

Original Article

Chewing side preference in first and all mastication cycles for hard and soft morsels

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Abstract: Preferred chewing side is a still controversial matter and various methods used have yielded some inconsistencies. The aim of this study is to compare the preference determined in different conditions. Nineteen healthy subjects were offered hard (walnut) and soft (cake) foods, while the electromyography was recorded from their masseter muscles, in 2009 in the Research Center of Physical Medicine and Rehabilitation, Tabriz University of Medical Sciences, Tabriz, Iran. Four occurrences were determined as the side of the first chews/all chews in the two food types, and then analyzed for correlations and agreements. For hard food 73.68% and for soft food 57.89% of the subjects showed preference. The comparison of all chews showed a highly significant preference towards the right side in both food types ($p=0.000$ & 0.003). There was both correlation and agreement between the first chew preferences in both food types, and an agreement between the first and all chew preferences in the hard food. Therefore, there seems to exist some laterality in mastication, which is more explicit when using hard food and assessing all chews.

Keywords: Chewing laterality, masticatory preferred side, food texture, surface electromyography, method comparison

Introduction

The concept of chewing preference (chewing laterality) has developed gradually during decades and has implications for dentistry procedures. A seminal text in dentistry argued that unilateral chewing occurs in most of the population with an apparent preference for chewing on a particular side [1, 2].

Unfortunately, this preference has no universal definition and yet needs to get honed. Its determination is somewhat complex and, therefore, it has been investigated with various methods [3-5]. Some studies have introduced preference as the side in which most of the first chews or random chews occurred, and assessed the chews by observation; asking the subjects, kinesiography (instruments recording jaw movements), or

electromyography; most authors have considered the side of the first cycle as chewing preferred side.

A classic study reported there was no overall significant preference for either the right or left side in chewing [6], but in most other studies masticatory preference was demonstrated. Some studies report chews or subjects with no preference more than others [5, 7, 8, 9]. Different results could be the consequence of different methods employed. Varela et al [3] compared the methods of observation and kinesiography and reported no statistically significant agreement; nevertheless, both techniques reflected a marked preference for the right side. Thus, attempts for the complex determination of chewing preference have manifested inconsistencies, and, similarly, it is of essential research

importance to investigate more aspects of this preference and find a more convincing estimate of it.

Most investigations were done by gum-chewing [1, 3, 6, 8, 10-12]; however, food texture may affect the chewing pattern. Texture is the quality of the food perceived by an individual. Although somehow related, it is not the same as food structure. This characteristic of food is determined by structural parameters detected by several sensory modalities affected by psychological factors and memory [13-15]. Chewing is governed by a pattern generator which is regulated by sensory feedback [16]. This feedback is triggered by texture perception. It is known that the food texture affects muscle activity and chewing cycles, so chewing preference may differ in various food textures [4, 9, 16, 17]. Texture includes several parameters such as hardness, cohesiveness, viscosity, size, shape and etc [14]. Studies have assessed some of the parameters and reported hardness and size to be effective on chewing movements [4, 17, 18].

In the current study, we recorded the chewing cycles in two food textures (hard and soft), determining the preferred side for starting the mastication and for all the chewing sequences (calculating Asymmetry indexes) in each food texture. The different preferred sides determined were then compared to show whether they are consistent. The aim is to investigate different conditions in order to find an efficient design for assessing this preference. Upon an extensive look at the literature, we found no study comparing the preference of the first and all masticatory cycles.

Materials and methods

Nineteen young healthy subjects (12 female and 7 male) mean \pm SD age 19.42 ± 2.27 years participated in this study. All subjects gave their voluntary, written and informed consent for their participation. The study was reviewed and approved by the Investigation Deputy of Tabriz University of Medical Sciences and the Ethics Committee of the university and have therefore been performed in accordance with the ethical standards. None of the subjects exhibited any signs of jaw dysfunction or any symptomatic dental or chewing problem. All subjects were familiarized with the experiments, and to reduce bias, explanations were given with no emphasis

on chewing side. Each subject ate a piece of walnut (hard food) and a piece of cake (soft food) while surface electromyography (surface EMG, Biometrics LTD, Cwmfelinfach, Gwent, UK) of the Masseter muscles of both sides were recorded. The instrument possessed a device which contained two irremovable electrodes with a fixed distance between them, placed on the skin by special removable labels, which made the electrodes steady. Before starting the experiment of chewing the food, the subjects were asked to clench their teeth to the highest force. This presented the electromyographic *maximum contractility* on both sides. Chewing preferred side in four different occurrences was determined for each subject including 1) the side of the first chewing cycles in the hard food, 2) the side of the first chewing cycles in the soft food, (we assessed the first three chewing cycles) 3) the side of the majority of cycles in the hard food, and 4) the side of the majority of cycles in the soft food. A preference index (*Asymmetry index- AI*) was calculated for the hard and soft food separately to obtain a degree of preference for these food types: $AI = (R - L) / (R + L)$, where R is the number of chewing cycles on the right side, L, the number of chewing cycles on the left side. A subject was considered to prefer the right side in positive AIs and the left in negative AIs. Subjects having $-0.3 < AI < +0.3$ were considered to show insignificant preferences.

Statistical analysis

Primary analysis of the EMG activity of Masseter muscles was done by the EMG software (surface EMG, Biometrics LTD, Cwmfelinfach, Gwent, UK) to determine the side of chewing cycles (**Figure 1**). The relative pattern of the amplitudes in the *maximum contractility* presentation was taken into account by the software to do the right comparison of the amplitudes of the two sides in each chewing cycle and choose the dominant side. Further descriptive and analytical statistics were analyzed by SPSS15. To compare the chews of the two sides, Pearson Correlation tests were performed. In order to determine the relationship between the different preferences determined, Chi-square tests were used. Also, Cohen's Kappa test was used to establish the extent of the agreement among them. Values of $P < 0.05$ were considered to be statistically significant, confidence interval was considered 95% and all data are presented as

Chewing preference, first/all cycles, hard/soft food

Table 1. The sides of chewing preference in the four different occurrences, presented as percentages

Chewing cycle(s)	Food type	Preferred side			Overall preference
		Right	Left	None	
First	Hard	63.6%	36.3%	-	-
First	Soft	57.9%	42.1%	-	-
All	Hard	47.36%	26.32%	26.32%	73.68%
All	Soft	47.36%	10.53%	42.11%	57.89%

Table 2. The preference index (AI) for the two food types.

	Mean	Maximum	Minimum	SD
AI for hard food	0.16	+1	-0.73	0.58
AI for soft food	0.25	+1	-0.64	0.43

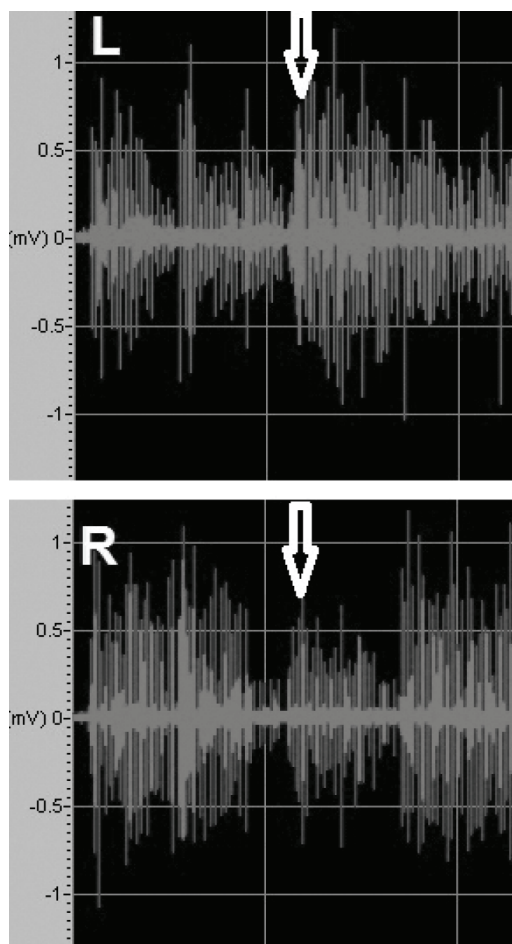


Figure 1. The electromyographic recordings of the left and right masseter muscles of a male volunteer during chewing. L indicates the recordings of the left side; R indicates the recordings of the right side. The arrows show the point where the volunteer has switched from chewing by the right side to the left side.

means \pm SD.

Results

For hard food, 73.68% and for soft food, 57.89% of the subjects showed masticatory preference. The preferences in all subjects, collectively, are shown in **Table 1**.

There was a significant correlation between the preferred sides in the first chewing cycles of the two food types with above average agreement (Kappa value: 0.45). There was also an average agreement between the preferred sides in the first and all chewing cycles of the hard food (Kappa value: 0.36). Between other preferences, there existed no significant correlation or agreement.

The comparison of all chewing cycles showed a highly significant preference towards the right side in both food types ($P= 0.000$ & 0.003). While 31.5% of the subjects preferred the right side in all the four occurrences, no subject had left preference in the four occurrences coincidentally.

The range of AI calculated for subjects are shown in **Table 2**. No subject had an AI=0.

Discussion

Most of our subjects showed masticatory preference, mainly to the right side, and the preference was more apparent in chewing the hard food (**Table 1**). For hard food 73.68% of subjects showed preference to one side and for soft food

57.89% (**Table 1**). Most of the studies do favor the existence of laterality in chewing process. But there are some controversies with regard to details, such as the exact method to reveal it. A wide range of variation for the percentage of chewing preference has been reported, in the order of 45 to 70% of the subjects [3-5, 7, 10]. Our results, in line with previous reports, indicate that most people show preference to one side in their chewing pattern; but as the results indicate and some authors have mentioned [5, 17], this preference could be more conspicuous when it comes to hard food. It has been reported that the bite force differs in the two sides of the mouth and the side on which more bite force can be exerted is more likely to be preferred for chewing [4]. Obviously, a harder food requires more effort to chew than a softer one, so it can evoke more laterality [17]. Texture and chewing preference were assessed in two classic studies: Delpont et al (1983) had reached similar results in their study in four different textures [18]; Hoogmart and Caubergh (1987) used sugar lump and bread in their study but made no comment on the texture differences, merely reporting to find chewing preference in 45% of subjects [7].

Nearly half of our subjects showed a preference to the right side with different methods, much more than left preference or no preference. Furthermore, the overall analysis reveals highly significant preference towards the right side in both food textures ($p=0.000$ & 0.003). More chewing preference in the right side has previously been reported in the literature [1, 4, 9] which is believed to be an indication of central regulation of masticatory preference [4].

As to describing chewing preference, some authors tried to show the strength of the preference through calculated *preference indexes*. Initially *I index* was introduced including calculations of the first chews, and recently *Asymmetry index (AI)* has been adopted, which is the same calculation of *I index* for all masticatory cycles. We have calculated AI (**Table 2**) assessing its agreement with preferred side in first chews. There was an average agreement between the preferred sides in the first and all chewing cycles of the hard food, while no such agreement existed for the soft food. This may indicate that the laterality evoked by the hard food is more probable to be towards the same side on which the first chews occurred; the side with the

higher force needed to masticate a hard food. Moreover, in daily life, when eating soft foods, the preference of the whole process of chewing is more likely to differ from the first chews. This could be assessed more precisely if we repeated the first chews and calculated *I indexes*, then comparing them with the AI. It is suggested that such a comparison be undertaken in future studies.

We found a significant correlation and an above average agreement between the preferred sides in the first chewing cycles of the hard and soft food. The same preference in the foods with different textures may indicate that mastication starts with a similar pattern and the sensory feedback of the food texture may affect the following chewing sequence. This can explain the disagreement between AI of the hard food and the soft food in our study. Nevertheless, some authors believe that texture perception exists during observing and handling the food as well as during food tasting, mastication and swallow [13-15]. According to our results, it is the texture perception during but not before the initiation of mastication which plays the main role in determining the preferred side for chewing. In other words, texture perception prior to the actual chewing process is probably not strong enough to affect the start of mastication, so, in most cases the pattern of mastication might have a fixed beginning, insensitive to texture signals, possibly starting with a specialized side for sensing food texture, or probably the side which is more comfortable and more effective for chewing. It has been stated that oral processes have a significant effect on the breakdown of the physicochemical structure of the food in the mouth and, thus, on the sensory perception. Texture perception is therefore a dynamic process, with changing food structures and changing perception in time, while the food is being masticated [14]. So the feedback governing the chewing pattern changes as mastication proceeds.

These changes together with the highly significant preferences derived from all chewing cycles, and AIs as strong as +1 point to the fact that assessing all the chewing cycles for AI calculation is more reliable for preference determination.

It is commonly accepted that strictly unilateral chewing has a high potentially traumatic effect

on dentition, jaw muscles and the Temporomandibular Joint (TMJ). Restoration of missing dental units on the preferred side would improve chewing efficiency and ease the occlusal burden on the existing teeth. It follows that examination and recording of chewing side preference merits consideration in the routine dental examination and treatment planning [1]. Also, natural teeth on this side may decay earlier and more precise care and examination may be needed. Our results provide more insight into this important issue. However, further investigation is needed to clarify the clinical relevance of such findings [1]. If preferred side is to be considered in dentistry procedures without precise examination of this preference, a tenable assumption is that most people prefer to chew with the right side.

We used Surface electromyography (Surface EMG) for recording chewing cycles. For observing and recording muscle functions and movements, EMG has frequently been employed in different studies. Especially recording from the skin surface is a common procedure, which is non-invasive and simple [19]. EMG validity for masticatory studies has been assessed in previous investigations. It has been reported that the preferred chewing side determined by EMG and observation are significantly correlated ($p < 0.001$) [20]. Another study concludes that by reducing the influences of electrode relocation EMG analysis may be used for the evaluation of masticatory muscle activity [21]. Some classic studies had casted doubt on electromyography applicability for this purpose [7, 18, 22].

Conclusion

The different conditions assessed here shows that chewing preference can be better manifested assessing all the masticatory cycles (by Asymmetry index) than just the first cycle. Also, using hard food evokes more laterality.

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