

Association between preferred chewing side and dynamic occlusal parameters

Journal of International Medical Research

2019, Vol. 47(5) 1908–1915

© The Author(s) 2019


Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/0300060519827165

journals.sagepub.com/home/imr



Satheesh B. Haralur ,
Muhammad Irfan Majeed,
Saurabh Chaturvedi, Nasser M. Alqahtani and
Mohammed Alfarsi

Abstract

Objectives: Evaluation of dynamic occlusal parameters can help dentists to understand the association of occlusion with the preferred chewing side (PCS) and enable optimal restoration of masticatory efficiency. This study evaluated the association between PCS and dynamic occlusal parameters.

Methods: One hundred participants (50 each, right and left PCS) were included in this study. PCS was determined by the visual spot-checking method, and occlusal analysis was conducted by T Scan. Occlusal parameters evaluated included initial contact, center of force, tooth contact area, occlusal interferences, and occlusal time. Data were assessed by chi-squared test and eta correlation coefficient.

Results: Initial contact towards the PCS was observed in 68% and 70% of right and left unilateral chewers, respectively. Likewise, center of force towards the PCS was present in 72% and 66% of right and left unilateral chewers, respectively. A larger area of tooth contact was predominant towards the PCS in 70% and 72% of right and left unilateral chewers, respectively. Chi-squared analysis showed a strong positive correlation between PCS and occlusal parameters at maximum intercuspation. Eta correlation coefficients between PCS and occlusal interferences, as well as centric and eccentric occlusion, revealed negligible associations.

Conclusion: Dynamic occlusal parameters may be associated with PCS.

Keywords

Preferred chewing side, dental occlusion, occlusal analysis, mastication, unilateral chewing, centric occlusion, eccentric occlusion, center of force

Date received: 30 September 2018; accepted: 7 January 2019

Department of Prosthodontics, College of Dentistry, King Khalid University, Abha, Kingdom of Saudi Arabia

Corresponding author:

Satheesh B Haralur, Department of Prosthodontics,
College of Dentistry, King Khalid University, Abha,
Kingdom of Saudi Arabia.

Email: hb_satheesh@yahoo.com; sharlor@kku.edu.sa



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<http://www.creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

Introduction

Laterality constitutes the preference for use of a particular side of the body. Mastication can be bilateral, where both sides are utilized relatively equally. However, mastication in 45%–98% of the population occurs predominantly on one side, known as the preferred chewing side (PCS).^{1,2} Dental literature is contradictory regarding determinants of PCS. Nissan et al.³ reported that laterality in the body is determined by cerebral hemisphere; Pond et al.⁴ also reported an insignificant correlation between PCS and occlusal factors. Jiang et al.⁵ reported that hemispheric dominance in the primary sensorimotor cortex contributed to rhythmic chewing movement. Moreover, blood oxygen level-dependent signals supporting the PCS were observed in the brain stem and cerebellum. Barcellos et al.⁶ described diverse hemispheric laterality in different types of dentition, all of which exhibited weak associations between PCS and systemic laterality. Conversely, some researchers have reported no correlation between lateral dominance and chewing side.⁷ Omar et al.⁸ proposed that the quality and quantity of occlusal contact induced selection of PCS; moreover, they showed strong correlations between PCS and other dental factors (e.g., oral pain and temporomandibular joint disorders).⁹ Goldaracena et al.¹⁰ reported that dental caries affect PCS. Conversely, Nayak et al.¹¹ reported no association between PCS and dental caries in both deciduous and permanent dentition.

PCS selection could be due to improved comfort and chewing efficiency. Rovira-Lastra et al.¹² described the PCS as the side with better masticatory function. Occlusal contact area and bite force are crucial elements in determining masticatory function.¹³ Masticatory efficiency is greatly influenced by lateral gliding contacts; hence, dynamic occlusal factors (e.g., occlusal contact area, bite force balance,

occlusal interferences, and disocclusion time) provide insight into the role of occlusal factors in selecting PCS. Some researchers¹⁴ have evaluated the relationship between PCS and occlusion; however, dynamic occlusal contacts during masticatory function not been thoroughly studied. This *in vivo*, non-interventional, clinical trial aimed to evaluate associations between PCS and dynamic occlusal parameters. The primary objective of prosthodontic rehabilitation is to deliver sufficient dental units to restore masticatory efficiency and occlusal stability. Hence, the results of this study will aid in design of appropriate treatment plans for optimal prosthetic and restorative rehabilitation.

Methods

Participants

Institutional ethics committee approval was obtained for this cross-sectional study (registration no: SRC/ETH/2017-18/045) prior to participant recruitment. The investigation was a single center study conducted at the Dental clinics of King Khalid University, Kingdom of Saudi Arabia, during academic year 2017–2018. The participants were recruited from among student volunteers and patients attending the dental clinics for treatment. All participants received a detailed explanation regarding the study protocol, then obtained their written consent before inclusion in the study.

Participants were screened by a single trained dentist during the selection process. The inclusion criteria were as follows: participants exhibited an evident PCS; participants did not exhibit clinical conditions, such as temporomandibular joint disorders, orofacial pain, restricted mouth opening, major occlusal abnormalities, dental caries, or tenderness on percussion of any teeth; participants reported no past history of active orthodontic treatment, extensive

maxillofacial surgery, systemic neurological disorders, or missing natural teeth (excluding third molars).

Determination of preferred chewing side

PCS was determined by a modified visual spot-checking method.^{15,16} Participants were asked to perform natural chewing of sugar-free chewing gum (Wrigley Co., Ltd., Plymouth, UK) over the posterior teeth. After 15 seconds, participants were asked to stop chewing and smile broadly to show the location of the gum, and left or right side was noted. The procedure was repeated seven times, successively, with 5-second intervals. Participants with PCS were those that exhibited the gum on the same side, a minimum of five times. Participants with no PCS were eliminated from the study.

T-scan analysis

T Scan analyses (T Scan III, Tekscan Inc, South Boston, MA, USA) of the participants were recorded by a single researcher, under the guidance of the corresponding author. Maxillary central incisor width was recorded with a digital caliper to customize the dental arch dimension; this was followed by intra-oral sensor calibration with a maximum of three high-force pink graphic displays for the trial bite. Participants were guided to achieve centric relation by using the Dawson bimanual method. During closure to centric relation, the initial contact was recorded; subsequently, the center of force, number of teeth, and area of tooth contact were determined at maximum intercuspation. Other dynamic occlusal contacts were consecutively recorded, including centric, right lateral, left lateral, and protrusive interferences. A relative force-time graph was generated to record centric and eccentric disocclusion times. All recordings were repeated three times to confirm the findings.

All analyses of force-time graphs were performed by the first author, to avoid interobserver bias.

Statistical analysis

Data were analyzed using SPSS 19 software (IBM Corp, Armonk, NY, USA). Associations between variables were assessed by chi-squared (χ^2) analysis, with a significance level of $p=0.05$. Strength of association was estimated by the phi correlation coefficient (ϕ). Associations between each of the occlusion time parameters and PCS were assessed using the eta correlation coefficient (η).

Results

A total of 476 participants were screened for selecting the study sample; 184 participants were eliminated due to not meeting inclusion criteria, 82 participants were removed due to the bilateral chewing pattern, and 24 participants declined to participate in the study. Among the remaining 186 participants, 136 were right-side chewers and 50 were left-side chewers. One hundred young adults (50 each, right and left PCS) were included; non-proportional quota sampling was used to establish subgroups based upon the inclusion criteria described below. The participants comprised 46 women and 54 men, ranging in age from 18 to 25 years. The occlusal parameters are summarized in Tables 1 and 2. Most participants showed initial contact on the same side, regardless of PCS; moreover, the center of force was predominantly towards the preferred side in most participants, regardless of PCS. Additionally, the greatest number of teeth in contact and the largest area of tooth contact at maximum intercuspation were principally towards the preferred side, regardless of PCS. Notably, maximum tooth contact on the same side at centric

Table 1. Occlusal parameters of participants in the study

Occlusal Parameter	PCS	Towards PCS (%)	Contralateral side (%)	Neutral (%)
Initial contact	Left	35 (70)	15 (30)	–
	Right	34 (68)	16 (32)	–
Center of force	Left	33 (66)	15 (30)	2 (4)
	Right	36 (72)	11 (22)	3 (6)
Teeth in contact at centric occlusion	Left	28 (56)	8 (16)	14 (28)
	Right	22 (44)	11 (22)	17 (34)
Maximum area of tooth contact	Left	35 (70)	15 (30)	–
	Right	36 (72)	13 (26)	1 (2)

PCS, preferred chewing side

Table 2. Interference observed in participants in the study

Interference	PCS	Yes	No
Centric	Left	15 (30)	35 (70)
	Right	20 (40)	30 (60)
Right lateral	Left	27 (54)	23 (46)
	Right	28 (56)	22 (44)
Left lateral	Left	23 (46)	27 (54)
	Right	25 (50)	25 (50)
Protrusive	Left	15 (30)	35 (70)
	Right	25 (50)	25 (50)

PCS, preferred chewing side

occlusion was observed in most participants with left PCS, whereas it was present in nearly half of the participants with right PCS.

Table 3 demonstrates the results of χ^2 and ϕ correlation analyses between PCS and dynamic occlusion parameters. The correlation between initial contact and PCS was significant ($p < 0.001$) and showed a moderate, positive relationship. The center of force and PCS were significantly correlated ($p < 0.001$) and showed a moderate, positive relationship. The largest surface area of tooth contact was significantly associated with PCS ($p < 0.001$) and showed a strong, positive relationship. The PCS and greatest number of teeth in contact showed a moderate, positive relationship ($p = 0.001$). Other dynamic occlusal parameters (e.g., centric,

Table 3. Chi-squared (χ^2) tests of associations between preferred chewing side and occlusal parameters

Occlusion variables	χ^2 value	p value	ϕ value
Initial contact	14.44	<0.001	0.380
Center of force	19.84	<0.001	0.446
Increased number of tooth contacts	14.234	0.001	0.377
Increased tooth contact surface area	19.730	<0.001	0.444
Right lateral interference	0.040	0.841	-0.020
Left lateral interference	0.160	0.689	-0.040
Centric interference	1.099	0.295	-0.105

Significance level, $p < 0.05$

right lateral, and left lateral interferences) did not differ on the basis of PCS.

Table 4 shows the minimum, maximum, and mean centric occlusion and eccentric occlusion times (seconds) in participants with right and left PCS. A negligible association was observed between centric occlusion time and PCS. Weak associations were observed between PCS and each of the following: right lateral, left lateral, and protrusive disocclusion times.

Discussion

Chewing pattern is the result of an interaction of intrinsic neural pattern and sensory

Table 4. η correlation coefficients between occlusion time parameters (in seconds) and preferred chewing side

Occlusion variables	Left			Right			η correlation coefficient
	Min	Max	Mean	Min	Max	Mean	
Centric occlusion time	0.17	1.57	0.547	0.23	1.51	0.578	0.059
Right lateral disocclusion time	0.29	2.02	0.882	0.22	1.42	0.696	0.255
Left lateral disocclusion time	0.22	2.28	0.831	0.20	1.31	0.670	0.215
Protrusive disocclusion time	0.21	2.20	0.799	0.20	1.50	0.709	0.133

feedback from the masticatory system. Contradictory hypotheses have been proposed by researchers: some suggest that chewing side is based on hemispheric laterality,^{6,17} while others support the involvement of peripheral influences, including occlusal factors, in determining PCS.¹

Tooth contact during function is unlike occlusal contact during lateral mandibular movements. Pameijer et al.¹⁸ reported that maximum intercuspation was important for chewing, as well as evaluation of masticatory efficiency. Earlier studies indicated that the largest areas of occlusal contact were found during later stages of food breakdown in centric occlusion. The greatest masticatory forces during later stages of food chewing were also reported in centric occlusion.¹⁹ The results of the present study indicated a strong correlation between contact area and PCS, suggesting that the tooth contact area on the PCS was larger than that on the contralateral side. These results are consistent with those of Yurkstas et al.,²⁰ who showed that the PCS is more efficient for mastication. Chewing efficiency has been correlated with occlusal contact area within the same individual.²¹ Notably, our results contradict the findings of Wilding et al.,⁷ who reported no correlation between area of occlusal contact and PCS. Differences in results could be attributed to methodology; earlier researchers utilized wax to determine occlusal contact area and measured the remaining thickness of wax between the teeth. Wax exhibits

poor dimensional stability; thus, researchers were unable to record the smallest contact areas. Variation in the results could be due to differences in thickness of T scan sensors (approximately 98 μm), compared with the wax thickness of 0.5–0.75 mm.

Unilateral chewing is observed while chewing difficult food substances. Notably, the PCS is favored in the initial few chewing cycles, due to the difficulty of breaking down food at an early stage.²² The study results showed that initial contact was strongly correlated with PCS. The chewing side first molar is positioned superior to the first molar on the contralateral side during early and middle closing phases of chewing.²³ A previous investigation revealed upward movement of the condyle on the non-chewing side during submaximal clenching on the unilateral side.²⁴ Palla et al.²⁵ recorded smaller condyle-fossa on the non-chewing side, compared with that on the chewing side, during the opening phase of the masticatory cycle. Hence, tilting of the mandible leads to elevation of the mandible on the non-chewing side during the final stage of chewing. Initial contact on the chewing side during the early and middle phases is expected to prevent occlusal contact on the non-chewing side. The prevention of tooth contact on the non-chewing side helps to preclude deleterious jaw muscle activities and enhance smooth masticatory movements.²⁶

The results of the study indicated that the center of force at maximum intercuspation

was primarily towards the chewing side. The correlation between the center of force and PCS was strong. Laterality during mastication is evoked during the first chewing cycles, as well as chewing of hard food. A previous study showed²⁷ that individuals favor the PCS when masticating hard food. The force on the preferred side is expected to be high, due to the increased occlusal contact area. The results of the present study showed that occlusal interferences during centric and lateral mandibular movements were not correlated with PCS. These findings were consistent with the findings of Pond et al.,⁴ who reported that there were no correlations between PCS and working interference or balancing interferences. Our study suggested that there was no significant correlation between PCS and the occlusion time during maximum intercuspation, or between PCS and disocclusion time during lateral excursion. Prior reports have also shown²⁸ no differences in parameters of mandibular movements between preferred and contralateral chewing sides. Hence, the duration of centric and eccentric mandibular movements does not appear to differ.

Jiang et al.²⁹ reported changes in the osseous morphology of the temporomandibular joint on the preferred side. They observed that posterior–superior and lateral joint spaces were smaller towards the PCS; the inclination of articular eminence showed reduced perpendicularity to the long axis of the condyle on the preferred side. Hence, the PCS may be chosen because it exhibits increased masticatory efficiency and comfort. Dienberger³⁰ reported associations of PCS with temporomandibular joint disorders, temporomandibular joint pain, and loss of antagonist teeth. The replacement of missing teeth did not reinforce bilateral chewing. Moreover, a PCS is observed with increasing frequency in patients who exhibit unilateral temporomandibular joint pain.³¹ Notably, the PCS is associated with

psychological and social domains of the Oral Health Impact Profile.³²

The study results suggest that effective restorative rehabilitation is feasible with restoration of dentition on the PCS. The loss of natural teeth and defective occlusal contacts on the PCS could cause severe loss of masticatory efficiency. Hence, preferential dental rehabilitation of the PCS is needed for occlusal rehabilitation. Unilateral chewing on the PCS also supports accelerated deterioration of dentition, muscles, and temporomandibular joint. Hence, regular dental examination and treatment of the chewing side is imperative to maintain masticatory efficiency and quality of life. Limitations of this study include its inclusion of a small number of participants, as well the use of a single test food for determination of the PCS. Occlusal contacts are known to be affected by temporomandibular joint forms, occlusal plane inclination, and muscles of mastication. Variations in these factors may alter occlusal parameters, which are related to the PCS. Thus, longitudinal studies are needed to understand whether increased tooth contact on the PCS is the cause or result of the increased chewing period on that side. Further studies are also needed to understand the influence of age progression on the PCS.

Conclusion

The results of the present study suggest positive associations between the PCS and multiple occlusal factors. The PCS had a strong positive correlation with initial contact, while it had moderate positive correlations with contact area and the number of teeth in contact at maximum intercuspation. Occlusal interferences on centric and eccentric mandibular movements were not correlated with the PCS. The associations of the PCS with centric occlusion and disocclusion times were negligible.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Satheesh B. Haralur  <http://orcid.org/0000-0001-7871-1513>

References

- Martinez-Gomis J, Lujan-Climent M, Palau S, et al. Relationship between chewing side preference and handedness and lateral asymmetry of peripheral factors. *Arch Oral Biol* 2009; 54: 101–107.
- Paphangkorakit J, Thothongkam N and Supanont N. Chewing-side determination of three food textures. *J Oral Rehabil* 2006; 33: 2–7.
- Nissan J, Gross MD, Shifman A, et al. Chewing side preference as a type of hemispheric laterality. *J Oral Rehabil* 2004; 31: 412–416.
- Pond LH, Barghi N and Barnwell GM. Occlusion and chewing side preference. *J Prosthet Dent* 1986; 55: 498–500.
- Jiang H, Liu H, Liu G, et al. Analysis of brain activity involved in chewing-side preference during chewing: an fMRI study. *J Oral Rehabil* 2015; 42: 27–33.
- Barcellos DC, da Silva MA, Batista GR, et al. Absence or weak correlation between chewing side preference and lateralities in primary, mixed and permanent dentition. *Arch Oral Biol* 2012; 57: 1086–1092.
- Wilding RJ, Adams LP and Lewin A. Absence of association between a preferred chewing side and its area of functional occlusal contact in the human dentition. *Arch Oral Biol* 1992; 37: 423–428.
- Omar SM, McEwen JD and Ogston SA. A test for occlusal function. The value of a masticatory efficiency test in the assessment of occlusal function. *Br J Orthod* 1987; 14: 85–90.
- Reinhardt R, Tremel T, Wehrbein H, et al. The unilateral chewing phenomenon, occlusion, and TMD. *Cranio* 2006; 24: 166–170.
- Goldaracena P, Ray R and Martinez C. Dental caries and chewing side preference in Maya Indians. *J Dent Res* 1984; 63: 182.
- Nayak UA, Sharma R, Kashyap N, et al. Association between chewing side preference and dental caries among deciduous, mixed and permanent dentition. *J Clin Diagn Res* 2016; 10: ZC05–ZC08.
- Rovira-Lastra B, Flores-Orozco EI, Salsench J, et al. Is the side with the best masticatory performance selected for chewing? *Arch Oral Biol* 2014; 59: 1316–1320.
- Gomes SG, Custodio W, Faot F, et al. Masticatory features, EMG activity and muscle effort of subjects with different facial patterns. *J Oral Rehabil* 2010; 37: 813–819.
- Wilding RJ. The association between chewing efficiency and occlusal contact area in man. *Arch Oral Biol* 1993; 38: 589–596.
- Mc Donnell ST, Hector MP and Hannigan A. Chewing side preferences in children. *J Oral Rehabil* 2004; 31: 855–860.
- Christensen LV and Radue JT. Lateral preference in mastication: an electromyographic study. *J Oral Rehabil* 1985; 12: 429–434.
- Serel Arslan S, Inal O, Demir N, et al. Chewing side preference is associated with hemispheric laterality in healthy adults. *Somatosens Mot Res* 2017; 34: 92–95.
- Pameijer JH, Glickman I and Roeber FW. Intraoral occlusal telemetry. 3. Tooth contacts in chewing, swallowing and bruxism. *J Periodontol* 1969; 40: 253–258.
- Ahlgren J and Öwall B. Muscular activity and chewing force: a polygraphic study of human mandibular movements. *Arch Oral Biol* 1970; 15: 271–280.
- Yurkstas AA. The masticatory act. A review. *J Prosthet Dent* 1965; 15: 248–262.
- Laird MF, Vogel ER and Pontzer H. Chewing efficiency and occlusal functional morphology in modern humans. *J Hum Evol* 2016; 93: 1–11.
- Kazazoglu E, Heath MR and Muller F. A simple test for determination of the

- preferred chewing side. *J Oral Rehabil* 1994; 21: 723.
23. Tomonari H, Kwon S, Kuninori T, et al. Differences between the chewing and non-chewing sides of the mandibular first molars and condyles in the closing phase during chewing in normal subjects. *Arch Oral Biol* 2017; 81: 198–205.
 24. Baba K, Yugami K, Yaka T, et al. Impact of balancing-side tooth contact on clenching induced mandibular displacements in humans. *J Oral Rehabil* 2001; 28: 721–727.
 25. Palla S, Gallo LM and Gossi D. Dynamic stereometry of the temporomandibular joint. *Orthod Craniofac Res* 2003; 6: 37–47.
 26. Proschel PA, Jamal T and Morneburg TR. Motor control of jaw muscles in chewing and in isometric biting with graded narrowing of jaw gape. *J Oral Rehabil* 2008; 35: 722–728.
 27. Zamanlu M, Khamnei S, Salarilak S, et al. Chewing side preference in first and all mastication cycles for hard and soft morsels. *Int J Clin Exp Med* 2012; 5: 326–331.
 28. Farias Gomes SG, Custodio W, Moura Jufer JS, et al. Correlation of mastication and masticatory movements and effect of chewing side preference. *Braz Dent J* 2010; 21: 351–355.
 29. Jiang H, Li C, Wang Z, et al. Assessment of osseous morphology of temporomandibular joint in asymptomatic participants with chewing-side preference. *J Oral Rehabil* 2015; 42: 105–112.
 30. Diernberger S, Bernhardt O, Schwahn C, et al. Self-reported chewing side preference and its associations with occlusal, temporomandibular and prosthodontic factors: results from the population-based Study of Health in Pomerania (SHIP-0). *J Oral Rehabil* 2008; 35: 613–620.
 31. Chen CY, Palla S, Erni S et al. Nonfunctional tooth contact in healthy controls and patients with myogenous facial pain. *J Orofac Pain* 2007 21: 185–193.
 32. Su N, Liu Y, Yang X, et al. Association of malocclusion, self-reported bruxism and chewing-side preference with oral health-related quality of life in patients with temporomandibular joint osteoarthritis. *Int Dent J* 2018; 68: 97–104.