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CLINICAL RESEARCH

Three tests to determine a preferred chewing side in partially edentulous patients: A pilot study

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ABSTRACT

Statement of problem. Determining the preferred chewing side may be an important factor in prosthetic treatment planning, especially where additional support for a removable dental prosthesis can be provided by implants.

Purpose. The purpose of this clinical study was to investigate the validity and reproducibility of 3 different tests to determine the preferred chewing side.

Material and methods. A total of 82 partial denture wearers, with an average age of 70 years, were enrolled in this study. The first test (CG) evaluated the left or right position of a piece of chewing gum after spontaneous mouth opening during mastication. A second test (ASI) videotaped 30 seconds of mastication and analyzed the distribution of masticatory cycles by means of an asymmetry index. For the third test (VAS), participants were asked to mark their subjective perception of their preferred chewing side on a visual analog scale representing the right and left sides. All the tests were performed and repeated in a randomized sequence. The reproducibility of the tests was first evaluated. The mean values of the ASI and VAS tests were calculated, and the results were compared with the second series of the CG test. The Pearson correlation test was used to associate ASI and VAS, and the Cohen kappa agreement was used for the inter-reliability of CG (α=.01).

Results. The results indicated fair to almost perfect reproducibility for the 3 tests. Kappa values were.37 ($P<.01$) for the CG,.47 ($P<.01$) for the ASI and.91 ($P<.01$) for the VAS. Correlation coefficients resulted in rho=.86 ($P<.01$) for the ASI and rho=.97 ($P<.01$) for the VAS. The correlation between ASI and VAS was excellent, with rho=.85 ($P<.010$). CG and ASI (test kappa=.36, $P<.010$) and CG and VAS (test kappa=.39, $P<.010$) showed fair agreement.

Conclusions. ASI and VAS seem more reliable than CG to determine a patient's preferred chewing side and might be helpful within the context of prosthetic treatment planning, where additional support may improve denture function. (J Prosthet Dent 2025;133:163-168)

Most individuals have a preferred chewing side,[1–3] but determining this preference in a reliable way remains a challenge. The definition of preferred chewing side has varied, but the side on which the food bolus is placed and masticated consistently or predominantly has been one of the most commonly used.[4,5] The preferred chewing side has also been known as the masticatory side with stronger muscular activity compared with the non-masticatory side or the side where the jaw is positioned during the closure phase of the mastication cycle.[5–8] Knowing a patient's preferred chewing side might be beneficial when planning a prosthodontic rehabilitation, where masticatory forces are an important criterion to allocate support from abutments on existing teeth or on a dental implant.[9] Several tests have been developed to determine the preferred chewing side, both objectively observed or subjectively, in a patient-stated manner. Analyzing jaw movements using jaw tracking devices or assessing the activity of both masseter muscles using electromyography have been used to determine

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Clinical Implications

Knowing the preferred chewing side of partially edentulous patients restored with removable partial dentures might be useful in prosthetic treatment planning. Creating additional support where the patient mostly and effectively masticates could enhance masticatory efficiency, comfort, and general satisfaction.

mastication predominance in an objective manner. These tracking methods have used electromagnetic, optical, or ultrasonic registration techniques. While promising, most jaw tracking devices are complicated to set up, expensive, and difficult to transport, which does not facilitate data acquisition in a clinical context, especially in older people.[10] Moreover, jaw tracking devices need to be placed on the head and in the mouth. This artificial environment may modify the natural mastication pattern, while other methods like electromagnetic measurement with electrodes may have less influence.[8,11]

Straightforward methods, such as the observation of the position of the food bolus, have also been used to determine the preferred chewing side. Christensen et al[1] asked their patients about their perceived side preference and registered the placement of the gum bolus after established time intervals. Other studies have based analysis on the first masticatory cycles of the masticatory process. Kazazoglu et al[2] reported that food is most difficult to masticate before its comminution, and therefore a preference, if present, would appear in the early cycles. They recorded the position of a piece of chewing gum to assess an observed preferred chewing side (OPCS) and asked their participants about the side they preferred for mastication, determining the stated preferred chewing side (SPCS). The correlation between OPCS and SPCS was reported to be consistent for the early cycles.[2] The direction toward which a piece of chewing gum placed on the center of the tongue is moved by the patient for the first masticatory cycle has also been used for determining the preferred chewing side.[3,12] A video recording of the mastication movements in the frontal plane was used to examine the mastication pattern. Initially, authors observed the side of the mandible during the closing phase of the first mastication cycle to define the preferred chewing side.[13] More recently, the sidedness of all masticatory cycles has been recorded to calculate an asymmetry index (AI).[8]

For measurement of the SPCS, Flores-Orozco et al[4] tested the reliability of a visual analog scale (VAS) by comparing it with alternative subjective evaluation methods to determine the masticatory laterality. The VAS has been well established for the assessment of pain intensity but has not yet been used to determine the masticatory laterality.[14] Despite its subjective nature, this method seems to be able to determine the preferred chewing side more rapidly than other methods. Another subjective method of evaluating the preferred chewing side uses straightforward questionnaires, which have been reported to be as reliable as the VAS.[4]

Even if various methods have been developed and studied, from complex jaw tracking devices to straightforward questionnaires, a consensus on the most reliable test is lacking. The aim of this project was therefore to investigate the validity and reproducibility of 3 clinical tests to determine the preferred chewing side in partially edentulous individuals restored with removable partial dentures (RPDs). The null hypothesis was that objective methods of determining the preferred chewing side in partially edentulous individuals would have similar reliability to the tested subjective methods.

MATERIAL AND METHODS

Participants were recruited from the patient pool of the University Clinics of Dental Medicine at the University of Geneva. Patients were contacted by letter, telephone, or during routine dental visits. Financial compensation was not provided for participating in the study, although participants benefited from a free dental and prosthetic evaluation before the study. Approval from the ethics committee was obtained for project ID 2020–02959, and informed consent was signed by all participants before entering the study.

Participants included in this study were RPD wearers with Kennedy class I or II partial edentulism.[15] A minimum age of 18 years and willingness to participate in the experiment, plus signing the consent form, were required. Exclusion criteria included other partial edentulism classes, pain or discomfort during mastication, poor neuromuscular control, or health conditions rendering a series of tests difficult.

Three tests to assess the participant's hypothetical preferred chewing side were chosen. The tests were performed and repeated once in a single visit. All experiments were performed by the same operator (Q.O.) in a predetermined computer-generated random sequence (http://www.randomizer.org) which was stored in opaque sealed envelopes until the day of the experiments.

The first test (CG) consisted of placing a piece of chewing gum on the center of the participant's tongue. The position of the gum after spontaneous mouth opening was registered at the first, third, fifth, and seventh masticatory cycle.[2] The preferred chewing side was defined when the majority of cycles were on the same side.

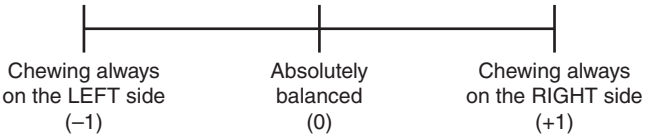

Figure 1. Visual analog scale according to Flores-Orozco et al.[4]

For the second test (ASI), participants were filmed in the frontal plane with a video camera (Smartphone Iphone 12 ProMax; Apple) while freely masticating a piece of gum for 30 seconds. The distribution of right and left masticatory cycles was used to calculate an asymmetry index (ASI) as follows: (number of right strokes–number of left strokes)/(number of right strokes +number of left strokes).[8] The determination of the preferred chewing side was based on this ASI.

The third test (VAS) was a subjective one and used a 10-cm VAS labelled "always right" (+1) and "always left" (–1) at its extremities and "no preference" (0) in the middle (Fig. 1).[4] Participants were asked to mark the line according to their personal perception of the location of their preferred chewing side. In the present analysis, data were categorized into right masticatory preference or left masticatory preference, and a quantitative value was recorded to assess the degree of side preference.

A power analysis was conducted based on a large previous survey[9] that reported that 45% of participants had no preferred chewing side and that, when participants lose masticatory units, a decrease of 10% in the no preferred chewing side group was reported. The analysis showed that 82 participants, divided into 3 groups were required to achieve a power of 0.80.

Statistical analyses were performed using a statistical software program (IBM SPSS Statistics, v26; IBM Corp). Mean values were calculated from the first and repeated ASI and VAS tests, while for CG only the second test was used for analysis to avoid introducing the category "no preference." Also, at the repeated test, the participant had received some training for the spontaneous opening of the mouth. To verify the validity of the different tests, the Pearson correlation test was used for ASI and VAS, and kappa agreement was used for CG. Reproducibility was tested with either a measure of agreement (kappa analysis; CG) or the Pearson correlation test (ASI and VAS) (α=.01).

RESULTS

A total of 82 participants took part in the experiments, 29 women and 53 men, with a mean ±standard deviation age of 69.9 ±11.5 years. Forty-six participants had been restored with RPDs in both arches, 17 wore an RPD in 1 arch and a complete denture on the opposing arch, and 9 participants wore an RPD and were completely dentate on the opposing arch (at least until the first molar in both quadrants). The remaining 10 participants wore an RPD in 1 arch while being partially edentulous in the opposing arch without tooth replacement (Fig. 2).

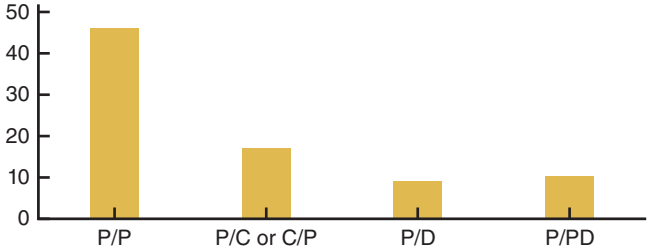

Figure 2. Number of participants per group. Distribution of dentures and natural teeth: Partial dentures in both arches (P/P), partial denture in one arch and complete denture in opposing arch (P/C or C/P), partial denture opposed to complete natural dentition (P/D) or partial denture opposed to partial dentition (P/PD).

The results indicated fair to almost perfect reproducibility for the 3 tests. CG showed fair reproducibility with a kappa of .37 (P<.010). With a kappa of .47 (P<.01), ASI was slightly more reproducible. VAS showed an almost perfect agreement with a kappa of .91 (P<.01). The Pearson correlation test showed a positive correlation between the repeated test rounds of both ASI and VAS, with a linear correlation coefficient of rho=.86 (P<.01) for ASI (Fig. 3) and rho=.97 (P<.01) for VAS (Fig. 4).

The mean values of the ASI and VAS tests were calculated and compared with the results of the second series of CG. The mean values of ASI and VAS showed a correlation coefficient of rho=.85 (P<.01) (Fig. 5). A fair agreement was found between CG and ASI (kappa = .36, P<.01), as well as CG and VAS (kappa.39, P<.01).

DISCUSSION

The 3 methods evaluated in this study have all been reported to be adequate tools to determine the preferred chewing side in a relatively rapid and straightforward way, based either on objective measurements and observations or on subjective patient perceptions. A very good correlation was revealed between ASI and VAS, but the agreement of CG with both ASI and VAS was only fair. As the VAS method showed higher reproducibility and was positively correlated with an observational method requiring the video camera, the null hypothesis that objective methods to determine the preferred chewing side in partially edentulous individuals would have similar reliability to the tested subjective methods was rejected.

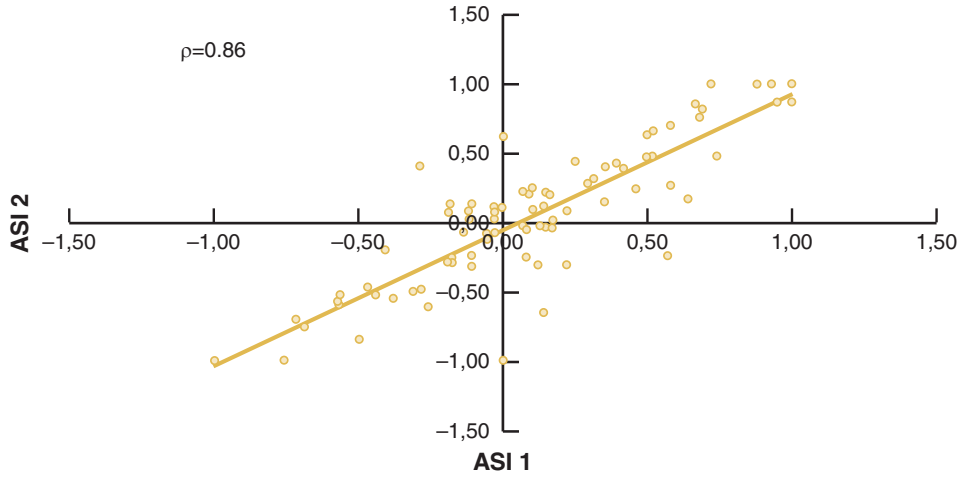

Figure 3. Reproducibility of ASI test between two test series. Correlation coefficient (Pearson test) of rho=.86 *(P*<.01).

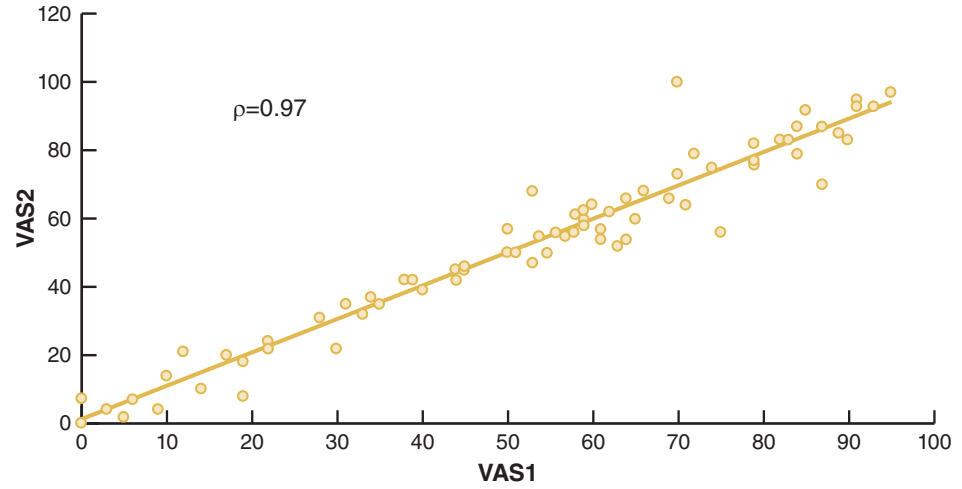

Figure 4. Reproducibility of VAS test between two test series. Correlation coefficient (Pearson test) of rho=.97 *(P*<.01).

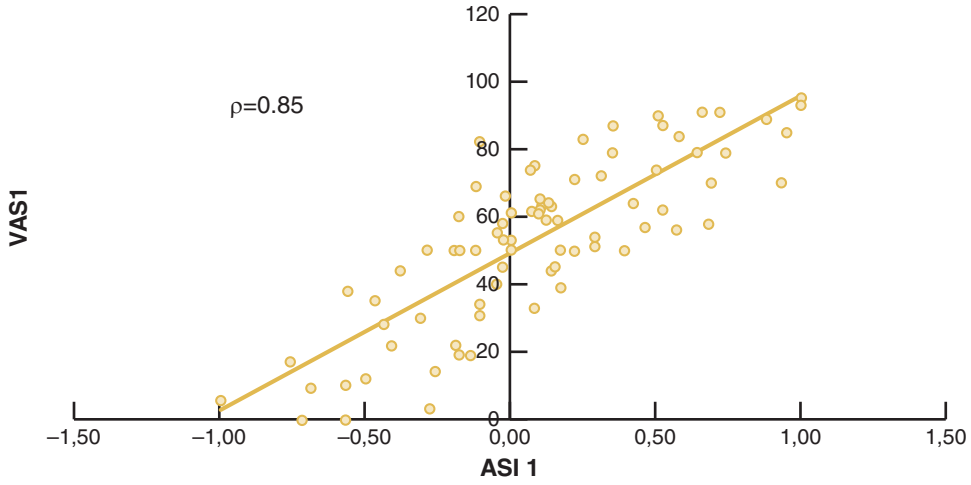

Figure 5. Validity between ASI and VAS (mean values). Correlation coefficient (Pearson test) of rho=.85 *(P*<.01).

In contrast to cumbersome methods that register jaw movements and muscle activity,[11–13] the 3 chosen tests were straightforward to perform in a clinical context. No sophisticated or expensive equipment was necessary, and the patient does not have to leave the dental chair. The present study design aimed to eliminate bias by repeating tests and performing them in a previously determined random order. A single operator performed all the tests, so the procedures and the evaluations were obtained in a similar manner. However, the results were not verified by a second operator. Verification would have been especially beneficial for ASI, which used a video camera where the investigator analyzed the participant's jaw movements on the recording. A further limitation was that no assessment of denture quality was performed, as retention and stability may have influenced the pattern.[16] Although the recruited participants were subjectively functioning well with their dentures without reporting pain or discomfort, an evaluation of prosthesis quality was not part of the inclusion criteria. However, participants did perform all tests with the same RPD, so a potential masticatory handicap would have influenced all the test results in a similar way. A statistical shortcoming was that CG, a categorical variable, could not be correlated for validity with ASI and VAS, which are continuous variables.

Different methods have been described to determine the preferred chewing side,[1,2,4,11] but to date, no best practice has been defined. The present study demonstrates a high level of agreement between VAS and ASI, a subjective and an objective test method. This finding was consistent with that of a previous study.[4] However, the present results were obtained from a cohort of patients with a heterogeneous distribution of the remaining natural teeth. Therefore, studies conducted on completely dentate individuals are not easily comparable.[1,3,4,17] The dental state is expected to influence the preferred chewing side. Specifically, when teeth are missing predominantly on one side, a person is more likely to masticate on the side where natural teeth are present.

An evaluation of only the first mastication cycle might be sufficient to assess the preferred chewing side[3,12] because food is mostly difficult to masticate before its comminution.[2,7] Likewise, Flores-Orozco et al[4] reported that the analysis of the first cycle was positively correlated with other methods in the evaluation of the preferred chewing side, but a generally low reliability was found in methods that used the location of a chewing gum bolus at standardized time intervals. The results of the present study found that the assessment of only the initial cycles might be a less reliable method compared with a longer and continuous observation period, such as the assessment with the video camera. However, the first cycle was not analyzed separately in the present study, and, as with the CG test, the preferred chewing side was determined based on the first, third, fifth, and seventh cycles.

The present experiments showed that the opinion of the patient from a VAS may be adequate and sufficient to assess the preferred chewing side in a reliable manner. This subjective evaluation correlated very well with ASI, using a videorecording of the entire mastication sequence, which can objectively verify the sidedness of the masticatory movements.[8] ASI proved a reliable reference, as the test and re-test reliability showed excellent correlation and fair agreement according to the kappa analysis.

Being able to reliably determine the PCS may be important in the planning of a partial or complete removable dental prosthesis. When implant placement is being considered, the determination of the preferred chewing side is of particular relevance. For example, placing an implant in the midline of the mandible has been recommended for single implant-retained overdentures.[18] However, mastication forces are low in the anterior region, even more so in complete denture wearers with difficulty incising.[19] If the preferred chewing side has been determined, support could be located closer to the center of mastication. Likewise, distal extension RPDs could be supported by implants when they are located on the preferred chewing side. However, clinical studies are required to verify the reasoning behind such strategic implant placement in terms of clinical outcomes and patient satisfaction.

Various factors determine the preferred chewing side in addition to the number of functional units. Neurological determinants, genetic factors, or an individual's side may have an important influence on function.[3,20] Future research in these areas may help better understand the function of the orofacial system and its relevance for restorative dentistry.

CONCLUSIONS

Based on the findings of this clinical study, the following conclusions were drawn:

1. The VAS test used to determine the patient's opinion on their preferred chewing side was the most reproducible method in this study, being highly correlated with the results from the observational test based on an asymmetry index.
2. The use of these tests therefore seems to be preferable to the observation of initial masticatory cycles.
3. The opinion of the patient may be an adequate and sufficient method of assessing the preferred chewing side in a reliable manner in the partially edentulous population.

PATIENT CONSENT

Informed consent was obtained from all participants involved in the study.

REFERENCES

1. Christensen LV, Radue JT. Lateral preference in mastication: a feasibility study. *J Oral Rehabil*. 1985;12:421–427.
2. Kazazoglu E, Heath MR, Müller F. A simple test for determination of the preferred chewing side. *J Oral Rehabil*. 1994;21:723–724.
3. Nissan J, Gross MD, Shifman A, Tzadok L, Assif D. Chewing side preference as a type of hemispheric laterality. *J Oral Rehabil*. 2004;31:412–416.
4. Flores-Orozco EI, Rovira-Lastra B, Peraire M, Salsench J, Martinez-Gomis J. Reliability of a visual analog scale for determining the preferred mastication side. *J Prosthet Dent*. 2016;115:203–208.
5. Christensen LV, Radue JT. Lateral preference in mastication: an electromyographic study. *J Oral Rehabil*. 1985;12:429–434.
6. Martinez-Gomis J, Lujan-Climent M, Palau S, Bizar J, Salsench J, Peraire M. Relationship between chewing side preference and handedness and lateral asymmetry of peripheral factors. *Arch Oral Biol*. 2009;54:101–107.
7. Paphangkorakit J, Thothongkam N, Supanont N. Chewing-side determination of three food textures. *J Oral Rehabil*. 2006;33:2–7.
8. Mizumori T, Tsubakimoto T, Iwasaki M, Nakamura T. Masticatory laterality—evaluation and influence of food texture. *J Oral Rehabil*. 2003;30:995–999.
9. Diernberger S, Bernhardt O, Schwahn C, Kordass B. 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.
10. Minami I, Wirianski A, Harakawa R, Wakabayashi N, Murray GM. The three-axial gyroscope sensor detects the turning point between opening and closing phases of chewing. *Clin Exp Dent Res*. 2018;4:249–254.
11. Yamasaki Y, Kuwatsuru R, Tsukiyama Y, Matsumoto H, Oki K, Koyano K. Objective assessment of actual chewing side by measurement of bilateral masseter muscle electromyography. *Arch Oral Biol*. 2015;60:1756–1762.
12. Delport HP, de Laat A, Nijs J, Hoogmartens MJ. Preference pattern of mastication during the first chewing cycle. *Electromyogr Clin Neurophysiol*. 1983;23:491–500.
13. Hoogmartens MJ, Caubergh MA. Chewing side preference during the first chewing cycle as a new type of lateral preference in man. *Electromyogr Clin Neurophysiol*. 1987;27:3–6.
14. Boyce JM, Eccles R. Assessment of subjective scales for selection of patients for nasal septal surgery. *Clin Otolaryngol*. 2006;31:297–302.
15. Kennedy E. Partial denture construction. Brooklyn: Dental Items of Interest Publishing Co,; 1928:472.
16. Limpuangthip N, Somkotra T, Arksornnukit M. Modified retention and stability criteria for complete denture wearers: A risk assessment tool for impaired masticatory ability and oral health-related quality of life. *J Prosthet Dent*. 2018;120:43–49.
17. Haralur SB, Majeed MI, Chaturvedi S, Alqahtani NM, Alfarsi M. Association between preferred chewing side and dynamic occlusal parameters. *J Int Med Res*. 2019;47:1908–1915.
18. Couthino PC, Nogueira TE, Leles CR. Single-implant mandibular overdentures: Clinical, radiographic, and patient-reported outcomes after a 5-year follow-up. *J Prosthet Dent 2022*. 2022;128:949–955.
19. Shinogaya T, Bakke M, Thomsen CE, Vilmann A, Matsumoto M. Bite force and occlusal load in healthy young subjects-a methodological study. *Eur J Prosthodont Restor Dent*. 2000;8:11–15.
20. Rovira-Lastra B, Flores-Orozco EI, Ayuso-Montero R, Peraire M, Martinez-Gomis J. Peripheral, functional and postural asymmetries related to the preferred chewing side in adults with natural dentition. *J Oral Rehabil*. 2016;43:279–285.

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