Clinical study of analysis of deviation from the mean of Bennett angles using electronic condylography measurement

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Abstract

The study was carried out on a group of 140 Romanian patients to analyze the deviation from the average (15°) of the Bennett angles in order to identify some potential common aspects. Based on the exact values of the Bennett angles sent to the dental laboratory, customized prosthetic works will be carried out later.

The measurements were made by condylography, a method of recording mandibular dynamics and all the functions of the craniomandibular system: breathing, speech, swallowing, mastication, aesthetics, stress-management. An ARCUSDigma condylograph from KaVo Dental GmbH was used for diagnostic condylography, and biacrylic composite, fixed with Temp-Bond NE temporary cement from Kerr Dental, was used to create the clutch.

After the study we found that 25% of the patients had a Bennett angle of at least 4° and another 9% had values close to 4°, which demonstrates the existence of repetitive common aspects.

Keywords: Bennett's angle, condylography, lateral movement, recording of mandibular dynamics

INTRODUCTION

140 patients participated in this study (of which 100 were female and 40 were male), who underwent diagnostic condylographies using the ARCUSDigma condylograph from KaVo Dental GmbH.

All measurements were made with the same device, by the same doctor, in the same office.

With this group of patients we intended to identify the pattern of Bennett values found on the patients having deviation from the average (15°) of the Bennett angles.

The Bennett angle is the angle formed between the sagittal plane and the condyle, during lateral movement of the mandible. The Bennett angle is identified on the non-working (swing) side, in other words when we perform left laterality we have a Bennett angle on the right side and vice versa.

The lateral movement is a complex, translational movement, the most complex that is performed in the human body. The Bennett angle has one horizontal component and one vertical component: when we perform the lateral movement, at the beginning of it, the condyle makes a movement towards sagittal plane (immediate ISS, Shift) and then starts moving forward and down, supporting the lateral movement on the non-working side. The Bennett angle is influenced by the anatomical structures and the ligaments and muscles that are creating and supporting this complex movement.

That is why it is very important to obtain exact values of the Bennett angles (left-right) in order to be able to share them later with the dental laboratory and carry out personalized prosthetic work.

Given the complexity of this translational movement and the importance of the mechanical relationship between the Bennett angles and the anatomy of the glenoid fossa, we initiated this study to analyze the values obtained on this group of Romanian patients. This analysis will allow us to determine if common repetitive aspects along the measured values can be identified from a statistical point of view. The results obtained in the measurements are exact, mathematical, demonstrating clear causality between the anatomy of the skull, the glenoid fossa, the eminence and the shape of the condyles.

We analyzed the deviation from the mean Bennett value to identify what are the common values, if any, and the percentage in this batch of patients. If any common values are found, may become useful statistical data in our daily practice.

Aim and objectives

The objectives are the measurement with condylography of Bennett angles, the collection of data resulting from condylography of mandibular dynamics, the introduction of the obtained data in a table - the ratio of the articulator - the analysis of the deviation from the average of 15° of each electronic record, the interpretation from a statistical point of view of the data obtained from the mandibular dynamics recording and the identification of potential quantitative informational aspects towards a certain mathematical value. The data is obtained and processed in the KaVo KiD software from ARCUSDigma (KaVo Dental GmbH).

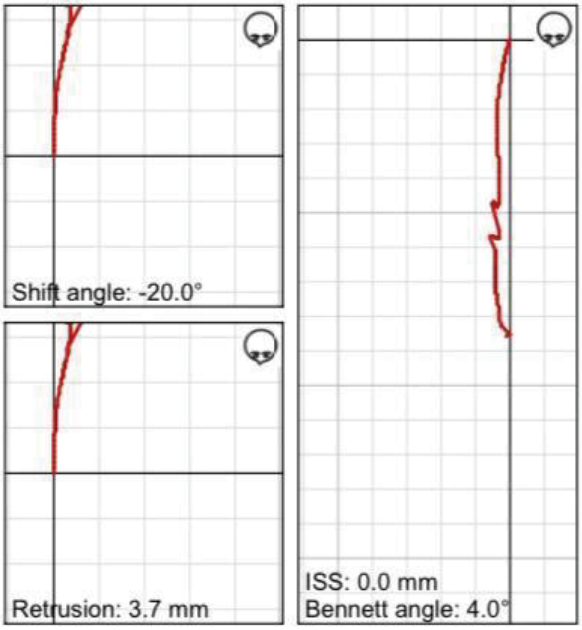

Figure 1. Bennett Angle

The aim is to identify potential repetitive values, which would demonstrate the existence of common points in the anatomy of the skull of the examined patients and in terms of the masticatory reflex, which is achieved through lateral movements, directly related to the Bennett angle. All this information will later be used to carry out direct or indirect prosthetic work on natural teeth or implants.

When we understand and control this lateral movement and have a record of it, the patient will benefit from a functional treatment plan, and not a random one, given that this exact, mathematical information about mandibular dynamics is shared by the dental office with the laboratory, so that the dental technique applies it to perform prosthetic works.

MATERIAL AND METHODS

The patients are Romanian and have participated voluntarily in the study. They all are beneficiaries of prosthetic works on natural teeth or implants.

In a first stage, the impressions of the 2 arches, upper and lower, was made using Speedex additive silicone, manufacturer Coltene/Whaledent AG.

On the basis of these impressions, the 2 models (upper and lower) were realised in the laboratory from class IV Fujirock plaster from GC Europe N.V. Also in the dental laboratory, the clutch was made using Silatray photopolymerizable base plate, manufacturer SILADENT Dr. Böhme & Schöps GmbH and the prefabricated metal clutch from ARCUSDigma from KaVo Dental GmbH.

The clutch is made on the lower model and copies the vestibular faces of the lower teeth without interfering with maximum intercuspation.

Light curing of the base plate and finishing of the composite material (base plate) are also laboratory steps.

Afterwards, a check is made so that they do not press on the gum and the interdental papillae and that there is sufficient friction between it and the vestibular surfaces of the lower teeth.

The clutch check is done in situ in the dental office and is done with 40μ articulation paper, manufacturer Dr. Jean Bausch GmbH & Co.KG, positioned between the 2 arches on the left-right occlusal plane.

After this check, the clutch is provisionally fixed with Kerr Dental's Temp-Bond NE cement or with VOCO GmbH's Structur Premium biacrylic composite. The excess cement or biacrylic composite is removed.

On the upper metal plate, which has a marking for the median of the upper teeth, we put bite silicone and fix it on the occlusal faces and incisal edges of the upper teeth. This plate transmits to us, in the mathematical system and software, the position of the three-dimensional jaw bone in the virtual articulator or analog articulator.

The lower part of the kinematic bow from ARCUSDigma is attached to this clutch. On this lower device there are 4 emitters that produce ultrasound. Fixing is done magnetically.

The kinematic bow is fixed at the level of the clavicle and the 2 auditory pathways, left-right, after which it is connected via the module and the connection cables to the condylograph and computer.

The actual condylography consists in the recording of mandibular dynamic movements: protrusion, retrusion, left laterality and right laterality.

Each dynamic movement will be recorded 3 times, this means 3 consecutive separate recordings, and the KaVo KiD software will average the 3 values for each movement.

After the registration is finished, the software will generate a file, report for the articulator that contains all the information about the anatomy of the skull. This report is important because it actually represents the prosthetic or pre-prosthetic treatment plan.

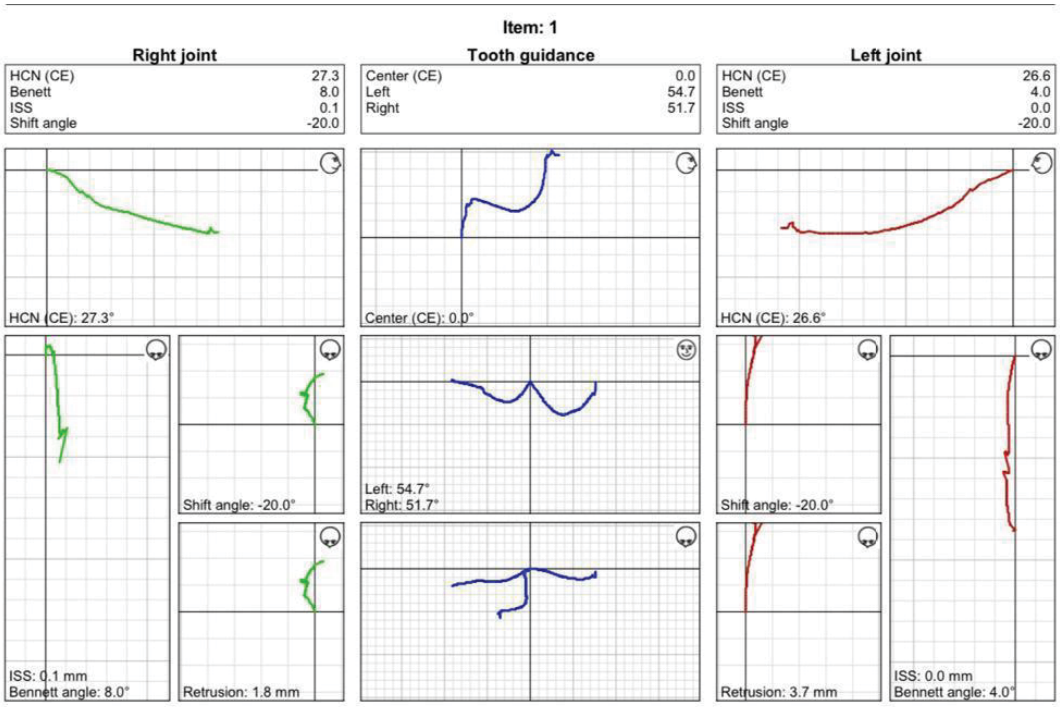

Figure 2. Articulator Report

The next step is to remove the kinematic arch from the patient's skull, manually remove the clutch, and clean the lower teeth with cement or biacrylic composite.

Also, the kinematic bow shows us in the mathematical system the position of the skull through the upper metal plate.

Figure 3. Kinematic Bow – Top view

Figure 4. Kinematic Bow – Lateral view

Figure 5. Kinematic Bow – Front view

RESULTS

The interpretation of the condylography, of the tracings, show us if there are neuromuscular and occluso-articular imbalances, if we have intra- and extracapsular changes in the 2 temporomandibular joints, what is the position of the left-right articular discs and if there are changes in their position, median, vestibular or posterior.

Table I. The results of condylography

Id	Anonymous Name	Gender	RIGHT BENNETT	LEFT BENNETT	Right Deviation	Left Deviation	Left-right difference
1.	A.A.	F	21.3	4.0	+6.3	-11	+17.3
2.	A.E.	F	7.7	4.0	-7.3	-11	+3.7
3.	B.N.	F	4.0	4.0	-11	-11	0.0
4.	B.C.	M	28.5	9.2	+13.5	-5.8	+19.3
5.	B.C.	M	_	20.6	-	+5.6	-
6.	B.C.	F	12.8	6.7	-2.2	-8.3	+6.1
7.	B.I-M.	F	4.0	8.0	-11	-7	-4.0
8.	B.I-A.	F	_	10.8	-	-4.2	-
9.	B.B.	M	30.0	6.7	+15	-8.3	+23.3
10.	B.D.	F	4.0	4.2	-11	-10.8	-0.2
11.	B.D.	M	17.2	11.7	+2.2	-3.3	+5.5
12.	B.M.	M	15.9	15.4	+0.9	+0.4	+0.5
13.	C.S.	F	4.0	23.5	-11	+8.5	-19.5
14.	C.N.	F	4.0	6.5	-11	-8.5	-2.5
15.	C.M.	F	10.8	_	-4.2	-	-
16.	C.M.	F	10.7	_	-4.3	-	-
17.	C.G.	F	_	4.6	-	-10.4	-
18.	C.I.	M	_	6.0	-	-9	-
19.	C.L.	F	6.2	4.0	-8.8	-11	+2.2
20.	D.A.	F	4.0	14.3	-11	-0.7	-10.3
21.	D.I.	F	5.0	4.0	-10	-11	+1.0
22.	F.V.	F	_	6.5	-	-8.5	-
23.	F.P.	M	21.8	13.6	+6.8	-1.4	+8.2
24.	G.C.	F	4.0	_	-11	-	-

25.	G.M.	F	18.1	4.0	+3.1	-11	+14.1
26.	G.S.	F	_	4.9	-	-10.1	-
27.	G.I.	M	13.6	8.4	-1.4	-6.6	+5.2
28.	I.A.	F	4.0	4.0	-11	-11	0.0
29.	J.G.	M	12.0	5.2	-3	-9.8	+6.8
30.	M.M.	M	16.5	4.0	+1.5	-11	+12.5
31.	M.S.	F	8.9	11.8	-6.1	-3.2	-2.9
32.	M.A.	F	12.4	4.0	-2.6	-11	+8.4
33.	M.T.	F	4.0	4.0	-11	-11	0.0
34.	M.V.	M	6.8	11.8	-8.2	-3.2	-5.0
35.	M.A.	F	_	10.8	-	-4.2	-
36.	M.G.	F	8.7	_	-6.3	-	-
37.	M.M.	M	4.0	4.3	-11	-10.7	-0.3
38.	N.G.	M	17.3	17.5	+2.3	+2.5	-0.2
39.	N.V.	F	12.1	9.9	-2.9	-5.1	+2.2
40.	N.C.	F	7.7	4.0	-7.3	-11	+3.7
41.	N.A.	F	4.9	4.0	-10.1	-11	+0.9
42.	N.O.	F	_	18.7	-	+3.7	-
43.	O.C.	F	30.0	5.6	+15	-9.4	+24.4
44.	P.E.	F	4.0	4.0	-11	-11	0.0
45.	P.A-M.	F	10.2	8.4	-4.8	-6.6	+1.8
46.	P.I.	F	13.9	30.0	-1.1	+15	-16.1
47.	P.A.	F	6.3	_	-8.7	-	-
48.	P.B.	F	6.0	2.9	-9	-12.1	+3.1
49.	P.Z.	M	12.3	19.4	-2.7	+4.4	-7.1
50.	P.A.	F	_	5.7	-	-9.3	-
51.	R.A-M.	F	8.4	15.4	-6.6	+0.4	-7.0
52.	R.A.	F	9.0	4.0	-6	-11	+5.0
53.	R.M.	F	11.5	6.8	-3.5	-8.2	+4.7
54.	S.V.	M	8.7	22.3	-6.3	+7.3	-13.6
55.	S.V.	F	_	16.6	-	+1.6	-
56.	S.R.	F	8.9	_	-6.1	-	-
57.	S.A.	F	4.0	4.0	-11	-11	0.0
58.	S.S.	M	4.0	17.7	-11	+2.7	-13.7
59.	S.B.	M	18.5	21.6	+3.5	+6.6	-3.1
60.	T.G.	F	_	4.0	-	-11	-
61.	T.C.	M	4.0	10.2	-11	-4.8	-8.2
62.	T.C.	F	13.6	4.0	-1.4	-11	+9.6
63.	U.M.	F	_	4.0	-	-11	-
64.	B.V.	F	8.0	4.0	-7	-11	+4.0
65.	S.V.	F	13.0	_	-2	-	-
66.	D.W.	M	17.5	4.0	+2.5	-11	+13.5
67.	Z.V-G.	M	4.4	6.3	-10.6	-8.7	-1.9
68.	Z.D.	F	4.0	4.4	-11	-10.6	-0.4
69.	A.L.	F	8.5	_	-6.5	-	-
70.	B.G.	F	_	4.7	-	-10.3	-
71.	B.S.	F	30.0	4.0	+15	-11	+26.0
72.	B.D.	M	7.9	17.2	-7.1	+2.2	-9.3
73.	B.S.	F	5.4	4.0	-9.6	-11	+1.4
74.	B.B.	F	6.2	_	-8.8	-	-
75.	B.C.	M	18.1	_	+3.1	-	-
76.	B.E.	F	4.0	_	-11	-	-
77.	B.V.	F	4.0	4.0	-11	-11	0.0
78.	B.C.	F	5.6	_	-9.4	-	-
79.	C.L.	M	6.7	5.9	-8.3	-9.1	+0.8
80.	C.L.	F	15.6	4.0	+0.6	-11	+11.6
81.	C.E.	F	6.7	10.2	-8.3	-4.8	-3.5
82.	D.A.	F	4.0	10.2	-11	-4.8	-6.2

83.	P.D.	M	18.5	4.0	+3.5	-11	+14.5
84.	B.D.	F	_	5.4	-	-9.6	-
85.	D.F.	M	16.4	4.0	+1.4	-11	+12.4
86.	D.E.	F	16.6	4.0	+1.6	-11	+12.6
87.	D.C.	F	4.0	_	-11	-	-
88.	H.C.	M	5.6	4.0	-9.4	-11	+1.6
89.	H.G.	F	_	6.3	-	-8.7	-
90.	H.M.	F	12.6	_	-2.4	-	-
91.	I.R.	M	4.0	14.0	-11	-1	-10.0
92.	J.J.	M	5.9	10.1	-9.1	-4.9	-4.2
93.	L.A.	F	4.0	10.1	-11	-4.9	-6.1
94.	M.I.	F	7.2	_	-7.8	-	-
95.	M.V-E.	F	4.0	_	-11	-	-
96.	N.G.	M	17.3	17.5	+2.3	+2.5	-0.2
97.	N.R.	F	13.9	4.0	-1.1	-11	+9.1
98.	O.A.	F	18.2	11.9	+3.2	-3.1	+6.3
99.	P.O.	F	4.0	4.0	-11	-11	0.0
100.	P.A.	F	6.1	_	-8.9	-	-
101.	P.A-M.	F	6.5	_	-8.5	-	-
102.	S.M.	F	13.6	17.2	-1.4	+2.2	-3.6
103.	S.M.	F	4.0	7.5	-11	-7.5	-3.5
104.	S.C.	F	7.1	17.5	-7.9	+2.5	-10.4
105.	P.S.	F	_	11.1	-	-3.9	-
106.	S.K.	F	4.9	_	-10.1	-	-
107.	T.E.	M	17.1	12.7	+2.1	-2.3	-4.4
108.	T.G.	F	_	4.8	-	-10.2	-
109.	T.A.	F	4.0	_	-11	-	-
110.	T.S.	F	4.0	4.0	-11	-11	0.0
111.	T.P.	M	15.3	_	+0.3	-	-
112.	V.S.	F	4.3	4.0	-10.7	-11	+0.3
113.	V.P.	F	7.5	13.6	-7.5	-1.4	-6.1
114.	A.B.	F	2.0	4.0	-13	-11	-2.0
115.	A.O.	M	3.0	13.0	-12	-2	-10.0
116.	A.I.	F	8.0	4.0	-7	-11	+4.0
117.	B.I.	F	1.0	0	-14	-15	+1.0
118.	B.A.	F	0	0	-15	-15	0.0
119.	B.L.	F	8	4	-7	-11	+4.0
120.	C.B.	M	13	15	-2	0	-2.0
121.	C.L.	F	22	0	+7	-15	22.0
122.	C.S.	M	8	7	-7	-8	+1.0
123.	D.A.	F	7	0	-8	-15	+7.0
124.	G.M.	F	3	0	-12	-15	+3.0
125.	K.M.	M	8	0	-7	-15	+8.0
126.	L.A.	M	6	10	-9	-5	-4.0
127.	M.C.	F	3	19	-12	+4	-16.0
128.	M.M.	F	10	0	-5	-15	+10.0
129.	M.C.	M	5	6	-10	-9	-1.0
130.	M.I.	F	0	20	-15	+5	-20.0
131.	G.O.	F	7	0	-8	-15	+7.0
132.	P.I.	M	4	10	-11	-5	-6.0
133.	R.M.	F	0	1	-15	-14	-1.0
134.	F.D.	F	12.1	9.9	-2.9	-5.1	+2.2
135.	R.A-M.	F	3	1	-12	-1	+2.0
136.	H.S.	F	6	13	-9	-2	-7.0
137.	S.E.	M	14	9	-1	-6	+5.0
138.	T.G.	F	8	16	-7	+1	-8.0
139.	Z.M.	F	0	10	-15	-5	-10.0
140.	O.I.	M	9	0	-6	-15	+9.0

DISCUSSIONS

From the data obtained, we observe a percentage of 83% below the Bennett value of 15 degrees. If the prosthetic works are carried out using an average value of 15 degrees for the left/right Bennett angle, then the positioning of the volumes represented by the artificial teeth will be distalized. Similarly, the canine guidance will have a distalized path, which in situ will result in interference and loading of the canines, because the laterality achieved in the laboratory on the programmable articulator will not be the same as the laterality movements perfomed by the patient.

When we perform indirect prosthetic work on natural teeth or implants, it is necessary to transmit the exact measurements from the condylography to the dental technician. In the dental laboratory, the process of performing prosthetic works requires understanding the specifications of the case and its limitations. The maximum intercuspation position is a static position and everything related to the masticatory reflex is part of the dynamic occlusion where the programming of the Bennett angles can determine the functionality in the oral cavity. Erroneous programming of Bennett angles can lead to neuromuscular and occluso-articular imbalances.

CONCLUSIONS

242 results from 140 patients are recorded in the statistical table. In the case of patients where the value of the Bennett angle could not be recorded on one of the sides, we interpreted it as a missing measurement.

We considered the deviation from the average of 15°: those lower than 15° are minus, and the largest are plus. Only 42 results are positive, i.e. over 15°, which represents 17% of all measurements. The rest, i.e. 83%, are less than or equal to 15.

The frequency with which -11 appears, that is 4°, is surprising. There are 62 such results, which represents 25% of the total measurements. So a quarter of the patients had at least a 4° Bennett angle. There are another 20 values near 4 (that is, strictly greater than 3 and strictly less than 5), which brings the number of occurrences of a value near 4 to about 34%. This observation can be generalized, statistically speaking, at the level of the entire population.

In total we have:

- between 0° and 5°: 97 values, i.e. 40%
- between 5° and 10°: 63 values, i.e. 26%
- between 10° and 15°: 38 values, i.e. 15.7%
- between 15° and 20°: 31 values, i.e. 12.8%
- between 20° and 25°: 8 values, i.e. 3.3%
- between 25° and 30°: 5 values, i.e. 2%

Right-Left differences (these could only be done for 102 patients, both measurements were possible):

- between 0 and 5°: 32 positive values and 21 negative values, total 53, i.e. 52%
- between 5 and 10°: 14 positive values and 14 negative values, total 28, i.e. 27.4%
- between 10 and 15°: 7 positive values and 4 negative values, total 11, i.e. 10.7%
- between 15 and 20°: 2 positive values and 4 negative values, total 6, i.e. 5%
- between 20 and 25°: 3 positive values and 0 negative values, total 3, i.e. 3%
- between 25 and 30°: 1 positive value and 0 negative values, total 1, i.e. 1%

Of the 9 0.0 Right-Left differences, 8 are given by the 4-4 angles and one by 0-0.

In 38 patients, i.e. 27.1% of the total, due to temporomandibular joint problems, only one measurement could be performed. Of these, 17, i.e. 44.7%, could not be performed on the right side, and 21, i.e. 55.3%, on the left side.

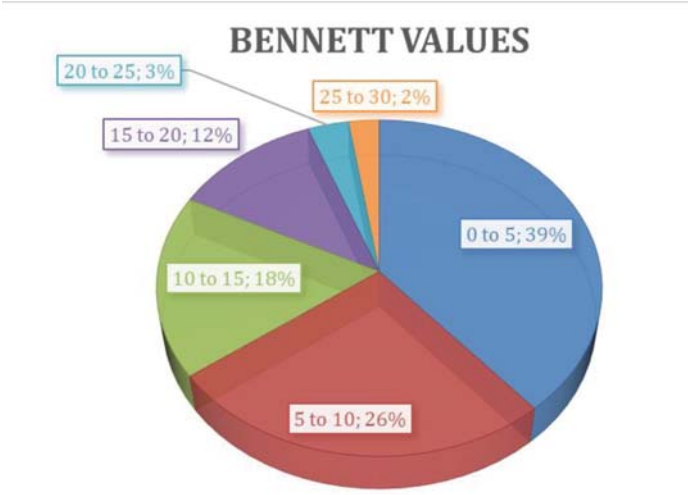

Figure 6. Chart – Bennett Values

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