*Short Communication*

# A New Clinical Method for Evaluating the Closest Speaking Space in Dentulous and Edentulous Subjects: A Pilot Study

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This study proposes a new clinical procedure for measuring the closest speaking space (CSS) and compares it with an instrumental method. The study population included 15 edentulous and 10 dentulous subjects free of systemic disease, speech defects, or masticatory system dysfunction. For all subjects, the CSS was measured using clinical and instrumental methods. The clinical method utilized polyvinyl siloxane, commonly used for interocclusal records, injected on the occlusal surface of the premolars just before the pronunciation of a word containing the consonant sound "s" 3 times. The instrumental method used a kinesiograph. Statistical analysis was performed using 1-way repeated-measures analysis of variance and the Student *t* test for paired data. There was no statistical difference between the clinical and instrumental methods of determining CSS. Within the limitations of this study, based on a small sample, the new simpler and less expensive method to record the CSS should be considered and further investigated. *Int J Prosthodont 2007;20:259–262.*

The closest speaking space (CSS) is the minimum distance between the anterior teeth that occurs during the pronunciation of words containing "s," "e," and "i" sounds. The CSS is characterized by a great individual variability, ranging from 0 to 10 mm.[1] Burnett and Clifford[2] demonstrated that the CSS could be determined by having subjects pronounce words containing a consonant defined by a hissing sound. Morrison[3] suggested using the words "sixty-six" and "Mississippi."

Currently, only instrumental methods, such as kinesiography, are available to obtain precise measurements of CSS. Unfortunately, kinesiography requires expensive equipment and well-trained operators.

A clinical method has been used during denture construction that is based on observation of a 2-mm clearance at the premolars while the patient is pronouncing words containing a sibilant sound.[4] In this study, a new clinical method is proposed. The tested hypothesis was that the CSS measurements obtained using this method are not significantly different from those obtained using the kinesiographic method.

## Materials and Methods

The study included 15 edentulous Caucasian subjects ranging in age from 46 to 76 years (10 men, 5 women) and 10 dentulous subjects ranging in age from 22 to 26 years (6 men, 4 women). All edentulous subjects wore complete dentures with adequate retention that had been supplied by the Department of Prosthetic Dentistry at the University of Turin, Italy. All subjects were free of systemic disease, speech defects, and masticatory system dysfunctions. Informed consent was obtained from all subjects.

For each subject, the CSS was measured with a new clinical method and with a kinesiograph (K6-I; Myotronics). The authors have named the new clinical method *IRVS* (interocclusal records with polyvinyl siloxane [Memoreg; Heraeus Kulzer]), because polyvinyl siloxane has been used primarily to make standard interocclusal records.

Before comparing the data obtained using the IRVS and kinesiographic methods, a test was performed to determine whether the clinical method was repeatable

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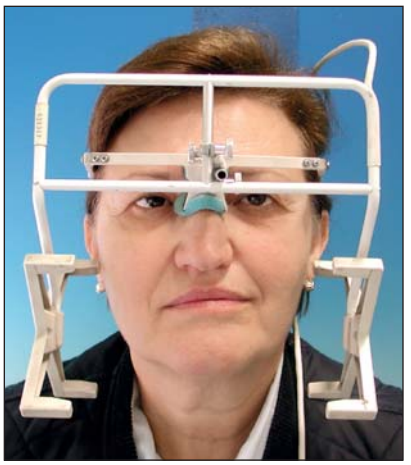

**Fig 1** *(left)* The CSS was measured using a caliper.

**Fig 2** *(right)* The sensor device fixed to a patient's head.

and predictable. The IRVS test was performed 4 times each in 5 subjects from both the edentulous and dentulous groups.

### *Clinical Method: IRVS*

The operator positioned 1 cm (4 g) of polyvinyl siloxane on the occlusal surface of the posterior teeth (both sides). The subject was instructed to repeat the Italian word "sessantasei" (sixty-six) without interruption until the material hardened. The polyvinyl siloxane was not placed on the anterior teeth to avoid any interference with the "s" canal. Next, the operator measured the thinnest point of the polyvinyl siloxane at the first premolar using a caliper (Fig 1). The resulting value corresponded to the CSS.

### *Instrumental Method: Kinesiography*

The mandibular movement was measured using a kinesiograph. Mandibular movements are recorded as changes in the magnetic field produced during the movement of a lightweight magnet (5 × 6 × 9 mm) fixed to the mandibular incisors by an adhesive (Stomahesive; ConvaTec).

Variations in the force of the magnetic field were detected with the aid of a device comprising 8 tips fixed to the patient's head (weight: 50 g) (Fig 2). These sensors detect alterations in the magnetic field and transform them into electrical potentials, which are then relayed directly to a computer. The software system records and displays spatial coordinates in the frontal, sagittal, and coronal planes and reconstructs the mandibular movement.

In edentulous subjects, the magnet was placed at the level of the buccal resin flange, corresponding to the position of the mandibular central incisors. In dentulous subjects, the magnet was placed at the deepest point of the fornix, adjacent to the mandibular central incisor. The magnet was covered with dental wax to reduce irritation of the lip mucosa. The records were taken in a quiet, peaceful place, without external interference.

The CSS was determined while each subject pronounced the Italian word "sessantasei" 4 consecutive times.

The kinesiograph consists of 3 traces that represent the different components of the mandibular movements—vertical, horizontal, and anteroposterior—and are shown in different colors. Two kinesiographic registrations were made for each patient. For the first record, the patient pronounced the word "sessantasei" once, starting from the resting position and finishing in the intercuspal position. For the second record, the patient pronounced the word "sessantasei" 4 consecutive times, starting from the resting position and finishing in the intercuspal position.

For both the clinical and kinesiographic analyses, the subjects were asked to repeat the word at a volume of voice that could be heard 5 meters away.

For the kinesiographic method, 1-way repeated-measures analysis of variance (ANOVA) was used to investigate the differences in CSS between the 4 consecutive pronunciations of the word "sessantasei." To compare the IRVS method with the kinesiographic method, a *t* test for paired data was used.

## Results

The preliminary data obtained from the IRVS measurements are shown in Table 1. One-way repeated-measures ANOVA showed no significant difference between the 4 pronunciations in either dentulous or edentulous subjects (dentulous subjects, $P = .6986$; edentulous subjects, $P = .7198$).

The data obtained from the kinesiograph records and IRVS measurements are shown in Tables 2 to 4. A comparison of the values for the 4 consecutive pronunciations of the word "sessantasei" determined

**Table 1** CSS (mm) for Each of 4 Consecutive Pronunciations of "Sessantasei" Obtained Using the IRVS Method in the First 5 Dentulous and Edentulous Subjects

| | Dentulous | | | | Edentulous | | | |
|---|---|---|---|---|---|---|---|---|
| Patient | IRVS 1 | IRVS 2 | IRVS 3 | IRVS 4 | IRVS 1 | IRVS 2 | IRVS 3 | IRVS 4 |
| 1 | 0.75 | 1.25 | 1.25 | 1.25 | 1.25 | 1 | 0.55 | 1.1 |
| 2 | 1.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.8 | 1 | 1.05 |
| 3 | 1.45 | 2 | 2 | 2 | 2 | 1.3 | 1.8 | 1.35 |
| 4 | 2 | 0.7 | 0.7 | 0.7 | 0.7 | 2.4 | 1.95 | 2.7 |
| 5 | 0.8 | 2 | 2 | 2 | 2 | 0.5 | 0.3 | 0.45 |

**Table 2** CSS (mm) for Each of 4 Consecutive Pronunciations of "Sessantasei" Obtained Using the Kinesiographic (Kine) Method in Dentulous and Edentulous Subjects

| | Dentulous | | | | | Edentulous | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Patient | Kine 1 | Kine 2 | Kine 3 | Kine 4 | Mean | Kine 1 | Kine 2 | Kine 3 | Kine 4 | Mean |
| 1 | 2.7 | 3.3 | 3 | 3.2 | 3.05 | 0.9 | 0.5 | 1.1 | 1.1 | 0.9 |
| 2 | 1.3 | 1.4 | 1.5 | 1.5 | 1.425 | 0.8 | 1.2 | 1.05 | 1.7 | 1.1875 |
| 3 | 0.5 | 0.5 | 0.65 | 0.9 | 0.6375 | 1.45 | 1.7 | 1.35 | 1.9 | 1.6 |
| 4 | 0.7 | 0.65 | 0.6 | 0.6 | 0.6375 | 2.4 | 1.95 | 2.7 | 2.8 | 2.4625 |
| 5 | 0.8 | 1.3 | 1 | 0.95 | 1.0125 | 0.5 | 0.6 | 0.4 | 0.5 | 0.5 |
| 6 | 2.7 | 1.8 | 1.1 | 2.3 | 1.975 | 0.6 | 0.6 | 0.65 | 0.6 | 0.6125 |
| 7 | 0.3 | 0.2 | 0.2 | 0.2 | 0.225 | 0.6 | 0.8 | 0.75 | 0.8 | 0.7375 |
| 8 | 1 | 1.8 | 2.2 | 2.1 | 1.775 | 1.65 | 1.8 | 1.45 | 1.65 | 1.6375 |
| 9 | 1.1 | 0.3 | 0.5 | 0.3 | 0.55 | 2.3 | 2.1 | 1.5 | 2.2 | 2.025 |
| 10 | 3 | 3 | 2.6 | 2.5 | 2.775 | 1.75 | 1.95 | 2.05 | 1.8 | 1.8875 |
| 11 | | | | | | 1.2 | 1.2 | 1.4 | 1.1 | 1.225 |
| 12 | | | | | | 1.5 | 2.9 | 3 | 3 | 2.6 |
| 13 | | | | | | 5.1 | 4.9 | 5.05 | 5.25 | 5.075 |
| 14 | | | | | | 0.1 | 0.05 | 0.1 | 0.1 | 0.0875 |
| 15 | | | | | | 0.55 | 0.2 | 0.2 | 0.2 | 0.2875 |

**Table 3** CSS (mm) Obtained Using the IRVS and Kinesiographic (Kine) Methods While Pronouncing "Sessantasei" Once in Dentulous and Edentulous Subjects

| | Dentulous | | Edentulous | |
|---|---|---|---|---|
| Patient | IRVS | Kine | IRVS | Kine |
| 1 | 2 | 2.9 | 0.85 | 1.2 |
| 2 | 1.3 | 1.6 | 0.9 | 1.7 |
| 3 | 0.8 | 0.8 | 1.7 | 0.85 |
| 4 | 0.5 | 0.6 | 2.3 | 1.5 |
| 5 | 1.3 | 0.7 | 0.4 | 0.55 |
| 6 | 1.3 | 2.9 | 0.3 | 1.2 |
| 7 | 0.5 | 0.2 | 0.7 | 0.45 |
| 8 | 1.5 | 2.2 | 1.6 | 2.25 |
| 9 | 0.6 | 1.5 | 1.8 | 1.8 |
| 10 | 2.1 | 2.6 | 1.8 | 2 |
| 11 | | | 1.6 | 1.2 |
| 12 | | | 1.8 | 1.5 |
| 13 | | | 4.4 | 5.1 |
| 14 | | | 0.4 | 0.1 |
| 15 | | | 0.25 | 0.8 |

**Table 4** CSS (mm) Obtained Using the IRVS Method and the Mean CSS Obtained Using the Kinesiographic (Kine) Method for 4 Consecutive Pronunciations of "Sessantasei" in Dentulous and Edentulous Subjects

| | Dentulous | | Edentulous | |
|---|---|---|---|---|
| Patient | IRVS | Kine (mean) | IRVS | Kine (mean) |
| 1 | 2 | 3.05 | 0.85 | 0.9 |
| 2 | 1.3 | 1.425 | 0.9 | 1.1875 |
| 3 | 0.8 | 0.6375 | 1.7 | 1.6 |
| 4 | 0.5 | 0.6375 | 2.3 | 2.4625 |
| 5 | 1.3 | 1.0125 | 0.4 | 0.5 |
| 6 | 1.3 | 1.975 | 0.3 | 0.6125 |
| 7 | 0.5 | 0.225 | 0.7 | 0.7375 |
| 8 | 1.5 | 1.775 | 1.6 | 1.6375 |
| 9 | 0.6 | 0.55 | 1.8 | 2.025 |
| 10 | 2.1 | 2.775 | 1.8 | 1.8875 |
| 11 | | | 1.6 | 1.225 |
| 12 | | | 1.8 | 2.6 |
| 13 | | | 4.4 | 5.075 |
| 14 | | | 0.4 | 0.0875 |
| 15 | | | 0.25 | 0.2875 |

using the kinesiograph showed that the differences were not statistically significant (Fisher exact test = 1.61, $P = .2006$), even when controlling for between-subject variability.

In addition, the Student *t* test comparison of the IRVS and kinesiographic methods (mean value of 4 pronunciations and a single pronunciation) showed no statistically significant differences. Comparing the CSS recorded using kinesiography and the IRVS method for a single pronunciation of the word "sessantasei," the Student *t* test for paired data showed *P* values of .5333 in edentulous subjects and .0768 in dentulous subjects. Comparing the mean values obtained using kinesiography and the IRVS method for multiple pronunciations, the Student *t* test for paired data showed *P* values of .1103 for edentulous subjects and .1651 for dentulous subjects.

## Discussion

The kinesiographic method collects very precise measurements but requires complex equipments and trained operators. The new IRVS method described in this study has the great advantage of being less expensive and more user friendly. Because of the simplicity of the IRVS method and the quality of the material employed for the measurements, this technique is precise enough for the purposes of this field of research.

Two possible limitations of this method were considered. The backward position of registration compared to the one determined using the kinesiograph may cause differences. However, the authors postulated that the position used for the IRVS method was not far enough posteriorly from the incisor to invalidate the method. This is supported by the results, which showed no significant differences between the 2 methods.

The possibility that the impression material affects proprioceptive information was also considered. Mastication and phonetics are complex movements requiring proprioceptive information conveyed by several receptors.[5] Mandibular movement during phonetics, unlike mastication, does not require tooth contact. In this context, it must be emphasized that the IRVS method was used in 2 different groups of subjects in whom the proprioceptive information differed in many ways.

Neither of these factors seemed to significantly affect the IRVS measurements, since this method was validated by data collected in the same subjects using kinesiographic measurements.

## Conclusions

Within the limitations of this study based on 2 small samples, the proposed IRVS method seems to be a simple, inexpensive, and reliable technique for recording the CSS and is applicable in both clinical practice and research.

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