The bow divider is an appropriate method to space measurement in mixed dentition by undergraduate students

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Abstract

Background: The mixed dentition (MD) phase is dynamic and prone to disturbances in its normal development that might result in a decrease of the perimeter of the dental arch. None of the analyses of MD is sufficiently accurate, especially for undergraduate students. **Objective:** The objective of this study was to compare two measuring instruments used to determine the leeway space: brass wire (BW) and bow divider (BD), to verify whether the two methods are equivalent or whether one is more accurate for undergraduate students. **Methods and Materials:** Five undergraduate students from the Dental School, Federal University of Pelotas, and an orthodontist expert (the gold-standard) performed the measurement of leeway space using BW and BD on the inferior dental arch in thirty-five plaster models. A Bland-Altman and paired Student t test were used for statistical analysis. **Results:** Both methods showed statistical agreement. No significant statistical difference was obtained in the measurements of the BD method between the gold-standard and the students measurements. However, there was a difference between the gold standard measurements and two students' measurements using the BW method. **Discussion:** The results show the high practicality and simplicity of the BD method. **Conclusions:** Both methods are equivalent when used by trained professionals, but the BD method is more accurate for undergraduate students. **Clinical significance:** The selection of a easily and reliable method for orthodontic measurements by beginner professionals.

Keywords: brass wire, bow divider, leeway space, measurements, mixed dentition

Short Title: Bow divider is a method for undergraduate students

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Introduction

The mixed dentition (MD) is a dynamic phase subject to disturbances in its normal development, its analysis being an important aspect for orthodontic diagnosis and treatment planning.[1] The main perturbation in MD is the early loss of deciduous teeth leading to a decrease in arch perimeter and in space for the correct alignment of the permanent teeth, causing malocclusion.[1] In orthodontic evaluation, the models of dental records are a main source of information as they allow a thorough assessment, complementary to the clinical examination.[2] The plaster models are used to determine the relationship between the amount of available space in the dental arch (leeway space) and the amount of required space for the proper alignment of all permanent teeth.[2,3]

The bow divider (BD) and brass wire (BW) are recommended methods to analyze the leeway space through plaster models in MD.[3] This space is determined by the available value in millimeters for the eruption of permanent teeth which are mesially positioned to the first permanent molars.[3] The BD method evaluates the dental arch dividing the model in segments and the BW assesses the entire arch of the mesial molar to the other side.[9] Due to the technical variability of both methods, the importance of evaluating an accurate, more practical and simpler measurement method is essential. This effort can minimize the errors as well as the distortion of the results, and does not compromise the diagnosis, the treatment plan, and consequently the prognosis. The objective of this study was to compare two measurement tools, BW and BD, used to determine the leeway space in MD, and to verify whether the two methods are equivalent, and which is performed with greater accuracy by dentistry undergraduate students.

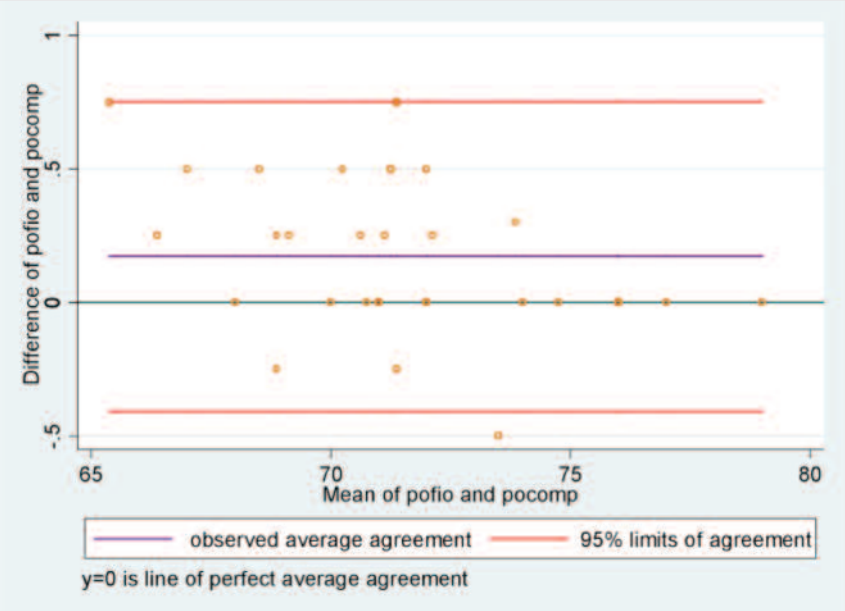

Chart 1 - Bland-Altman plot of concordance analysis of measurements obtained by the gold standard. Mean difference: 0.17mm (p value = 0.0004¬).

Materials and methods

This study was carried out at the Dental School of the Federal University of Pelotas, Pelotas, Rio Grande do Sul, Brazil. Five undergraduate students and a professor of orthodontics performed two techniques of measuring the leeway space and the available space of the lower dental arch in plaster models. The methods used were BW and BD. Thirty-five plaster models of the lower dental arch of patients in the MD phase were selected from the archives of the orthodontic clinic of the Pelotas Dental School with no additional information. The models were identified by numbers from 01 to 35; the examiners were identified by capital letters: A, B, C, D, E, and gold-standard.

All examiners were supervised by the gold standard to perform the research. The dental arch was measured to evaluate the leeway space with the BW (0.027" inch diameter, Morelli) passing over the buccal cusps and incisor edges of the lower teeth from the mesial surface of the first permanent molar on one side to the mesial surface of the first permanent molar on the opposite side. The wire was bent and measured with a millimeter ruler. The values obtained were recorded on an annotation card. To evaluate the leeway space with the BD, the plaster model was divided into six sections: from the mesial contact point of the first permanent molar to the mesial of the first deciduous molar; from the mesial contact point of the first deciduous molar to the distal contact point of lateral incisor, and from the distal contact point of lateral incisor to the contact point between central incisors. The same areas were completed on the opposite side. All measurements were transferred to the annotation card and the sum of the values indicated the leeway space.

Two separate measurements of the thirty-five plaster models were taken by the gold standard, and the average of each was calculated using both methods. These averages constituted the standard values which allowed the comparison between the two methods for the gold-standard themselves, as well as the comparison between the gold standard (professor of orthodontics) and other examiners (undergraduate students), in both methods. The gold-standard means were subjected to Bland-Altman statistical analysis to assess the agreement between the two methods, BW and BD. Using the paired Student's t-Test, the comparison of the means of the measurements between the gold standard and the undergraduate students was analyzed. A significance level of 0.05 was considered for both statistical tests.

Results

The measurements for the two methods obtained by the gold standard and the five examiners are shown in Table 1. The average values of the gold-standard for the BW and BD are shown in Table 2. No statistical difference was observed between the two methods for the gold-standard measurements (p=0.82). Moreover, a correlation of 99.4% was found between the two methods, with a mean difference of 0.17 mm (Chart 1 and 2).

No significant statistical difference was found between the measurements for the BD method between the gold-standard and undergraduate students. Nevertheless, with regard to the BW method, statistically significant differences were found between the specialist and two undergraduate examiners: C (value p = 0.0389) and D (value p =

Table 1 – Measurements obtained by the examiners in thirty-five plaster models.

Model	Measurement method	Gold Standard 1st measurement	Gold Standard 2nd measurement	Examiner A	Examiner B	Examiner C	Examiner D	Examiner E
1	Bow divider	74.0	74.0	73.0	74.0	74.0	74.0	73.0
	Brass wire	74.0	74.0	74.5	74.0	72.0	72.0	75.0
2	Bow divider	73.5	74.0	73.0	74.0	72.0	73.0	72.0
	Brass wire	74.0	74.0	72.0	75.0	71.0	70.0	72.0
3	Bow divider	68.0	68.0	69.0	67.0	69.0	71.5	67.0
	Brass wire	68.0	68.0	65.0	67.0	67.0	68.0	67.0
4	Bow divider	71.5	71.5	70.0	74.0	71.0	68.0	70.0
	Brass wire	71.0	71.5	70.5	75.0	69.5	69.0	70.0
5	Bow divider	70.5	70.5	70.0	71.0	72.5	70.0	70.0
	Brass wire	71.0	70.5	71.5	71.5	70.0	69.0	72.0
6	Bow divider	72.0	72.0	71.0	72.0	71.5	71.0	70.5
	Brass wire	72.0	72.0	72.0	72.0	70.0	69.5	71.0
7	Bow divider	71.0	71.0	71.0	69.0	70.5	70.0	70.0
	Brass wire	71.0	71.0	73.0	72.0	72.0	71.0	79.0
8	Bow divider	70.5	71.0	70.0	69.5	69.5	71.0	69.0
	Brass wire	71.0	70.5	72.0	72.0	71.0	68.0	72.0
9	Bow divider	76.0	76.0	75.5	77.5	71.0	74.0	75.5
	Brass wire	76.0	76.0	75.0	77.0	73.0	73.0	74.5
10	Bow divider	68.0	68.5	68.0	68.5	69.0	68.0	69.0
	Brass wire	68.5	69.0	70.0	70.0	69.0	67.0	69.0
11	Bow divider	72.0	72.0	72.0	72.0	71.0	72.0	71.5
	Brass wire	72.0	72.0	72.0	73.0	71.0	70.0	71.0
12	Bow divider	71.5	72.0	69.5	71.0	71.5	70.0	69.0
	Brass wire	72.0	72.5	71.5	71.0	70.0	69.0	70.0
13	Bow divider	77.0	77.0	75.0	76.0	75.0	73.0	75.0
	Brass wire	77.0	77.0	73.0	76.0	74.0	73.5	73.5
14	Bow divider	71.0	71.0	72.5	72.0	71.0	72.0	70.0
	Brass wire	71.0	71.0	72.0	72.0	71.0	69.5	72.0
15	Bow divider	76.0	76.0	74.0	76.0	75.0	75.0	75.0
	Brass wire	76.0	76.0	72.0	77.0	74.5	72.0	73.0
16	Bow divider	70.0	70.0	68.5	69.0	69.0	69.0	69.0
	Brass wire	71.0	70.0	69.5	70.0	67.0	68.0	69.5
17	Bow divider	76.0	76.0	72.0	77.0	75.0	72.0	74.0
	Brass wire	76.0	76.0	75.0	77.0	75.0	73.0	75.0
18	Bow divider	66.0	66.5	66.0	67.0	67.0	66.0	65.0
	Brass wire	66.5	66.5	68.5	66.0	66.0	64.0	65.5
19	Bow divider	72.0	72.0	72.0	72.5	72.0	73.0	71.0
	Brass wire	72.0	72.5	72.0	72.0	71.0	70.0	71.5
20	Bow divider	71.0	71.0	73.0	71.0	70.0	71.0	71.0
	Brass wire	71.5	71.0	72.0	72.0	68.0	68.0	70.5
21	Bow divider	73.5	74.0	73.0	78.0	75.0	73.5	72.0
	Brass wire	73.0	73.5	76.0	78.0	74.0	73.0	70.0
22	Bow divider	74.5	75.0	73.0	74.0	73.0	74.0	72.0
	Brass wire	74.5	75.0	75.0	75.0	73.0	73.0	74.0
23	Bow divider	79.0	79.0	77.0	73.0	77.0	78.0	76.5
	Brass wire	79.0	79.0	77.0	79.0	77.0	76.0	80.0
24	Bow divider	70.0	70.0	69.0	70.5	69.0	67.5	69.5
	Brass wire	70.0	70.0	70.0	71.0	68.5	68.0	69.5
25	Bow divider	71.0	71.0	69.0	71.0	68.5	69.0	68.0
	Brass wire	71.5	72.0	71.0	70.0	68.0	68.5	69.0
26	Bow divider	76.0	76.0	75.0	76.0	76.0	74.0	76.0
	Brass wire	76.0	76.0	76.0	75.0	73.0	74.0	76.0
27	Bow divider	69.0	69.0	68.0	69.0	69.0	67.5	69.0
	Brass wire	69.5	69.0	73.0	69.0	70.0	68.5	69.0
28	Bow divider	66.5	67.0	65.5	68.5	66.0	66.0	65.0
	Brass wire	67.5	67.0	66.0	65.0	64.0	65.0	64.5
29	Bow divider	71.0	71.0	70.0	70.0	69.5	69.0	70.0
	Brass wire	72.0	71.0	74.0	70.0	72.0	70.0	72.0
30	Bow divider	68.5	69.0	68.5	69.0	70.0	68.0	67.5
	Brass wire	69.0	69.0	69.0	68.0	67.0	66.0	66.0
31	Bow divider	71.0	71.0	70.0	70.0	69.0	70.0	70.0
	Brass wire	71.0	71.0	71.0	71.0	70.0	70.0	70.0
32	Bow divider	69.0	69.0	69.0	69.0	69.0	69.0	69.0
	Brass wire	68.5	69.0	69.0	70.0	68.0	68.5	68.0
33	Bow divider	71.0	71.0	70.0	69.0	69.5	69.0	71.0
	Brass wire	72.0	71.0	74.0	72.0	70.5	71.0	73.0
34	Bow divider	71.0	71.0	68.5	66.5	67.0	66.0	68.0
	Brass wire	72.0	71.5	68.0	66.0	67.0	67.0	68.0
35	Bow divider	65.0	65.0	66.0	65.0	67.0	65.0	63.0
	Brass wire	66.0	65.5	65.0	65.0	65.0	63.0	65.5

Table 2 - Average of measures obtained by Gold Standard (real difference in millimeters). T-Student test (p = 0.82).

No	Bow Divider	Brass Wire	Difference
1	74	74	0
2	73.75	74	-0.25
3	68	68	0
4	71.5	71.25	0.25
5	70.5	70.75	-0.25
6	72	72	0
7	71	71	0
8	70.75	70.75	0
9	76	76	0
10	68.25	68.75	-0.5
11	72	72	0
12	71.75	72.25	-0.5
13	77	77	0
14	71	71	0
15	76	76	0
16	70	70.5	-0.5
17	76	76	0
18	66.25	66.5	-0.25
19	72	72.25	-0.25
20	71	71.25	-0.25
21	73.75	73.25	0.5
22	74.75	74.75	0
23	79	79	0
24	70	70	0
25	71	71.75	-0.75
26	76	76	0
27	69	69.25	-0.25
28	66.75	67.25	-0.5
29	71	71.5	-0.5
30	68.75	69	-0.25
31	71	71	0
32	69	68.75	0.25
33	71	71.5	-0.5
34	71	71.75	-0.75
35	65	65.75	-0.75

0.0027). Table 3 shows the measurements of the five examiners compared with the gold standard for both methods.

Table 3 - Unpaired t-test difference of means of the gold standard and the examiners for bow divider and brass wire methods.

Examiner	Bow Divider (p)	Brass Wire (p)
A	0.2440	0.8501
B	0.7907	0.8946
C	0.3224	0.0389
D	0.1573	0.0027
E	0.1067	0.3821

Discussion

The diagnosis of perturbations in the MD is essential due to its transient and preceding role of MD before the permanent dentition characterized by occlusion maturation.[2] Diverse events occur at this time, therefore prevention and interception of future malocclusions may be decisive. For this, it is possible to predict the course of the development of the occlusion by using specific methods for the analysis of MD since two or three millimeters of the real discrepancy may compromise the treatment plan.[2]

Based on the importance of choosing an accurate method of measuring the difference between the leeway space in the dental arches and the space required for permanent teeth eruption, different methods have been described in the literature.[2,3,4] Nevertheless, there is no consensus about which is the most appropriate method; which one presents minimum systematic error; and whether both can be performed with equal safety by the novice and the specialist.[5,6,7] Furthermore, no article in the English literature has previously compared these methods.

In the present study, the analysis of BW and BD, the most used daily tools in the undergraduate clinic, revealed no statistically significant difference between the two methods for the specialist. The difference between the two methods was 0.17mm which has no clinical relevance in relation to efficiency between the both methods. Thus, this concordance may be attributed to the experience and skill of the orthodontist, due to high training and frequent use of these tools.

However, the measurements from the BW method revealed a statistically significant difference between two undergraduate students in relation to the standard examiner. inexperience of the students in handling the brass wire correctly to get around the dental arch. Although the BW has been considered by some authors as the most efficient and reliable method of measurement,[5] there are differences between the methods with regard to the ease of execution, an aspect that was evident in the present study. On the other hand, the measurements with BD did not show a statistically significant difference between the specialist and the students. These results are in concordance with the findings obtained by other authors, indicating the high practicality and simplicity of this method.[7] Thus, the most convenient method of learning the orthodontic process in the dental school might be the BD, due to easier handling by beginners.

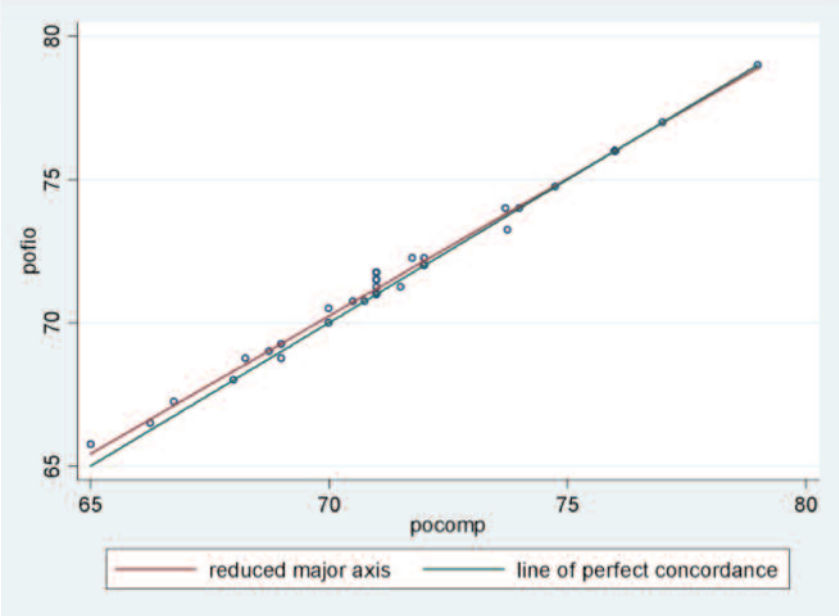

Chart 2 - Bland-Altman plot of concordance analysis. 99.4% of agreement.

Conclusion

Although previous studies on topic are scarce in the English Literature, we considered that using the BD method of measuremnet is more accurate than the BW for undergraduate dental students. Thus, this method is recommended for less trained professionals in order to minimize errors in performing space measurement in orthodontics. However, it should be emphasized that both methods are equivalent to evaluate the leeway space through the plaster models of patients in the MD when performed by trained professionals.

Conflicts of interest

The authors declare no conflicts of interest.

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