10.5005/jp-journals-10024-1176

ORIGINAL RESEARCH

Evaluation of the Cadiax Compact® II Accuracy in Recording Preadjusted Condylar Inclinations on Fully Adjustable Articulator

Ahmad Hasan Ahangari, Kianoosh Torabi, Sasan Rasaei Pour, Safoura Ghodsi

ABSTRACT

Background: Mandibular movement analysis is a critical step in making the functional occlusal morphology and improving the diagnosis and treatment of temporomandibular joint disorders (TMDs). Cadiax Compact® is an electronic condylograph that claims to record the horizontal condylar inclination (HCI), Bennett angle (BA) and relative shape of the articular eminence. This study aims at assessing the accuracy of Cadiax Compact® II in its claimed abilities.

Materials and methods: The electronic condylograph (Cadiax Compact®II) was fitted on the fully adjustable articulator (gamma dental reference- SL). After setting of HCI and BA on the arbitrary degrees, eccentric movements were produced manually on the articulator. The Cadiax recorded these preadjusted angles and the accuracy of its recordings was assessed by comparison of the results with the preadjusted HCI, BA and color inserts as references.

Results: The majority of the comparisons showed statistically significant differences between articulator settings and Cadiax recordings. However, the maximum difference was about 2.5^0 which seems acceptable for clinical practice.

Conclusion: The obtained results showed that Cadiax Compact is an accurate and reliable instrument for diagnostic purposes, yielding reproducible measurements. Despite this, Cadiax is a technically sensitive device that can preclude its routine usage.

Keywords: Articulator, Axiography, Recording, Condylography, Mandibular movement.

How to cite this article: Ahangari AH, Torabi K, Pour SR, Ghodsi S. Evaluation of the Cadiax Compact® II Accuracy in Recording Preadjusted Condylar Inclinations on Fully Adjustable Articulator. J Contemp Dent Pract 2012;13(4):504-508.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

Using the information resulting from the patients' jaw movements, dentists can reproduce occlusal surface forms of the restorations in accordance with the patient's teeth and available restorations.[1] These data can also be used for articulator settings,[2] improving of the diagnosis and treatment of temporomandibular joint disorders (TMDs),[3] and analysis of the patient's occlusion.[4]

The procedures of condylar inclination recording can be divided to three main methods: (1) radiographic methods, (2) extraoral tracing methods and (3) intraoral recording methods.[5,6]

Numerous approaches have been reported to record mandibular movements.[7-10] For many years the prosthodontists used interocclusal wax records for condylar guidance setting.[11] Berman questioned the accuracy of this method.[12]

The mechanical condylograph (axiograph) was introduced by Slavicek.[13] It is supported to improve and simplify the recording of the condylar path by tracing precisely the translation of the condyle.[1] Electronic pantograph was introduced in 1983 under the name of pantronic (Denar Corporation-Anaheim-Calif)[14] to minimize errors occurring in the transferring procedure and to improve the efficiency.[15]

Initial *in vivo* studies of pantronic by Clyton et al indicated that the device is accurate and reliable.[14,16] In 1986, in a study entitled as 'comparison of an electronic and a mechanical pantograph,' the authors concluded that the electronic pantograph's ability to record the articulator setting consistently was comparable to that of the mechanical pantograph. They claimed that the advantages of pantographic are rapid, sequential recording and elimination of the transferring procedure to set the articulator.[17]

In an *in vitro* study in 1987, it was shown that the electronic pantograph provided an accurate and reliable means of recoding immediate side shift, progressive side shift and protrusive condylar inclination.[15]

Price in 1988 compared electronic pantograph and interocclusal lateral records and showed that occlusal morphologic errors resulting from the use of electronic pantograph are fewer than interocclusal records.[18] Miller in 1992 demonstrated a high correlation of both the electronic method of recording (Cadiax: 1.7 D-Gamma Co-Vienna-Austria) and the mechanical one.[19]

In 2002, Celar and Tamaki evaluated the accuracy of recoding horizontal condylar inclination (HCI) and Bennett angle (BA) with Cadiax Compact 1.33. They used Artex articulator and concluded that electronic registrations used to set the articulator control are helpful in clinical practice.[20]

Chang and colleagues in 2004 showed that electronic pantograph had sufficient validity and reliability for HCI and BA and posterior and superior eminence inclinations recordings.[21]

Moreover, in 2008, Mantout, using Cadiax 5.12 and fully adjustable articulator (SAM2-SAM prazision- Stechnik co-Munich- Germany), reported slight differences between the adjusted angle on the bench and the computerized mean angle (± 0.5°) that confirmed the accuracy needed in clinical practice.[1]

This study evaluates the accuracy, reliability and reproducibility of the electronic pantograph records by comparing the preset HCI, BA and anatomic color inserts on a fully adjustable articulator (Gamma dental reference-SL) and the Cadiax Compact®II measurements. Our null hypothesis is that Cadiax records are statistically very close to preadjusted value, and this relatively complicated instrument has no statistically significant error.

MATERIALS AND METHODS

The electronic pantograph was assembled with an intermediate portion to the fully adjustable articulator parallel to its upper jaw. The intermediator was constructed to attach the upper face bow portion of Cadiax and the flags to the upper jaw of the articulator and simulate the clinical condition. The lower face bow was assembled to the lower jaw of the articulator. This bow carried recording styli aligned with articulator hinge axis. The incisal pin height was set to 0 mm and flat incisal table was used (Fig. 1).

Three different groups of recording were evaluated in different sessions by the same operator to eliminate inter-operator bias:

In group 1, the right HCI was set on 20° and the left one on 30°. The BAs was set according to the formula (H/8+ 12) on 14° and 16° respectively. The flat zero degree inserts (blue for HCI and white for side shift) were used. In group 2, the right and left HCLs were set on 50° and BAs were set on 18° according to the related formula. Blue inserts were used for HCI and white for side shift.

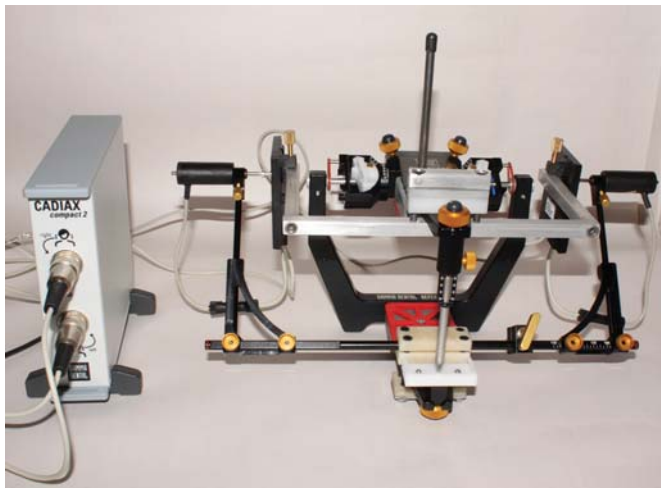

Fig. 1: The condylograph recording apparatus have been assembled on fully adjustable articulator for computerized recording of hinge axis movements

In these two groups, the flat inserts were used for HCI and side shift to reduce the number of variables. But for evaluating the claimed ability of Cadiax in diagnosis of anatomic shape of the articular eminence, a third group was added with the following setting:

The right HCI was set on 20° and right BA on 14°. Left HCI was set on 30° and left BA on 16°. Red horizontal inserts were used for HCI and yellow for the side shift on both sides.

The protrusive and latrotrusive movements were made manually up to 11 mm of the translation (Fig. 2). In the Cadiax software, intercondylar distance was set on 150 mm corresponding to the measurement on the articulator. Before recoding each movement, the software was calibrated (Zero represented the closed articulator position at CR).

Twenty sets of protrusive and latrotrusive movements were recorded for each group and at the end of each set, the measured angels and inserts were read at 10 mm from the

Fig. 2: The excursive movements were made manually up to 11 mm of the translation

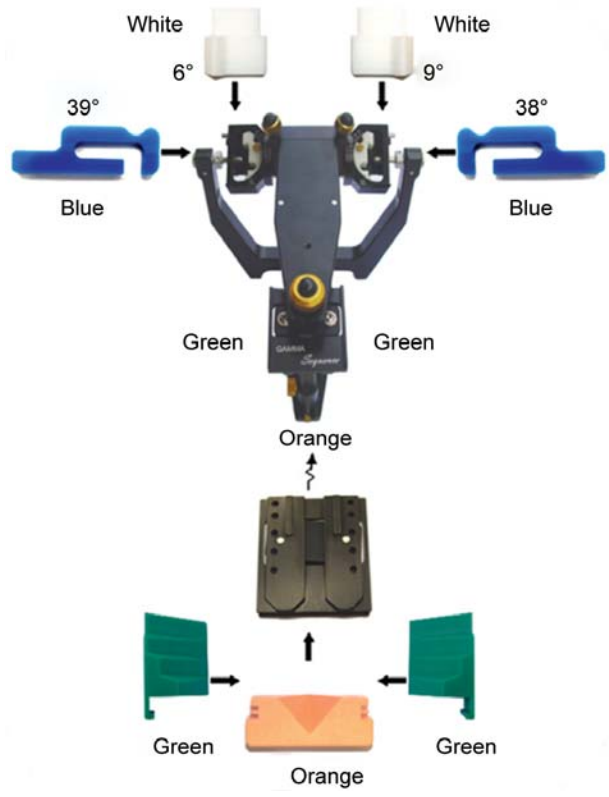

Fig. 3: The measured angles and inserts were read at 10 mm from the articulator setting option of the software

articulator setting option of the software (Fig. 3). Therefore, 20 sets of data were obtained for each group to be compared with reference preadjusted data.

RESULTS

Table 1 shows the detailed information of one of the groups (group 3). For each group the mean value, mean difference, paired t-test and the percentage of correct recordings for color inserts were assessed (Tables 1 to 3). The measured difference between Cadiax recordings and reference values ranged form (–0.8°) to (2.5°). The differences were statistically significant in all measurements except for right HCI and BA of the first group (HCI: 20° and BA: 14°) and Bennett settings of the third group (14° and 16°; $p > 0.05$).

The Cadiax diagnosed the color inserts in 93.3 of the instances correctly. The greatest error in color recognition was in the right horizontal insert of the third group (65% correct).

DISCUSSION

In this study, Cadiax Compact® II measured the preadjusted HCI and BA with the overall mean error of 0.44°. The Maximum mean error was 2.5° from the reference setting (group 3-left HCL). According to the literature, an error within 3.4° in the condylar setting seems acceptable for clinical use.[20] Using average quantities, graphic methods, or interocclusal records cause even more error in the articulator settings.[17,22-24]

Therefore, in this study although the majority of measurements differ significantly from the reference adjustment, the results appear acceptable for clinical practice

Table 1: Detailed information of angular and color assessments/statistical data

Group 3	*HCI*		*BA*		*Horizontal insert*		*Bennett insert*	
	Right: 20°	*Left: 30°*	*Right: 14°*	*Left: 16°*	*Right: Red*	*Left: Red*	*Right: Yellow*	*Left: Yellow*
1	20	33	13	15	Red	Red	Yellow	Yellow
2	19	32	14	16	Red	Red	Yellow	Yellow
3	19	34	13	16	Red	Red	Yellow	Yellow
4	18	32	14	16	Yellow	Red	Yellow	Yellow
5	20	33	14	17	Red	Red	Yellow	Yellow
6	19	32	15	18	Red	Red	Yellow	Yellow
7	19	33	13	15	Red	Red	Yellow	Yellow
8	19	32	14	16	Red	Red	Yellow	Yellow
9	20	33	14	17	Yellow	Red	Yellow	Yellow
10	19	32	15	17	Red	Red	Yellow	Yellow
11	19	33	14	16	Red	Red	Yellow	Yellow
12	19	32	15	17	White	Red	Yellow	Yellow
13	19	33	14	16	Red	Red	Yellow	Yellow
14	19	32	15	17	White	Red	Yellow	Yellow
15	20	33	10	14	Red	Red	Yellow	Yellow
16	19	31	12	16	White	Red	Yellow	Yellow
17	20	33	13	16	White	Red	Yellow	Yellow
18	19	32	14	17	Red	Red	Yellow	Yellow
19	19	33	13	16	Red	Red	Yellow	Yellow
20	19	32	14	17	White	Red	Yellow	Yellow
Mean	19.200	32.500	13.650	16.100				
Std.deviation	0.523	0.688	1.182	1.020				
Mean difference	–0.800	2.500	–0.350	0.100				
p	0.000	0.000	0.201	0.666				
Valid percent					65	100	100	100

Table 2: Statistical data of the second group

Group 2	*HCI*		*BA*		*Horizontal insert*		*Bennett insert*	
	Right: 50°	*Left: 50°*	*Right: 18°*	*Left: 18°*	*Right: Blue*	*Left: Blue*	*Right: White*	*Left: White*
Mean	50.950	51.350	17.200	17.700				
Std. deviation	0.394	1.460	0.615	0.571				
Mean difference	0.950	1.350	–0.800	-0.300				
p	0.000	0.001	0.000	0.030				
Valid percent					100	90	100	100

Table 3: Statistical data of the first group

Group 1	*HCI*		*BA*		*Horizontal insert*		*Bennett insert*	
	Right: 20°	*Left: 30°*	*Right: 14°*	*Left: 16°*	*Right: Blue*	*Left: Blue*	*Right: White*	*Left: White*
Mean	19.900	32.200	13.950	16.650				
Std. deviation	1.020	1.576	0.686	0.933				
Mean difference	–0.100	2.200	–0.050	0.650				
p	0.666	0.000	0.748	0.006				
Valid percent					85	80	100	100

and they will not cause noticeable errors in the occlusal morphology of restoration or other clinical diagnostic or treatment applications. Furthermore, the articulator settings obtained from the electronic pantograph showed more reproducibility compared with the mechanical pantograph or interocclusal records.[17,18]

In diagnosis of color inserts, the Cadiax showed 0 to 65% error. The mean diagnosis accuracy was higher than 90% but in the third group with nonflat, curved insert the mean error was greater. This was an *in vitro* study with precisely controlled conditions; so, we should expect even more errors in recording the patient's condylar inclinations and anatomy in the clinical situations. Although the results appear clinically acceptable but the majority of the measurements were statistically significant and this rejects our null hypothesis. A part of these errors lies in the technical sensitivity of the electronic pantograph. The least contamination on the sensitive plates (flags) can cause clear errors in recording.

It appears that change in the mouth's opening degree during excursive movements can cause significant errors, because it changes the relative position of styli to flags. Furthermore, adjustment of HCI can cause added inaccuracy because this articulator has not clear stop for inclination values.

Yet, according to the maximum mean error observed in this study (2.5°) and insignificance of such errors in clinical practice, Cadiax Compact® II can be considered an acceptable and accurate device to set the fully/semiadjustable articulators.

This finding is in agreement with the results of Mantout,[1] Celar,[20] Anderson[14] and Miller's studies.[19]

CONCLUSION

The accuracy of Cadiax Compact® II in recording pre-adjusted articulator guidance on Gamma dental reference articulator was evaluated and the following conclusions were reached:

1. Cadiax Compact® II can be used as an accurate and reliable instrument for recoding condylar inclinations and relative anatomy of condylar guidance in clinical practice.
2. Cadiax Compact is a technical sensitive device that can cause errors if not concentrated on details. This issue makes the clinical usage problematic. There may be other instruments with more simplicity and less technical sensitivity for routine clinical use.
3. Cadiax Compact results are reproducible and accurate; these characteristics make this instrument a reliable device for research purposes.

ACKNOWLEDGMENT

The authors would like to thank Dr Nasrin Shokrpour at Center for Development of Clinical Research of Nemazee Hospital for editorial assistance.

REFERENCES

1. Mantout B, Giraudeau A, Perez C, Ré JP, Orthlieb JD. Technical validation of a computerized condylographic system. Int J Stomat Occ Med 2009;1:45-50.
2. Slavicek R. Clinical and instrumental functional analysis for diagnosis and treatment planning. Part 5. Axiography. J Clin Orthod 1988;22:656-67.
3. Piehslinger E, Celar AG, Celar RM, Slavicek R. Computerized axiography: Principles and methods. Cranio 1991;9:344-55.

4. Guichet NF. Applied Gnathology: Why and how. Dent Clin North Am 1969;13:687-700.
5. Rosenstiel SF, et al. Contemporary fixed prosthodontics (4th ed), Mosby: Elsevier; 2006. Ch 1.
6. Curtis DA. A comparison of protrusive interocclusal records to pantographic tracings. J Prosthet Dent 1989;62:154-56.
7. Luce CE. The movements of the lower jaw. Boston Med Surg J 1889;121:8-11.
8. Campion GG. Some graphic records of movements of the mandible in the living subject (and their bearing on the mechanism of the joint and construction of articulators). Dent Cosmos 1905;47:39.
9. Hickey JC, Allison ML, Woelfel JB, Boucher CO, Stacy RW. Mandibular movements in three dimensions. J Prosth Dent 1963;13:72-92.
10. Lee RL. Jaw movements engraved in solid plastic for articular controls. I. Recording apparatus. J Prosthet Dent 1969;22: 209-24.
11. Craddock FW. The accuracy and practical value of records of condyle path inclination. J Am Dent Assoc 1949;38:697-710.
12. Berman MH. Accurate interocclusal records. J Prosthet Dent 1960;10:620-30.
13. Slavicek R, Luger P. Evaluation of Bennett angle in relation to a sagital path. Osterr Zeitcher F Stomatol 1978;7:8-15.
14. Clayton JA, Beard CC, Donaldson K, Myers GE. Clinical evaluation of electronic pantograph in relation to post axes. J Dent Res 1983;62:200.
15. Anderson GC, Schulte JK, Arnold TG. An in vitro study of an electronic pantograph. J Prosthet Dent 1987;57:577-80.
16. Clayton JA, Beard CC, Donaldson K, Myers GE. Clinical evaluation of electronic pantograph with mechanical pantograph. J Dent Res 1983;62:200.
17. Beard CC, Donaldson K, Clayton JA. Comparison of an electronic and a mechanical pantograph. Part I: Consistency of an electronic computerized pantograph to record articulator settings. J Prosthet Dent 1986;55(5):570-74.
18. Price RB, Bannerman RA. A comparison of articulator settings obtained by using an electronic pantograph and lateral interocclusal recordings. J Prosthet Dent 1988;60:159-164.
19. Miller D, Kulmer S, Dumfahrt H. Mechanical and computerized condylography, a comparative study. Inf Orthod Kieferorthop 1995;27:15-23.
20. Celar AG, Tamaki K. Accuracy of recording horizontal condylar inclination and Bennett angle with the Cadiax Compact. J Oral Rehabil 2002;29(11):1076-81.
21. Chang WS, Romberg E, Driscoll CF, Tabacco MJ. An in vitro evaluation of the reliability and validity of an electronic pantograph by testing with five different articulators. J Prosthet Dent 2004;92(1):83-89.
22. Posselt U. Skytting B. Registration of the condyle path inclination: Variations using the Gysi technique. J Prosthet Dent 1960;10:243-47.
23. Coye RB. A study of the variability of setting a fully adjustable gnathologic articulator to a pantographic tracing. J Prosthet Dent 1977;37(4):460-65.
24. Curtis DA, Sorensen JA. Errors incurred in programming a fully adjustable articulator with a pantograph. J Prosthet Dent 1986; 55(4):427-29.

ABOUT THE AUTHORS

Ahmad Hasan Ahangari

Assistant Professor, Department of Prosthodontics, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran

Kianoosh Torabi

Associate Professor, Department of Prosthodontics, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran

Sasan Rasaei Pour

Prosthodontist, Department of Prosthodontics, School of Dentistry Shiraz University of Medical Sciences, Shiraz, Iran

Safoura Ghodsi (Corresponding Author)

Prosthodontist, Department of Prosthodontics, School of Dentistry Shiraz University of Medical Sciences, Shiraz, Iran
e-mail: safura_gh82@yahoo.com