Original Article

Dentistry

Freeway Space Measurement by Willis Gauge and Sprung Divider

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ABSTRACT

Objective: To compare the accuracy of Willis gauge and Sprung divider in determination of freeway space in dentate subjects.

Study Design: cross-sectional comparative study.

Place and Duration of Study: This study was carried out at Department of Prosthodontics, Lahore Medical and Dental College, Lahore from March 2010 to August 2010.

Materials and Methods: Three hundred dentate subjects were included in this study. Both Willis gauge and Sprung divider methods were performed on same subject to measure the freeway space. Subjects were seated in comfortable upright position with unsupported head. Freeway space was measured by both Willis gauge and Sprung divider. The difference between the two measurements of rest position and maximum intercuspation was taken as freeway space. The collected data was entered in proforma. SPSS version 17 was used to analyze the data. Mean and SD was taken for age and gender. The measurement of both methods were compared through chi square test p value < 0.05 was considered significant.

Results: Out of 300 subjects, freeway space was achieved 217 (72.33%) with Willis Gauge and in 247 (82.33%) subjects freeway space was achieved with Sprung Divider. Although the achievement rate was slightly high with Sprig Divider as compare to Willis gauge method but it was non-significant (p-value = 0.078).

Conclusion: Sprung Divider measurement of freeway space is somewhat superior to Willis gauge.

Key Words: Freeway space, Vertical jaw relation, Willis gauge, Sprung divider.

INTRODUCTION

In the western societies the occurrence of edentulism is one tenth to one fifth of the general population and in above sixty five years of age group its almost half of the population which was very high few decades ago.[1,2] Edentulism and alveolar ridge resorption has an important effect on the form and function of subjects.[3] High incidence of periodontal diseases, increase caries rate, low socio-economic status and lack of health care facilities are considered main contributory factors in the loss of natural dentition.[4,5] The psychological & functional impact of edentulous state may range from feelings of inconvenience to feelings of handicap to compromise the quality of life and considered as a poor health out come. From technical viewpoint its long term existence leads soft tissues profile changes and loss of vertical dimension as well.[5-7]

These patients are mostly managed by providing them with complete denture.[6] The denture substitutes the full dentition and related structures of the maxilla and the mandible.[8] Thus it restores the facial form, function and the maintains the chewing ability of the patient.[9] Combined actions of oral soft tissues including floor of mouth lead all the functions like speech, mastication and smiling. All these functions are very complex and extremely individual. To simulate these functions complete dentures are designed such a way to provide mechanical stimulus to these structures. Hence the basic thing required for successful complete denture is the synchronization of denture with neuromuscular function.[10] From the patient's view point denture stability, comfort, speech, mastication, and ease of removal are the parameters of success.[11,12] To satisfy the patient with complete denture is very demanding job. Therefore its construction requires proper steps specially impression taking and recording jaw relation are the two significant stages on which success of the dentures rely.[13,14] In the treatment of edentulous patients the recording of exact vertical jaw relationship assists the adaptation of the dentures to the masticatory system for maximum comfort and function. To attain this objective, the recording must include a correct vertical occlusal dimension.[15,16] Vertical occlusion dimension is the fundamental element in the construction of total or partial prosthodontic replacement.[17,18] Any fault at this step may yield lasting damage to various elements of the stomatognathic system and will result in faulty and unacceptable prosthesis.[19]

Mastication, appearance and speech of the patient may be affected badly due to inappropriate recording of vertical jaw relation.[20] Currently to determine the vertical occlusion dimension, gauging of the freeway space is the most commonly used method.[19] Usually freeway space is measured indirectly by deducting the occlusal vertical height from resting vertical dimension.[18] Reduced freeway space increases the risk

soft tissue of trauma the under the denture due to continuous clenching and lip incompetence. The denture bearing mucosa becomes painful with particular soreness in masseter muscle. Poor aesthetics and clicking of the teeth during speech and other speech related problems may ensue beside possibility of temporomandibular joint dysfunction.[19] The problems associated with increased freeway space are poor aesthetics due to of lack lip and cheek support. Protrusion of the chin on closure of the jaws may also be evident apart reduced masticatory efficiency. Due to lack of support of the angles of the mouth causing dribbling and may lead to angular cheilitis.[21]

To determine the precise occlusal vertical dimension many approaches have been employed like the usage of physiological rest positioning, pre-extraction records, tracing of profile, craniofacial measurement, ridge parallelism, electromyography, phonetic, esthetics, swallowing technique, cephalometric radiography, Willis gauge, dividers (Sprung), and measurements of previous dentures.[22,23] But, there is no commonly accepted technique for recording vertical jaw relation. According to some authors there seems to be no benefits attached to one technique to other but satisfactory outcome is important for both clinician and patient in terms of form and function.[14,24]

Little work has been reported in the literature regarding the determination of freeway space in dentate subjects in our country. The aim of this study was to compare the Willis gauge and Sprung divider in determining freeway space in dentate subjects as its very difficult to get accurate comparison between two methods in edentulous patients. Therefore we opted to evaluate efficiency of both devices on dentate subjects in local population.

MATERIALS AND METHODS

In this cross-sectional comparative survey we have used the term freeway space as the difference between the vertical dimension of rest and the vertical dimension while in occlusion. Normal freeway space is 2-4mm. This study was conducted at Department of Prosthodontics, Lahore Medical and Dental College, Lahore from March 2010 to August 2010. The calculated sample size was 300 dentate subjects with non-probability purposive sampling technique. Both Willis gauge and Sprung divider methods were performed on same subject. We included dentate subjects of either gender between ages of 15-45 having angle class-I molar and canine relationship. While subjects with history of temporomandibular joint pain or dysfunction, occlusal wear, with bear and with neurologic/psychiatric disorder were excluded from this study. Informed written consent was obtained from all the subjects for using their data in this research. All the readings were taken early in morning office hours to avoid any possibility of muscle fatigue. The freeway space of the subjects was determined by Willis gauge and Sprung divider. The subjects were seated in comfortable, upright position with unsupported head and the frankfort horizontal plane was positioned parallel to the floor. The subjects were instructed to swallow saliva and to be relaxed and lightly touch the lips together. Willis gauge was positioned to have the upper arm in contact with the base of the nose and lower arm in firm contact with the lower border of the chin to measure the reading. All the subjects were then instructed close to maximum intercuspation. Reading was recorded three times with Willis gauge. The average of three measurements of rest position and maximum intercuspation was taken as freeway space. For Sprung divider, the subjects were seated in same way. A small piece of adhesive tape was placed on tip of the subject's nose and another on the chin protuberance. A pin point pencil mark was placed on adhesive tape. Sprung divider was positioned in same manner after same instructions as were given during Willis gauge measurement. To avoid error each distance was recorded three times by same operator and mean was taken. The difference between the two measurements of rest position and maximum intercuspation was taken as freeway space. The collected data was entered in proforma. SPSS version 17 was used to analyze the data. Mean and SD was taken for age and gender. The measurement of both methods were compared through chi square test p value < 0.05 was considered significant.

RESULTS

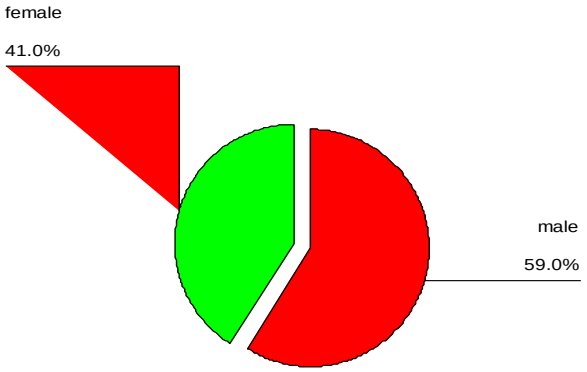
Data from three hundred subjects were collected. The mean age of the subjects in the study is shown in Table 1, while gender distribution is presented in Graph 1. The minimum and maximum rest vertical dimension and occlusal vertical dimension determined with Willis Gauge with mean rest vertical dimension. Minimum and maximum freeway space determined with Willis gauge was between 2.00 - 7.00 mm and mean freeway space was 3.38 ± 1.22 mm. rest vertical dimension determined and occlusal vertical dimension with Sprung Divider was 58 - 81 mm. Mean rest vertical dimension was 69.01 ± 4.56 mm. Minimum determined with sprung divider was 54 mm and maximum was 76 mm. Mean occlusal vertical dimension was 65.58 ± 4.37 mm. Minimum freeway space determined with sprung divider was 2.00 mm and maximum was 6.00 mm. Mean freeway space was 3.47±1.10 mm. (Table 2).

Out of 300 subjects, freeway space was achieved within recommended range (2-4 mm) in 217 (72.33%) subjects. In 83 (27.67%) subjects, freeway space was not achieved within recommended range of 2-4 mm. (Graph 2) Out of 300 subjects; freeway space was achieved within recommended range (2-4 mm) in 247 (82.3%) subjects. In 53 (17.7%) subjects, freeway space

was not achieved within recommended range of 2-4 mm. (Graph 3).

Table No.1: Mean Age of Subjects in years

N	300
Mean	25.4600
Std. Error of Mean	.31319
Std. Deviation	5.42462
Minimum	17.00
Maximum	40.00



Graph 1: Distribution of Gender

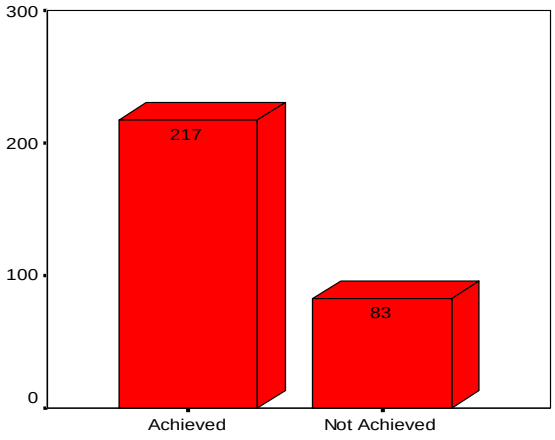
Table No.2: A. Determination of freeway space With Willis Gauge (W) mm

B. Determination of Freeway space with Sprung Divider (S) mm

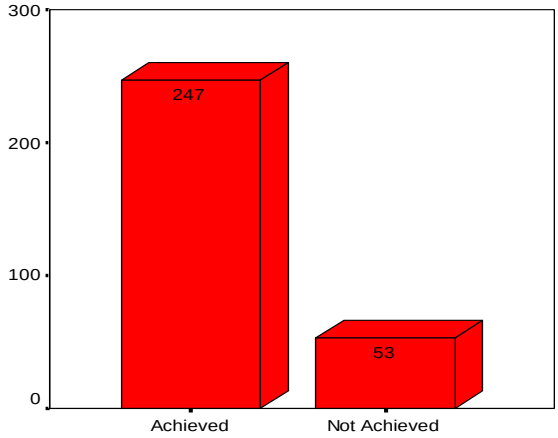
A	Rest Vertical Dimension (Wa)	Occlusal Vertical Dimension (Wb)	WA-WB= Average Freeway Space (Wc)
N	300	300	300
Mean	54.03	50.66	3.3867
Std. Error of Mean	0.20	0.20	0.07076
St. Deviation	3.49	3.49	1.22563
Minimum	47	45	2
Maximum	61	58	7
Range	14	13	5
B	Rest Vertical Dimension (Wa)	Occlusal Vertical Dimension (Wb)	WA-WB=Average Freeway Space (Wc)
N	300	300	300
Mean	69.05	65.58	3.4700
Std. Error of Mean	0.26	0.25	0.06394
St. Deviation	4.56	4.37	1.10748
Minimum	58	54	2.00
Maximum	81	76	6.00
Range	23	22	4

a= Rest Vertical dimension
b= Occlusal Vertical dimension
c= average Freeway Space

There were 197 (65.67%) subjects whose free way space was achieved with both Sprung Divider and Willis Gauge and the free way space was not achieved by both was 33 (11%). In 217 (72.33%) subjects the free way space was achieved only with Willis Gauge, and in 247 (82.33%) subjects free way space was achieved only with Sprung Divider (Table 3). Although the achievement rate was slightly high with Sprig Divider as compare to Willis gauge method but was non-significant (p-value = 0.078).



Graph No.2: Status of achievement of Freeway space with Willis gauge (WG)



Graph No.3: Status of achievement of Freeway space with Sprung Divider (SD)

Table No.3: Frequency Distribution of Achievement within freeway spaces with Sprung Divider vs. Willis Gauge

		Achievement within freeway space Sprung Divider		
		Yes	**No**	**Total**
Achievement within freeway space Willis Gauge	Yes	197 (65.67%)	20 (6.67%)	217 (72.33%)
	No	50 (16.67%)	33(11%)	83 (27.67%)
	Total	247 (82.33%)	53 (17.6%)	300 (100.0%)

Chi-square = 3.1
P-value = 0.078

DISCUSSION

Determining the vertical jaw relation is a critical procedure for a totally or partially edentulous patient. Various approaches have been suggested to determine the accurate vertical jaw relations. Millet et al[23] used swallowing method to record jaw relationship. de Souza et al[25] jaw-tracking device & speaking space methods to evaluate jaw relation record. While Sakar et al[26] used craniofacial measurements to determine OVD & found it unsatisfactory. All the methods & equipment used to measure the freeway space are inaccurate or costly and time consuming to use them in clinical practice. In present study the Willis gauge and Sprung divider were compared to determine freeway space in dentate subjects. Both the Sprung divider and the Willis gauge techniques are quick, easy and economical, beside this it is radiation free as OVD is determined through lateral cephalographs by some investgators.[27] Regarding freeway space analysis Johnson et al[21] also carried out a similar study to compare freeway space determined with Willis gauge and sprung divider in 72 same dentate subjects. In their study the lowest and highest, inter-operator, freeway space measurements were 0 and 7 mm, respectively, for the Willis gauge and 1 and 7 mm, respectively, for the sprung dividers method and when looking at the intra-operator measuring the freeway space of one patient 10 times ranges of 1.5 to 7 mm were seen for the Willis gauge and 1 to 5 mm when the dividers were used. While the mean freeway space using the Willis gauge was 3.3 mm, and with the sprung dividers 2.9 mm for intra-operator variability and inter-operator measured free way space with Willis guage was 3.3 mm and with sprung divider was 3.1mm. Results of this study are identical with their study with little difference, because they measured the free way space in same subject ten times by different operators but we measured three times by single operator. The findings of our study show range of freeway space between 2 to 4 mm as recommended by many other authors in different studies.[21, 28, 29]

In terms of reliability of a method our observations are in accordance with Johnson's study that showed reliable method of measuring freeway space is Sprung divider as compare to Willis gauge. These results support the findings of Geerts et al,[24] they found the differences in the rest vertical dimension values for the Willis gauge technique were higher than for the caliper technique for most dentate subjects. In their investigation Wilcoxon signed rank test showed that the accuracy of the occlusal vertical dimension measurements for the caliper technique was significantly superior to for the Willis gauge technique. This was not the case for the rest vertical dimension measurements. The average freeway space for the Willis method was significantly higher than the control interocclusal distance. The average interocclusal distance for the caliper method was not significantly higher than the control. In our study we found that the average freeway space with Sprung Divider method was not significantly higher than the Willis Guage method, although marginal superiority was noticed with Sprung Divider.

CONCLUSION

The sprung Divider method for measuring the freeway space was shown to be marginally accurate than the Willis Guage method, however, the difference between the two methods was statistically insignificant.

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