes dramatic losses in masticatory efficiency[15]. Focusing on stroke we run into the studies stating that patients with stroke have fewer residual teeth than healthy individuals, and missing teeth is a risk factor for stroke[16,17].

Even though the importance of orofacial dysfunction and dental state has been pointed out for mastication in patients with stroke, several studies focus directly on the topic[8,12]. From this point of view, this study aims to draw attention to the instruments not to the musicians.

Material and Methods

This study was conducted in Bitlis Tatvan State Hospital and approved by the Clinical Research Ethical Committee of the Van Training and Research Hospital (15.06.2022 – 2022/13-03).

Based on the reference study, power analysis was performed with 80% confidence interval and .10±.15 tolerance and 20% dropout rate, 20 patients with stroke and 27 healthy individuals were included in the study[8]. Only patients with ischemic stroke at the sub-acute or chronic stage, without any history of transient ischemic attack or multiple stroke were included in the study. Participants with cognitive impairment, history of jaw surgery or neurodegenerative disease or acute infection were excluded. During the study period, seven patients with hemorrhagic stroke, two with cognitive impairment, two with a history of multiple strokes and one with a history of transient ischemic attack were excluded from the study group. In the control group six participants were excluded from the study due to the following reasons: one had a neurodegenerative disease, one had cognitive impairment and four were declined to participate.

The dental characteristics of the participants were assessed by calculating the number of occlusal units and the use of complete denture wear. Calculating a pair of occluding opposing premolars or molars gives the number of occlusal units. While premolars in occlusion were considered one occlusal unit, molars in occlusion were considered two occlusal units[18]. A complete denture is a fixed or removable prosthesis used if the teeth in the mandibular or maxillar arc are missing[3].

Forward head posture was measured with craniocervical angle measurement. The measurement was performed while participants were sitting on a chair and their hands in natural head position[19,20]. Natural head position is defined as the final position of the head after the repetitive high amplitude of cervical flexion and extension[20]. After the participant is positioned, the spinous process of the seventh cervical vertebra was marked with colored adhesive tape. Then a photograph of the participants was taken laterally by a digital camera positioned 1 m away and analyzed with web plot digitizer software[21,22].

Labial angle was measured for the determination of facial asymmetry. For measurement, black and white photos of the participants were taken by a digital camera positioned 1 m away from the

participants while they were sitting on chairs. Then, photos were printed in A5 size, and previously described reference points were marked. After that, the angle between the marks was measured via protractor[23].

Masticatory efficiency was assessed with two-colored chewing gum. Participants were asked to chew the gum 20 times and then put the gum in the transparent plastic bag. Then, the gum was flattened, and both sides were scanned based on the previously reported study[24]. Then, the image of the chewed gum was analyzed with a gum program. A lower score indicates higher masticatory efficiency.

Oral health related quality of life of the participants was assessed with OHIP-14 questionnaire. The questionnaire includes 14 questions. The total score of the questionnaire is 56 points. A high scores indicate poor oral health related quality of life[25]. In addition, tooth brushing and its daily frequency were noted to determine of oral hygiene habits.

The data were given as mean, standard deviation or median and minimum maximum for continuous variables. Frequency and percentage were given for the categorical variables. Intergroup comparison of the variables was performed by independent t test, Mann Whitney U test, chi square test and Fisher's exact test. SPSS 25 program was used for the statistical analysis and significance grade was determined as $p<.05$.

Results

Baseline physical and sociodemographic characteristics of both groups were similar ($p>.05$). (Table 1).

Table 1. Intergroup comparison of the physical and sociodemographic characteristics

	Control group	**Study group**		
	Average	**Average**	**t**	**p**
Age (y)	60.66±8.61	61.2±12.05	.177	.86
Stature (cm)	166.40±10.11	164.7±8.66	.607	.547
Body weight (kg)	79.20±12.1	74.84±13.17	1.178	.245
BMI (kg/cm²)	28.81±5.28	27.63±4.68	.791	.433

*p<.05 statistical significance independent t test

Arteria cerebri media was the most common affected artery, followed by arteria cerebri anterior and vertebrobasilar artery. Poststroke elapsed time was below or equal to one year in nearly three-quarters of the patients with stroke. The affected side as the right or left side was equally distributed. Almost all the patients with stroke were not using dental floss, nearly three-quarters of them were cleaning their tongue and washing their mouth after the meal (Table 2).

Table 2. Stroke, oral health, and oral hygiene characteristics of the study group

		n	%
Affected side	Right	10	50
	Left	10	50
Affected artery	Cerebri media	14	70
	Cerebri anterior	4	20
	Vertebrobasillar	2	10
Poststroke elapsed time	0-1 year	14	70
	1-5 year	6	30
Daily toothbrush	Once	3	15
	Twice	1	5
	More than twice	2	10
	Occasionally	1	5
Toothbrush type	Soft	2	10
	Medium	1	5
	Hard	3	15
	Don't know	1	5
Brushing direction	Horizontal	1	5
	Vertical	-	-
	Both	6	30
Use of dental floss	Yes	1	5
	No	19	95
Tongue cleaning	Yes	14	70
	No	6	30
Mouth wash after meal	Yes	14	70
	No	6	30
Gingival bleeding	Yes	2	10
	No	18	90
OHIP-14 question 4	Never	14	70
	Occasionally	3	15
	Fairly often	2	10
	Very often	1	5
OHIP-14 question 7	Never	19	95
	Very often	1	5

More than half of the patients with stroke were not brushing their teeth (p<.05). More than half of the patients with stroke had a complete denture wear (p<.05) The total score of the OHIP-14 in both groups were similar (p>.05). (Table 3).

Table 3. Intergroup comparison of the oral hygiene, oral hygiene routines and complete denture wear

		Control group		Study group			
		n	%	n	%	x²	p
Tooth brushing	**Yes**	22	81	7	35	10.505	.001*
	No	5	19	13	65		
Complete Denture wear	**Yes**	4	15	12	60	10.447	.001*
	No	23	85	8	40		
OHIP-14 score		1 (0-26)		2.5 (0-17)		-.583	.56†

*p<.05 statistical significance chi square test, † Mann Whitney U test

Masticatory efficiency of the patients with stroke nearly half of the healthy individuals (p<.05), missing tooth and number of occlusal units were also lower in patients with stroke (p<.05). Facial asymmetry and forward head posture were similar in both groups (p>.05) (Table 4).

Table 4. Intergroup comparison of mastication and predisposing factors for impaired mastication

	Control group	Study group		
	Median	Median	u	p
	Min-max	Min-max	-3.707[a]	.001*†
Mastication efficiency	0.3589±0.2167	0.6289±0.2670		
Labial commissure angle	90.5 (88.5-94)	91 (88.5-93)	-1.736	.083
Craniocervical angle	31.55±8.32	30.1±10.06	.541	.591
Number of occlusal units	6 (0-12)	0 (0-12)	-2.455	.014*
Missing tooth	5 (0-28)	25.5 (0-28)	-2.613	.009*

*p<.05 statistical significance Mann Whitney U test, † independent t test

Current mastication side of the patients with stroke seems to be not affected by the affected body side (p>.05) (Table 5).

Table 5. Distribution of poststroke mastication side by affected body side

			Current mastication side				
			Right	Left	Both sides	x^2	p
Affected body side	Right	n (%)	3 (15)	4 (20)	3 (15)	1.167	.558
	Left	n (%)	5 (25)	2 (10)	3 (15)		

*p<.05 statistical significance Fischer's exact test

Discussion

This study has shown that in the subacute and chronic stages of the stroke, the interplay between the orofacial dysfunction and dental characteristics for impaired mastication might be shifted from orofacial dysfunction to dental characteristics.

The World Health Organization defines oral health as "a key indicator of overall health, well-being, and quality of life. It encompasses various diseases and conditions, including dental caries, periodontal (gum) disease, tooth loss, oral cancer, oro-dental trauma, noma and congenital defects such as cleft lip and palate"[26]. Tooth loss, as a component of this definition, is highly seen in patients with stroke[27]. In addition, patients with stroke have poor oral hygiene and oral hygiene routines[28]. Similarly, our study distinguished poor oral hygiene by the absence of oral hygiene routines and the high number of missing teeth. Due to tooth loss, denture wear was also highly observed in patients with stroke. Similar to previous studies[6], more than half of the patients with stroke used denture wear in our study. Interestingly, although the low rate of oral hygiene routine and low number of residual teeth in patients with stroke had a similar OHIP-14 score with the control group. Firstly, this might be caused by the importance of oral hygiene is overshadowed by the other deficits related to the stroke[29]. Secondly, patients with stroke may embrace compensatory strategies to cope with the effect of denture wear on mastication. Compensatory strategies for impaired mastication are an increase in masticatory strokes and swallowing of coarser particles or limiting the food choice[30]. Considering only one patient had reported not having a satisfactory diet according to the seventh question of the OHIP-14 questionnaire, patients with stroke in our study might swallow coarser particles or increase their masticatory stroke instead of limiting their food choice as a compensatory adaptation. Kim et al.[5] report that stroke patients have more chewing cycles and longer oral phase than healthy individuals.

Although patients with stroke might have developed compensatory strategies for mastication, it does not change the fact that patients with stroke in our study have impaired mastication. Based on the studies, we got three potential suspects to blame for the reduced masticatory efficiency that was observed in patients with stroke: orofacial dysfunction, missing teeth, and bite force[8,9,31,32]. Since the post-stroke bite force is similar to healthy individuals and only a fraction of bite force is

required for mastication, bite force can be excluded from the suspect list[33]. As for the orofacial dysfunction, the findings of our study, directly and indirectly, show that the impact of orofacial dysfunction on mastication may has taken a back seat. These findings are similar to intergroup labial commissure angle, answers that have been given to the fourth and seventh questions of the OHIP-14 questionnaire and preferred mastication side. Facial paralysis due to stroke results in falling of the corner of the mouth[34]. Considering the similar labial commissure angle between groups, it can be said that this effect of facial paralysis might be diminished in patients with stroke. The fourth question of the OHIP-14 questionnaire asks about any disturbance in eating, and the seventh question asks whether individuals have a satisfactory diet. Eating problems in nearly three-quarter of the patients with stroke[6]. This problem was reported in 30% of the patients with a different severity in our study. When we focused on these patients, we observed that these patients had missing teeth, poor occlusal unit or wearing complete denture wear. When we asked the patients with complete denture wear, they said they must cut food into small pieces to chew comfortably. Almost all stroke patients have had a satisfactory diet except for one. That patient had only three teeth left and no occlusal unit. In the two-colored chewing gum test, the patient used the central incisors to chew the gum. The assumption of one study pointing out that patients with stroke might prefer the ipsilesional side for the mastication due to orofacial dysfunction which was proved in previous research of ours strengthen our case[35,36]. Although the facts mentioned earlier support our hypothesis, considering the other components of the orofacial dysfunction, maximum lip force, and tongue pressure were not assessed, these data should be interpreted cautiously.

The final suspect, the missing teeth, seems to be the one to blame. There are several evidences and facts related to this matter. First the World Health Organization and World Dental Federation report that at least 20 teeth are required to maintain mastication[13,14]. Considering the residual teeth in patients with stroke in our study, it seems inevitable to have impaired mastication. Other factors related to efficient mastication are denture wear and occlusal units[31,37]. A decrease in occlusal unit number results in reduced masticatory efficiency[30]. Even an absence of one molar tooth, results in nearly one-quarter reduction in masticatory efficiency[30]. Another study reports that complete denture wearers have 2.5 times worse masticatory function than dentate individuals[15]. Putting together these facts with the findings of our study, which emphasize the lower number of occlusal units and a higher rate of complete denture wear in study group, it seems standard for patients with stroke to have impaired masticatory efficiency.

There are postural changes that increase masticatory muscle activity. Forward head posture is one of the changes that increase the activity of masseter muscle[38]. From this point, we considered that patients with stroke may use this postural change as a compensatory mechanism for impaired mastication. Yet, our findings related to forward head posture consumes our hypothesis. This

might be because only a fraction of bite force is needed for the mastication, and patients with stroke might prefer other impaired mastication compensation strategies.

Conclusions

Our study showed that central facial paralysis, which is a symptom of orofacial dysfunction, gradually loses its effect on impaired mastication and gives its place to dental characteristics. Masticatory muscle activation increasing postural adaptations like forward head posture may not be preferred by stroke patients. The preferred mastication side might be used to clinically assess the severity or existence of facial asymmetry in patients with stroke.

The study has some limitations. Firstly, we only used the labial commissure angle to assess and determine central facial paralysis. Secondly, we only focused on extracted teeth. Thirdly, we did not assess the compensation strategies for the impaired mastication.

Ethics: This study was conducted in Bitlis Tatvan State Hospital and approved by the Clinical Research Ethical Committee of the Van Training and Research Hospital (15.06.2022 – 2022/13-03).

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