Open Access

Original Article

Intra-Observer Variation of Space Available in the Mandibular Dental Arch by Two Different Measuring Tools-Vernier Calliper and Brass Wire with a Millimetre Ruler

Rooma Shahid, Abdullah Jan, Ayesha Fazal*, Alaina Tariq Mughal, Fareena Ghaffar, Sundas Mehmood

Armed Forces Institute of Dentistry/National University of Medical Sciences (NUMS) Rawalpindi Pakistan,
*Margalla Institute of Health Sciences Rawalpindi, Pakistan

ABSTRACT

Objective: To check the variation of space available in the mandibular dental arch using different tools, i.e., Vernier caliper and brass wire with a millimeter ruler.

Study Design: Comparative cross-sectional study.

Place and Duration of Study: Department of Orthodontics, Armed Forces Institute of Dentistry (AFID), Rawalpindi Pakistan, from Sep to Dec 2019.

Methodology: Seventy-five dental casts of patients, with an age range between 12-25 years were included in the study. The variation of the space available using two different measuring tools (Vernier calliper and brass wire with millimetre ruler) in the mandibular arch was determined by the same observer to assess random and systematic errors. The examiner recorded the measurements, and then the same examiner repeated the measurements after ten days by taking two readings each using the blinding technique to minimize bias. Random and systematic errors were analyzed with the use of two methods.

Results: Systematic errors were found to be significant with brass wire with millimetre ruler method only (p-value=0.02). For random errors, the Vernier calliper can be considered a better method to measure reproducibility and repeatability. However, brass wire with a millimetre ruler method can be considered better for measuring repeatability than reproducibility since the value to measure random errors was less than 1mm but in the upper limits (p-value=0.091).

Conclusion: In the current study, it is concluded that the Vernier calliper is more precise in measuring the readings in orthodontics for arch space measurement than that of brass wire with a millimetre ruler. However, brass wire with a millimetre ruler method can also take the readings.

Keywords: Brass wire, Intra observer, Space available, Systemic errors, Vernier calliper.

How to Cite This Article: *Shahid R, Jan A, Fazal A, Mughal AT, Ghaffar F, Mehmood S. Intra-Observer Variation of Space Available in the Mandibular Dental Arch by Two Different Measuring Tools-Vernier Calliper and Brass Wire with a Millimetre Ruler. Pak Armed Forces Med J 2023; 73(2): 389-401. DOI: https://doi.org/10.51253/pafmj.v73i2.5615*

INTRODUCTION

Precise measurements of dental casts are essential for correctly detecting dental anomalies to plan adequate treatment.[1] According to the previous literature, three methods already used for space analysis of the mandibular arch discrepancy include visual inspection, brass wire evaluation method, and contact point arch chart.[2,3] The latter was the most accurate; however, this method includes a lot of technical competency and accuracy with the procedure.[4]

Nic *et al*. defined repeatability as "the closeness of agreement between independent results obtained with the same method on identical test material under identical conditions" and reproducibility as "the closeness of agreement between independent results obtained with the same method on identical test material, under different conditions".[5] The readings obtained by the same observer are more reliable than those obtained by two different observers because readings by two different observers may induce systematic errors more than the intra-observer measurement methods.[6,8]

While taking multiple readings, there some errors might occur. These errors are either random or systematic. Random error occurs when different values are clustered around the true value. This may affect the precision of the results. Since random errors always exist, the average of multiple readings must be considered. Random errors may occur due to taking measurements at different angles of the objects. In lieu of random errors, there are also systematic errors, which occur due to some error in the observer's observation or some defect in the instrument. Systematic errors are predictable errors. Random errors will always exist in a study, while systematic errors can be eliminated by improving the measuring techniques.[9,10]

Therefore, the study aims to check the reproducibility of intraobserver variation in the space available in mandibular arches has been assessed after

Correspondence: Dr Rooma Shahid, Department of Orthodontics, Armed Forces Institute of Dentistry, Rawalpindi-Pakistan
Received: 31 Oct 2020; revision received: 15 Feb 2021; accepted: 24 Feb 2021

ten days by using a Vernier calliper and brass wire with a millimetre ruler. Two measurements were taken on the tenth day with the same examiner for repeatability.

METHODOLOGY

The comparative cross-sectional study was carried out at the Orthodontics Department of the Armed Forces Institute of Dentistry, Rawalpindi Pakistan, from September 2019 to December 2019. Before the study, a permission was taken from the Ethical Review Committee of the Armed Forces Institute of Dentistry (AFID), Rawalpindi (Reference number: 905/Trg-ABP1k2).

Inclusion Criteria: Dental casts of patients were included in the study who had no previous history of orthodontic treatment had no previous major dental treatment (prosthetic crowns, large fillings), and all the permanent teeth erupted in the mandibular arch up to the first molar, as measurements only include teeth up to first molars.

Exclusion Criteria: Patients presenting with a history of medication that could affect craniofacial growth or unilateral or bilateral crossbite cases were excluded from the study.

A blinding technique was used to minimize the bias by selecting study casts on the basis of their file numbers and a single examiner was trained to measure the space available in the mandibular arches by two techniques: 1) with the Vernier calliper and 2) by using brass wire.[11]

Using the first technique described by previous researchers,[12] measurements were taken by dividing the entire mandibular arch into four compartments, from the starting point on the mesial side of the first molar to the ending point on the mesial side of the first molar of the homologous arch. The four compartments distributed throughout the arch were as follows; 1) The contact point between the first molar and second premolar, up to the canine and lateral incisor of the arch, 2)The contact point between the lateral incisor and canine, up to the mid-point between the central incisors, 3)The same procedure was repeated on the opposite side of the mandibular arch for the measurements (Figure-1).

The second method used for measurements as shown in Figure-2, was brass wire by turning around the entire arch passing through their contact points from the mesial surface of one first molar up to the mesial surface of the other first molar, and then measuring the length by millimetre ruler, by straightening the wire.

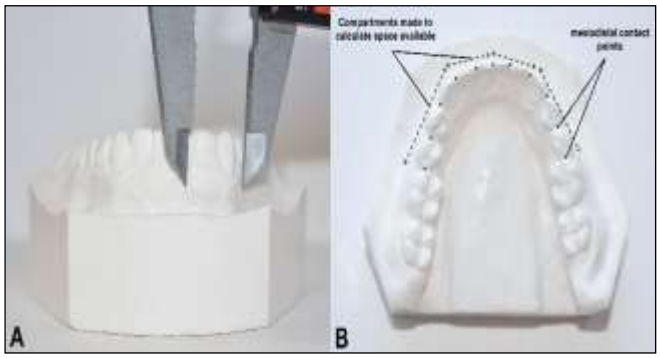

Figure-1: (A) Compartment measurement using Vernier caliper. (B) Distribution of dental arch into four compartments to obtain space available

Figure- 1: Brass Wire Adapted Around The Entire Arch From The Mesial Surface Of Right First Molar To The Mesial Surface Of Left First Molar For Calculation Of Space Available Using A Millimeter Ruler

Statistical Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. The measurements taken by the examiner were repeated after ten days using the two instruments (Vernier calliper and brass wire) by taking two readings each at the same time. The results obtained first were compared with those obtained after ten days by the same observer using paired t-test. The *p*-value lower than or up to 0.05 was considered as significant.

RESULTS

Out of 75 dental casts of the patients, 36(48%) were males, and 39(52%) were females. Although the age range was between 12-25 years (mean age 18.5 years), 60% of the total samples were between the 12-18 year age group, and 40% were between the 18-25 year age group. Table-I illustrates mean values by using space available at time 0, the average of the two measurements of space available on day 10, space available after ten days, and duplicate readings for

space available after ten days by digital Vernier calliper and brass wire method. Table-II states the mean values using the two measuring methods (Vernier calliper and brass wire with millimetre ruler) and then assessing the reproducibility by paired sample t-test. No difference was found in the readings using the two instruments.

Table-I : Means Space Available by Digital Vernier Caliper and Brass Wire with Millimeter Ruler (n=75)

Parameters		Mean±SD
Vernier Caliper	Space available at time 0	65.17±4.67
	Average of the two readings taken after 10 days	65.18±4.68
	Space available after 10 days (first reading)	65.18±4.69
	Space available after 10 days (second reading)	65.17±4.67
Brass Wire	Space available at time 0	68.48±7.64
	Average of the two readings taken after 10 days	70.65±6.01
	Space available after 10 days (first reading)	70.62±5.95
	Space available after 10 days (second reading)	70.68±6.07

Table-II: Pre- Readings (at time 0) and Post- Readings (After 10 Days) by using Vernier Caliper, and Brass Wire with Millimeter Ruler (n=75)

Parameters	Pre-readings of Space Available (At Time 0) Mean±SD	Post-readings of Space Available (After 10 Days) Mean±SD	*p*-value
Vernier caliper	65.17 ± 4.67	65.18 ± 4.68	0.299
Brass wire with millimeter ruler	68.48 ± 7.64	70.65 ± 6.01	0.021

Table-III explains the repeatability using the two instruments (Vernier calliper and brass wire with millimetre ruler). The two readings were taken simultaneously on day ten and were compared using paired t-test.

DISCUSSION

Repeatability and reproducibility of the dental casts of patients are measured in this study to evaluate the systematic and random errors. Proper commitment with single-mindedness and investment of enough time is required to analyse errors.[11] Repeatability can be measured only if the procedure is carried out under constant conditions, including location, measuring tool, observer, and period to control the cofounders.[12] While reproducibility of the results of a study can be obtained by carrying out the whole procedure again under varying conditions.[13] Reliability includes both repeatabilities and reproducibility. However, the repeatability of results was more relevant than the reproducibility.[5,14,15] In the current study, 75 dental casts of the patients were included to assess the reproducibility and repeatability.

For reproducibility, paired t-test was used to compare the mean values of the two measurements. For this purpose, two measurements were taken at the same time under the same conditions on day ten and were compared by using the same test, i.e., paired t-test. No significant difference was found while measuring the two sets of observations using Vernier calliper, i.e. *p*-value was greater than 0.05. Results were the same after ten days. However, the measurements were less than those taken after ten days. The confounding factors in the surroundings were controlled to minimize any bias. When the readings using brass wire with a millimetre ruler were taken, there was a statistically significant difference between the first and second sets of measurements. The *p*-value was found to be less than 0.05 (i.e., 0.021). Some uncontrolled confounding factors, such as operator expertise, and temperature, might have been there. This method might contain other confounding factors in it.

İrezli *et al.* explained that intra-observer results are found to be reliable. However, the reproducibility of results regarding esthetics is found to be maximum in orthodontists compared to other groups, including general dentists, oral maxillofacial surgeons, laypeople and postgraduate students.[16] LA Macahdo *et al.* stated that the irregularity index measurements found high correlations between the two examiners. Furthermore, the consistency of researchers was found while taking repeated measurements.[17]

For random errors, the readings with Vernier calliper were less than 1mm (0.01 between the space available at time 0 and between the two readings taken for the space available on day 10). The results with the brass wire method were 0.32 and 0.10 between 'space available at time 0' and 'average of the two readings at day 10; and between the two readings measured for the space available on day ten, respectively. Hence, there was no statistical difference between the second measurements of brass wire and millimetre ruler. Another study stated that random errors are found to be minimal with the use digital Vernier calliper as compared to that of the brass wire method, which is supported in this study too.[18] Mok *et al.* stated that while comparing the results using the two instruments, Vernier calliper and brass wire with a millimetre ruler, there was a statistically significant difference in the

intra-observer values for the maxillary arch, while there was no significant difference for mandibular arches.[19] Moreover, sonic digitization and digital calliper were introduced to analyse the dental arches' space. In addition, the digital calliper was a better option than sonic digitization.[20] Intra-examiner repeatability and inter-examiner reproducibility were highly correlated with manual & computerized cephalograms.

CONCLUSION

The current study concluded that the Vernier calliper is more precise in measuring the readings in orthodontics for arch space measurement than that of brass wire with a millimetre ruler. However, the brass wire method can also take the readings.

Conflict of Interest: None

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

RS & AJ: Study design, drafting the manuscript, critical review, approval of the final version to be published.

AF & ATM: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

FG & SM: Conception, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Altug-Atac AT, Erdem D. Prevalence and distribution of dental anomalies in orthodontic patients. Am J Orthod Dentofacial Orthop 2007; 131(4): 510-514. doi: 10.1016/j.ajodo.2005.06.027.
2. Ender A, Zimmermann M, Attin T, Mehl A. In vivo precision of conventional and digital methods for obtaining quadrant dental impressions. Clin Oral Investig 2016; 20(7): 1495-1504.
3. Glisic O, Hoejbjerre L, Sonnesen L. A comparison of patient experience, chair-side time, accuracy of dental arch measurements and costs of acquisition of dental models. Angle Orthod 2019; 89(6): 868-875. doi: 10.2319/020619-84.1.
4. Beazley WW. Assessment of mandibular arch length discrepancy utilizing an individualized arch form. Angle Orthod 1971; 41(1): 45-54. doi: 10.1043/0003-3219(1971)041<0045:Aomald>2.0.CO;2.
5. AD McNaught, A. Wilkinson. Compendium of Chemical Terminology. The Gold Book. Edition 2nd, United Kingdom; 1997, [Internet] availble at: https://goldbook.iupac.org/
6. Lauweryns I, van Cauwenberghe N, Carels C. Interobserver and intraobserver agreement of clinical orthodontic judgments based on intraoral and extraoral photographs. Angle Orthod 1994; 64(1): 23-30. doi: 10.1043/03-3219(1994)064<23:Iaiaoc>2.0.CO;2.
7. Heil A, Lazo Gonzalez E, Hilgenfeld T, Kickingereder P, Bendszus M, Heiland S, et al. Lateral cephalometric analysis for treatment planning in orthodontics based on MRI compared with radiographs: A feasibility study in children and adolescents. PLoS One 2017; 12(3): e0174524. doi: 10.1371/journal.pone.0174524.
8. Sam A, Currie K, Oh H, Flores-Mir C, Lagravére-Vich M. Reliability of different three-dimensional cephalometric landmarks in cone-beam computed tomography : A systematic review. Angle Orthod 2019; 89(2): 317-332. doi: 10.2319/042018-302.1.
9. Helmenstine AM. ThoughtCo. Random Error vs. Systematic Error. [Internet] available at: https://www.thoughtco.com/ random-vs-systematic-error-4175358 [Accessed on June 28, 2020].
10. Feinstein MM, Pannunzio AE, Castro P. Frequency of medication error in pediatric anesthesia: A systematic review and meta-analytic estimate. Paediatr Anaesth 2018; 28(12): 1071-1077. doi: 10.1111/pan.13521.
11. Moshkelgosha V, Khosravifard N, Golkari A. Tooth eruption sequence and dental crowding: a case-control study. F1000Res 2014; 3(1): 122. doi: 10.12688/f1000research.3196.1.
12. Ruairi J. Technology Networks. Repeatability vs. Reproducibility. [Internet] available at: https://www.technologynetworks.com/informatics/articles/repeatability-vsreproducibility-317157. [Accessed on June 28, 2020]
13. Kale Varlık S, Uzuner D, Tortop T. Assessment of agreement between molar landmarks: Repeatability, reproducibility, and comparability. Am J Orthod Dentofacial Orthop 2016; 150(3): 504-510. doi: 10.1016/j.ajodo.2016.02.029.
14. Baysal A, Sahan AO, Ozturk MA, Uysal T. Reproducibility and reliability of three-dimensional soft tissue landmark identification using three-dimensional stereophotogrammetry. Angle Orthod 2016; 86(6): 1004-1009. doi: 10.2319/120715-833.1.
15. Gehrke P, Lobert M, Dhom G. Reproducibility of the pink esthetic score--rating soft tissue esthetics around single-implant restorations with regard to dental observer specialization. J Esthet Restor Dent 2008; 20(6): 375-384; discussion 385. doi: 10.1111/j.1708-8240.2008.00212.x.
16. İrezli EC, Şahin MF, Demir R, Baysal A. Intra-examiner and Inter-examiner Reproducibility in Irregularity Index Measurements. Turk J Orthod 2019; 32(3): 160-164.
17. Machado LA, Vilella OD, Agostinho LM. Evaluation of two techniques to measure the available space in the mandibular dental arch using the method error. Revista Odonto Ciência 2012; 27(3): 228-232. doi:10.1590/S1980-65232012000300010.
18. Leifert MF, Leifert MM, Efstratiadis SS, Cangialosi TJ. Comparison of space analysis evaluations with digital models and plaster dental casts. Am J Orthod Dentofacial Orthop 2009; 136(1): 16.e1-4; discussion 16. doi: 10.1016/j.ajodo.2008.11.019.
19. Mok KH, Cooke MS. Space analysis: a comparison between sonic digitization (DigiGraph Workstation) and the digital caliper. Eur J Orthod 1998; 20(6): 653-661. doi: 10.1093/ejo/20.6.653.
20. Ajay SA, Dhananjaya G, Anandakrishna L. Evaluation of Repeatability and Reproducibility of Manual and Computerized Methods for Cephalometric Analysis. J Dental Orofacial Res 2018; 14(02): 10-15.