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Awake Bruxism – Definition through self-report and through Ecological Momentary Assessment

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Abstract

Diagnosis of Awake Bruxism (AB) is problematic due to the inability to use continuous recordings during daytime activities.

Recently, a new semi-instrumental approach was suggested, viz., an Ecological Momentary Assessment (EMA), with the use of a smartphone application. With the application subjects are requested to report, at least 12 times per day, the status of their masticatory muscle activity (relaxed muscles, jaw bracing without tooth contact, teeth contact, teeth clenching or teeth grinding).

The aim of the present study was to compare the EMA to the assessment of AB as defined by a single point self-report.

The most frequent condition recorded by the EMA was relaxed muscles (ca. 60%) and the least frequent one - Teeth grinding (0.6 %). The relaxed muscle condition also showed the lowest coefficient of variance over a 7day period of report. Additionally, only the relaxed muscles and the Jaw bracing conditions presented an acceptable ability to discriminate between AB positive and AB negative subjects, as defined by single point self-report questions.

The combination between self-report and EMA may have a potential to promote our ability to diagnose AB. We suggest to re-consider the conditions of Teeth contact and Teeth grinding while using EMA to evaluate AB.

Key words: Awake bruxism, self-report, Ecological momentary Assessment, Smartphone application

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Introduction:

The definition of Awake Bruxism (AB) was set by an international bruxism expert panel as a "masticatory muscle activity during wakefulness that is characterized by repetitive sustained tooth contact and/or bracing or thrusting of the mandible and is not a movement disorder in otherwise healthy individuals" [1].

It was further suggested to grade AB as: (i) Possible AB, based merely on a positive self-report; (ii) Probable AB based on a positive clinical inspection, with or without a positive self-report and (iii) Definite AB based on a positive instrumental assessment, with or without a positive self-report and/or a positive clinical inspection. [1]

Some studies suggest that the assessment accuracy of self-reported bruxism is low due to lack of individual awareness to such a behavior [2,3]. Assessment of probable AB may also be problematic due to the fact that the relevant intra-oral signs can also be present in subjects who perform sleep bruxism (SB) [4-8] as well as other oro-motor activities [9].

While both self- report and clinical assessment present some degrees of diagnostic sensitivity, they are insufficient in determining outcomes such as the intensity and duration of a specific muscle activity and its fluctuations over time [10,11]. This leaves the instrumental EMG recordings as the gold standard for the diagnosis of definite AB. Obviously, a continuous EMG evaluation of muscular activity during daytime is problematic for technical, emotional, and feasibility reasons.

Recently, a new semi-instrumental approach was suggested, viz., an Ecological Momentary Assessment (EMA), with the use of a smartphone. A specific application was developed as an option for multiple-point real-time subjective report about masticatory muscle activity during wakefulness [12-15].

Recent studies present frequencies of the different conditions recorded by an EMA among healthy young adults (University students) [12,14,15]. One of the conclusions was that an application can mainly be used to assess the frequency of AB behavior and to implement the control of AB in patients with potential clinical consequences. [14]

While the EMA is gaining popularity as a possible tool to implement the self-reported approach to AB assessment, questionnaires based on a single observation points are still the primary tool to gather data on AB in research and clinical practice. [1].

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The aim of the present study was to compare findings of an EMA assessment of AB among a cohort of Israeli dental students compared to the assessment of Possible AB as defined by single point self-report.

Materials and Methods:

Population:

238 dental students attending the School of Dental Medicine, Tel Aviv University, were approached in January 2020 and requested to respond to self-report questionnaires and to use an EMA application for at least 7 consecutive days. 147 students consented to participate (62% response rate).

Tools:

1. Single point observation self-report of AB:

An accepted way to assess AB is through single point observation self-report [16-21]. In the present study, participants were requested to respond to three questions related to their awareness to grinding, clenching, holding the teeth together and/or tightening the masticatory muscles during the day as follows:

(i) Do you grind your teeth during the day (namely, do you move repeatedly your jaw from one side to another and/or forward and backwards with teeth contact – ***Self report grinding***

(ii) Do you clench your teeth during the day (namely, do your lower teeth touch your upper teeth, even if lightly) - ***Self report teeth contact/clenching***

(iii) Do you experience jaw bracing during the day (namely, are your jaw muscles strained, kept in a fixed position without teeth contact) - ***Self report bracing***.

The scoring possibilities for each of the questions were as proposed by the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) oral behavior checklist [22]: 0- never, 1- almost never, 2- some of the time, 3- most of the time, 4- all of the time.

A scoring of 2, 3 or 4 on one or more of the three questions was considered as AB.

The questionnaire included also information concerning demographics and additional variables such as oral parafunctions, anxiety, depression, temporomandibular disorders (TMD) and other clinical information, which are not part of the present study.

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2. EMA with the use of a specific application:

The BruxApp is an EMA application, specifically developed for AB assessment. The use of BruxApp was as described in detail by Bracci etal.[12].

In the present study we followed the protocol described by Bracci et al. with an officially translated Hebrew version of the application. In brief, participants received two explanation /training sessions of how to use the application and to recognize the different conditions, by one of the investigators (TSA). Following the explanation, they downloaded the application to their smartphones.

The BruxApp sent each participant 20 alert sounds at random hours during the day. At each alert sound subject was requested to indicate on his/her smartphone (within 5 minutes from the alert sound), the present condition of his/her teeth and jaw position as follows:

(i) Relaxed jaw muscles: Condition of perceived relaxed state of jaw muscles, with jaws kept apart (***BA-Relaxed***).

(ii) Jaw bracing (without tooth contact): Condition of jaw muscle stiffness or tension, as in tooth clenching but with the teeth apart (***BA-Bracing***).

(iii) Teeth contact - Condition of slight tooth contact, like that which the patient perceives when a 40 µ articulating paper is placed between the dental arches, and the patient is asked to keep it there by lightly touching the teeth together with the mouth closed (***BA-Teeth contact***).

(iv) Teeth clenching - All conditions where tooth contact is more marked than those listed above, and the jaw muscles are tensed (***BA-Clenching*).**

(v) Teeth grinding - Condition in which the patient gnashes or grinds the opposing teeth, independent of the intensity and direction of antagonist tooth contact (***BA-Grinding***).

Data were recorded over a 7day period. Based on the compliance data reported by Collona et al, a minimum of 12 responded alerts per day was required [15]. Days with less than 12 responded alerts were discarded. Subjects who failed to complete 7 days of valid responses were not included in the study.

The study was approved by the Ethical committee of Tel-Aviv University, approval No.000693-1. A written informed consent was obtained from all the participants.

Statistics:

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1. Mean of the number of reports of each of the BruxApp conditions/per day was calculated for the study population, as well for the sum number of reports of four conditions other than BA-Relaxed (BA-Bracing, BA-Teeth contact, BA-Clenching and BA-grinding)/per day (BA-Awake bruxism***, BA-AB***).

2. Frequencies (percentage) of each of the BruxApp conditions, were calculated as described by Bracci et al. [12] Frequency of each condition (BA-Relaxed, BA- Bracing, BA-Teeth contact, BA-Clenching, BA-Grinding) was calculated as a percentage with respect to the answered alerts for all individuals. The frequencies were calculated daily, on an individual basis, and individual frequencies were used to calculate an average of the study population on a daily basis. At the end of the 7-day observation period, the mean frequency of each condition was assessed. Data were reported as mean values of the 7-day span per each condition. For each condition, a coefficient of variation (CV) of frequency data was assessed.

3. Pearson's Chi square test and Fisher's exact test were used to test the associations between categorical variables.

4. Area under the receiver operating characteristic (ROC) curve was used to evaluate the ability of the BruxApp variables to discriminate between positive and negative AB, as defined by a single point self- report .

Results:

1. Descriptive results:

Of the initial 147 students, who consented to participate in the study, 106 (63.2% female) completed 7 days of a full BruxApp response (at least 12 responses/day, minimum of 84 responses) and were included in the final analysis.

Mean age of the study population was 24.4±2.99 years. Of the study population, 36 subjects (34%) were defined as AB positive according to single point self- report (no differences between genders).

The total number of BruxApp reports for the entire study population over the 7 days period of observation, was 11,122. The mean number of reports/per day, for each of the BruxApp conditions, was as follows: BA-Relaxed: 8.96±4.59, BA- Bracing: 2.05±2.62, BA-Teeth contact: 3.04±3.0, BA-Clenching: 0.88±2.02, BA-Grinding: 0.08±0.42.

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2. Frequencies of the BruxApp behaviors:

The frequency of BA-Relaxed/per 7 days observation period (entire population) was 60%. The frequencies of the four conditions other than BA-Relaxed /per 7 day observation period, were as follows: BA-Bracing – 14%, BA-Teeth contact – 19%, BA-Clenching – 6%, BA-Grinding – 1%.

Mean frequencies for each of the BruxApp conditions/per day, over the 7-day observation period, and coefficient of variation (CV), are presented in Table 1.

The lowest CV was observed for the condition BA-Relaxed and the highest for the condition BA-Grinding.

3. Correlations between single point self-report AB and BruxApp conditions

Pearson correlation coefficient was computed between AB as defined by single point self- report (three questions) and the five BruxApp conditions (Table 2). Significant correlations between AB were found only for the following BruxApp conditions: BA-Relaxed (negative correlation) and BA-Bracing, BA-Clenching and the total BA-AB score (positive correlations).

No correlations between AB and BA-Teeth contact or BA-Grinding could be observed.

4. Receiver Operating Characteristic (ROC) curves

To examine the ability of the BruxApp application to discriminate between patients with and without AB (as defined by a single point self-response to three questions), ROC curves were calculated for each of the BruxApp conditions, as well as for the BA-AB variable (Table 3). The BA-Relaxed condition was calculated separately as its score had to be reversed.

The BruxApp conditions that had a significant ability to discriminate between AB positive and AB negative subjects were BA-Relaxed (AUC of 0.657, $p<0.01$, 95% CI 0.535-0.779, Graph 1), BA-Bracing (AUC 0.674, $p<0.01$. 95% CI 0.568-0.780) and BA-AB (AUC of 0.665, $p<0.01$, 95% CI 0.551-0.719, Graph 2).

The ability of BA-Clenching to discriminate between AB positive and AB negative subjects was low but approaching significance (AUC of 0.604, $p=0.08$). The conditions of BA-Teeth contact and BA-Grinding, had no predictive power whatsoever, with results no better than random guessing.

Discussion:

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An international expert panel suggested that both non-instrumental approaches (self-report) and instrumental approaches (electromyography) can be employed to assess bruxism. The clinical modes of assessment should be accurate (reliable, valid), applicable (feasible), affordable (cost-effective) and accessible (suitable for everyday clinical use) [23,24].

Self- report is the most feasible and used approach to assess AB [1,21,24,25]. It has been widely used and quoted in numerous studies worldwide [18-21, 26-30].

In the present study, the prevalence of AB among Israeli dental students, as defined by single point self–report, was 34%, which is in full accordance with previous findings among Israeli adolescents (34.5%) [19]. Both studies used basically similar questions to define AB (2 questions in the adolescent study, 3 questions in the present study). In a recent study, carried out in Israel and Poland during the first stage of the COVID-19 pandemic, the prevalence of AB, as assessed by similar single point self- report questions, was around 30% (21% for males, 38% for females) for subjects 18-35 of age [31].

The non-instrumental approaches for assessing bruxism, such as single point self-report, were sometimes presented as having poor concordance with instrumental approaches [24], partly due to lack of consensus regarding the questions and the scoring system [15,21]. A study by Paesani et al [30] found a strong positive correlation between self -reported and clinically based approach to the diagnosis of AB clenching. The consistent findings regarding the prevalence of AB among young Israeli adults indicate that the use of self-report to define possible AB is reliable when the questions used and the and scoring system are consistent.

The EMA approach, such as the BruxApp, is a relatively new strategy to evaluate AB which is both applicable, affordable and accessible. Its validity and reliability have still to be determined. Manfredini et al. note that even if close in time to the experience, the subjectivity of self-report may introduce some intra- and inter-individual reliability bias [13,33].

The present study included a relatively homogenous group of young adults. The group was age- and education-wise similar to the populations studied by Bracci et al. [12] and Zani et al. [14] and shows resembling results. The mean frequencies of the conditions, as recorded by the BruxApp, are resembling those reported by Zani et al [14] during their first assessment and those reported by Bracci et al.[12] (Table 4). The most frequent behavior in the three studies was BA-Relaxed (ca. 60-71%), followed by BA-Teeth contact (ca.14-20%) and BA-Bracing (ca. 10-14%) [12,14]. Thus,

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teeth contact, and jaw bracing/clenching are not unusual activities in otherwise healthy people while grinding may be irrelevant to healthy young adult population.

Bracci et al. also showed a low coefficient of intra-individual variability for the absence of AB over one week, namely for the relaxed muscle condition [12]. Similarly, in the present study the condition which showed the lowest variability over the 7 days of measurement was the AB-Relaxed condition.

The present results show that out of the five possible conditions reported by the BruxApp only three (BA-Relaxed, BA-Bracing, and BA-Clenching) correlate with the definition of AB as defined by single point self- report. Moreover, only the BA-Relaxed and BA-Bracing conditions (as well as the combined variable BA-AB) presented an acceptable ability to discriminate between subjects AB positive and AB negative. Although single point self-report has not been set as a gold standard reference for AB, the consistent findings among different Israeli populations grants the measure some validity.

The lack of correlation between self-reported AB and BA-Teeth contact or BA-Grinding is not surprising. Recent definition of bruxism specified the different muscle activities during wakefulness which are associated with AB and removed grinding from the definition [1, 32]. Teeth contact may be associated to regular oro-motor activities such as swallowing rather than with AB [20].

It is important to point out that beside recording real time information about jaw position and/or muscular strain, being asked about a certain behavior in close contextual and temporal proximity to its occurrence increases self- awareness and may promote control and lead to cognitive change [14, 33]. By doing that, BruxApp can serve as a biofeedback ecological momentary intervention (EMI) [35-39]. Zani et al. used BruxApp to monitor AB behaviors over time through collecting data for two distinct periods with a 1-month interval between them [14]. Their results showed an increase in the average frequency of relaxed jaw muscles report in the study population in the second evaluation period. The authors suggested that the application may be of a potential therapeutic use in myofascial pain patients with a self-reported history of AB [14].

The consensus obtained in 2018 [1] introduced the concept that muscle activity associated with AB (and/or SB) should not be considered as a disorder in ”otherwise healthy people” but rather as a behaviour that can be a risk factor for certain clinical conditions [1].

Little has been written on AB as a "normal behaviour". The assessment of such a normality is challenging, especially as the recommendation was to assess the activity in its continuum [1,14,33] rather than to determine clear cut-off points. EMA methods such as the BruxApp have a potential to record muscle activity and increase our knowledge on the epidemiological features of AB by studying the natural course and fluctuations of various AB behaviours [14].

The recent findings, which present recordings of AB behaviours with the use of BruxApp [12,14] indicate that the prevalence of the BruxApp condition of relaxed muscles (BA-Relaxed) among young adults ranges around 60-70%. Additionally, this condition consistently shows the lowest CV rate over 7 days of measurement. Therefore, this seems to be the most important condition in the evaluation of AB. We suggest to re-consider the conditions of BA-Teeth contact and BA-Grinding while using methods such as EMA to evaluate AB. Minimizing the reported BruxApp conditions to BA-Relaxed versus a one or two other conditions describing muscular strain, could make the application simpler, without losing its discriminatory ability.

Conclusions:

Definite diagnosis of AB is problematic due to the inability to use continuous EMG recordings during daytime activities. The combination between non-instrumental approaches (self-report) and instrumental ones (EMA, BruxApp) may have a potential to promote our ability to diagnose AB and increase the diagnosis level from Possible AB to Probable AB.

In the present study, only the BA-Relaxed and BA-Bracing conditions (as well as the combined variable BA-AB) presented an acceptable ability to define subjects with and without AB. Future studies and discussions should be carried out in order to reach a consensus regarding the questions used to assess single point self-report AB and the conditions recorded by the EMA applications [40]

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Table 1: Mean frequencies (%) of the different BruxApp conditions (per 7 days period and per each of the report days)

BruxApp conditions	*Range*		Mean	SD	L 95%CI	U 95%CI	CV***
BA-Relaxed 7 day average*	**0.00**	**100.00**	**59.72**	**24.91**	**54.98**	**64.46**	**0.48**
*Day 1***	0.00	100.00	56.53	25.52	51.67	61.39	
Day 2	0.00	100.00	55.56	26.23	50.54	60.57	
Day 3	0.00	100.00	59.92	28.87	54.42	65.41	
Day 4	0.00	100.00	59.76	29.00	54.24	65.28	
Day 5	0.00	100.00	59.75	28.73	54.25	65.24	
Day 6	0.00	100.00	62.17	31.52	56.17	68.17	
Day 7	0.00	100.00	63.72	29.30	58.15	69.30	
BA-Bracing 7 day average	**0.00**	**65.81**	**13.74**	**14.90**	**10.90**	**16.57**	**1.28**
Day 1	0.00	60.00	15.73	15.33	12.82	18.65	
Day 2	0.00	76.92	16.64	19.82	12.86	20.41	
Day 3	0.00	58.33	13.18	16.19	10.10	16.26	
Day 4	0.00	83.33	12.83	17.54	9.49	16.16	
Day 5	0.00	84.62	13.89	18.38	10.37	17.40	
Day 6	0.00	100.00	11.60	17.70	8.23	14.97	
Day 7	0.00	73.33	12.38	17.93	8.96	15.79	
BA-Teeth contact, 7 day average	**0.00**	**79.25**	**20.22**	**15.31**	**17.31**	**23.14**	**0.94**
Day 1	0.00	71.43	21.70	16.34	18.59	24.81	
Day 2	0.00	68.75	21.11	16.19	18.02	24.21	
Day 3	0.00	80.00	20.08	18.50	16.56	23.60	
Day 4	0.00	92.86	21.49	20.36	17.61	25.37	
Day 5	0.00	100.00	20.45	20.93	16.44	24.45	
Day 6	0.00	93.75	19.15	21.21	15.11	23.19	
Day 7	0.00	100.00	17.92	19.58	14.19	21.64	
BA-Clenching, 7 day average	**0.00**	**42.24**	**5.71**	**8.88**	**4.02**	**7.40**	**2.03**
Day 1	0.00	66.67	5.60	10.20	3.66	7.54	
Day 2	0.00	58.33	5.91	11.42	3.74	8.09	
Day 3	0.00	75.00	6.25	13.55	3.67	8.83	

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Day 4	0.00	46.67	5.40	9.90	3.51	7.28	
Day 5	0.00	75.00	5.20	11.64	2.98	7.41	
Day 6	0.00	64.29	6.54	12.47	4.16	8.91	
Day 7	0.00	80.00	5.08	11.78	2.84	7.32	
BA-Grinding, 7 day average	**0.00**	**18.28**	**0.60**	**2.00**	**0.22**	**0.98**	**5.19**
Day 1	0.00	14.29	0.43	2.09	0.04	0.83	
Day 2	0.00	20.00	0.56	2.78	0.03	1.09	
Day 3	0.00	15.38	0.57	2.27	0.14	1.00	
Day 4	0.00	12.50	0.53	2.05	0.14	0.92	
Day 5	0.00	21.43	0.66	3.29	0.04	1.29	
Day 6	0.00	33.33	0.54	3.49	-0.12	1.21	
Day 7	0.00	58.33	0.90	5.82	-0.21	2.01	

* Mean frequency over 7 day period of report
** Mean frequency /per each day of report
***Coefficient of variation over the 7 day recordings for each of the BruxApp conditions

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Table 2: Correlations between AB as defined by single point self-report and BruxApp conditions

BruxApp	BA-Relaxed	BA-Bracing	BA-Teeth contact	BA-Clenching	BA-Grinding	BA-AB
Pearson Correlation	**-.297****	**.220***	0.148	**.225***	0.111	**.320****
Sig (2-tailed)	**0.002**	**0.023**	0.130	**0.021**	0.259	**0.001**
Number	106	106	106	106	106	106

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Table 3: Summary of the ability of the BruxApp conditions to discriminate between patients with and without AB (ROC Area Under the Curve, ROC-AUC)

Test Result Variable(s)	ROC-AUC	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
BA-AB	**0.665**	0.058	**0.006**	**0.551**	**0.779**
BA-Bracing	**0.674**	0.054	**0.003**	**0.568**	**0.780**
BA-Teeth contact	0.556	0.059	0.349	0.439	0.672
BA-Clenching	0.604	0.060	0.081	0.485	0.722
BA-Grinding	0.505	0.060	0.936	0.387	0.623
BA-Relaxed*	**0.657**	0.062	**0.008**	**0.535**	**0.779**

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

* The score of "BA-Relaxed" was reversed
** Significant results in bold

Table 4: Frequencies of the BruxApp conditions (%) - comparison among studies

	Present study	Zani et al.*[14]	Bracci et al.[12]
BA-Relaxed	59.7	62	71
BA-Clenching	5.7	3	3.7
BA-Teeth contact	20.2	20	14
BA-Grinding	0.6	1	0.1
BA-Bracing	13.7	14	10**

* During the first recording period
** Defined as Bracing/Jaw clenching

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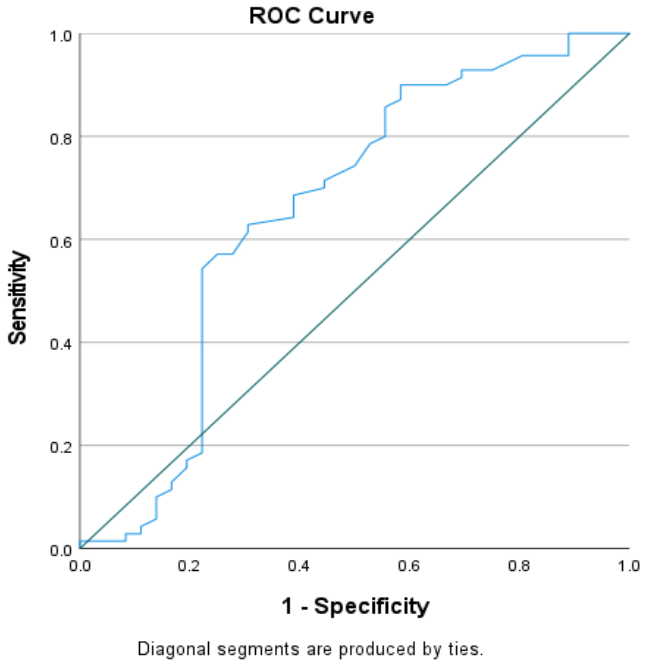
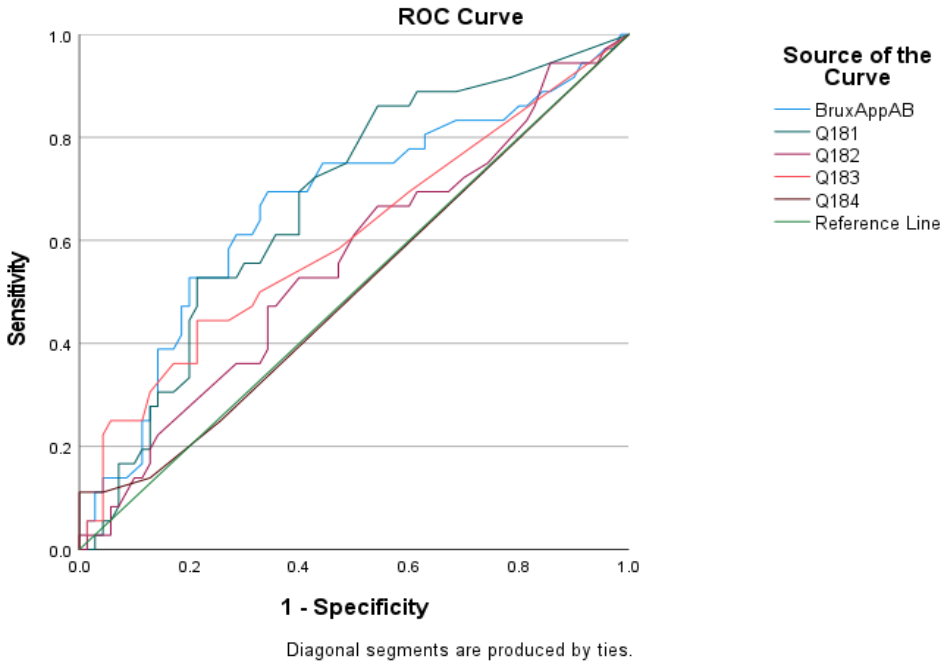
Graph 1: ROC curve for the BruxApp condition “BA-Relaxed”



Graph 2: ROC curves for the BruxApp conditions of BA-Bracing, BA-Teeth contact , BA-Clenching , BA-Grinding and BA-AB



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