Original Article

Validity of Wear at the Upper Canine's Cusp Tip in Predicting Sleep Bruxism

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Background: Sleep bruxism (SB) affects the dentition and could be the cause of temporomandibular disorders (TMD). Due to its nocturnal nature, the diagnosis of SB is mainly based on history taken from patients and family members. A verified clinical examination is still needed to help confirm the diagnosis.

Objective: To determine the validity of upper canine's cusp-tip wear for the diagnosis of SB using Brux Checker® as the reference diagnostic tool.

Materials and Methods: Eighty dental patients were screened for SB using ICSD-3 criteria. The wear at upper canine's cusp tip as well as any matched wear facets during eccentric movements were examined and scored according to Johansson et al (1993). They were subsequently prescribed to wear Brux Checker® for 7 consecutive nights. The abraded and perforated areas on Brux Checker® were used to identify 'current' bruxers. The sensitivity, specificity and AUC/ROC of upper canine's wear were determined with respect to ICSD-3 criteria and Brux Checker® perforation by day 1, day 2, and day 7 (P1, P2, P7).

Results: Prediction with good sensitivity (0.875) was found when Brux Checker® perforation was compared to ICSD-3 criteria (AUC = 0.773). Mean wear scores could predict SB diagnosed by ICSD-3 criteria (AUC = 0.789; sensitivity = 0.789 to 0.875, specificity = 0.641 to 0.703) but did not show any significant predictive values with respect to Brux Checker® perforation. However, the tooth-level wear score ≥1, with the presence of matched wear facets, could predict P2, and P7 (AUC = 0.599 to 0.626; sensitivity = 0.776 to 0.842, specificity = 0.410 to 0.422).

Conclusion: Mean wear score at upper canine's cusp tip seems to be a good indicator of SB based on ICSD-3 whereas individual tooth wear combined with the presence of matched wear facets could be a fair indicator of 'current' SB as indicated by Brux Checker® perforation.

Keywords: Sleep bruxism, Tooth wear, Brux Checker®

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Sleep bruxism (SB) is a parafunction habit occurring during sleep when tooth grinding and less often tooth clenching are observed. This condition is usually concomitant with unbearable sound that could subsequently result in problems with bed partner. It also underlies dental problems such as fracture of teeth and dental restorations, tooth hypersensitivity and pain in the masticatory system. The diagnosis of SB is therefore necessary for dental treatment planning. Since the occurrence of SB is intermittent and nocturnal in nature, the diagnosis is generally based on history taken from both patients and their family members. The International Classification of Sleep Disorders (ICSD) has established the criteria for the diagnosis of SB based on (1) tooth grinding sounds during sleep and (2) related clinical signs[(1)]. The current gold standard for SB diagnosis is polysomnography along with audio and video recordings for 1 to 2 nights. The procedure is likely to be accurate in identifying current, rather than long-term SB patients. However, due to the cost and time limitations, polysomnography is not always possible. A 0.1-mm thin color-coated foil fit to the upper dental arch or Brux Checker® (Scheu Dental GmbH, Iserlohn, Germany) was developed to be a simpler diagnostic tool for SB[(2)] in which the pattern of abraded foil was used to confirm tooth grinding during sleep. The appliance has been shown not to affect the activity of masseter and temporalis muscles[(3)].

Although significant tooth wear, especially in the anterior teeth, has been widely seen as an important indicator of SB in dental patients, generalized tooth wear is not very useful in SB diagnosis[(4)]. Abe et al[(5)] studied the severity of tooth wear in non-SB and SB patients diagnosed with

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polysomnography for 2 consecutive nights, and found that overall tooth wear score was significantly higher in SB group compared to controls. Pooled wear scores and those of molar teeth were best predictors of SB. However, tooth wear score was poor in predicting SB severity. Diracoglu et al[6] also found a significant correlation between tooth wear and SB (r = 0.79). Furthermore, Seligman and Pullinger[7] found the association between canine's wear and parafunctional activity. This study aimed to investigate further if the validity of tooth wear in predicting SB would be improved if only wear at upper canine's cusp tips were used since they were unlikely to be associated with normal chewing cycles. Brux checker® was used as the reference diagnosis because of its practicality.

Materials and Methods

The study was approved by the ethical committee at Khon Kaen University (HE602256). Eighty dental patients (31 males, 49 females), aged 18 to 45, gave consent and participated in the present study. They were randomly selected from those who visited the Dental Department, Buriram Hospital during August 2018 to 2019. The inclusion criteria were (1) being healthy, (2) having at least 28 natural teeth (excluding third molars), (3) class I Angles' classification. The exclusion criteria were (1) past or present orthodontic treatment, (2) history of misused biting habit, (3) history of gastroesophageal reflux (GERD), (4) regular consumption of acidic fruit and drinks, (5) neurological disorders affecting jaw movement, e.g. mandibular dystonia, Parkinson's disease, epilepsy, (6) taking selective serotonin reuptake inhibitors (SSRIs). All patients were assessed by the ICSD-3 diagnostic criteria (2014) for SB as follows: the presence of (a) regular or frequent tooth grinding sounds during sleep (>3 nights/week was used in this study) and (b) one or more of the following clinical signs (i) abnormal tooth wear, (ii) transient morning jaw muscle pain or fatigue, and/or temporal headache, and/or jaw locking on awakening consistent with reports of tooth grinding during sleep[1].

Examination of tooth wear

The wear at the upper canine's cusp tip was scored using the criteria proposed by Johansson et al[8] as follows. Score 0 is defined as no visible facets in the enamel with intact occlusal/incisal morphology, Score 1 as marked wear facets in the enamel with altered occlusal/incisal morphology, Score 2 as wear into the dentin and dentin is exposed occlusally/incisally or on an adjacent tooth surface and the occlusal/incisal morphology is changed in shape with a height reduction of the crown, Score 3 as extensive wear into the dentin, larger exposed dentin area (>2 mm^2) at the occlusal/incisal tooth surface, the occlusal/incisal morphology is totally lost locally or generally with substantial loss of crown height, Score 4 as wear into secondary dentin. In addition, any matched wear facets between upper and lower canines during eccentric jaw movements were recorded.

Evaluation of Brux Checker®

The alginate impression of the upper arch of each patient was taken and Brux Checker® was fabricated on the stone model by a trained dental technician. The patient was asked to wear Brux Checker® for 7 consecutive nights. The abraded areas were evaluated for 1st, 2nd and 7th nights according to Sato et al[9]. But this yielded an abnormally large number of SB patients (45 SB vs. 35 non-SB patients by 1st night). Therefore, only patients present with perforated areas on Brux Checker® by day 1 (P1), day 2 (P2) and day 7 (P7) were identified as 'current' bruxers and used in further analyses.

Data analysis

The association between the mean wear score on both canines vs. SB diagnosed by the ICSD-3 criteria and between the presence of cusp tip's wear (score 1, 2, 3) on each upper canine vs the presence of perforated Brux Checker® on the same side by days 1, 2 and 7 were analyzed using Chi-square tests. The sensitivity, specificity, AUC and the significance level were also determined using ROC with regard to ICSD-3 criteria and the presence of perforation. The whole analyses were repeated using the presence of cusp tip's wear combined with matched wear facet during eccentric jaw movements.

Results

The number of SB patients according to ICSD-3 criteria, P1, P2, and P7 was 16, 10, 19, 29 respectively (Table 1). The distribution of wear scores between SB and non-SB patients diagnosed by each criterion was shown in Figure 1. P1 was found to be the best predictor of ICSD-3 criteria (sensitivity = 0.875, specificity = 0.672, AUC = 0.773) (Table 2).

At individual level, when the mean wear score was analyzed with respect to ICSD-3, the cut-off score of 1.5 yielded the highest AUC (0.789, sensitivity = 0.938, specificity = 0.641). The same AUC was also found for the cut-off score of 1.5 when mean wear score was combined with matched wear facets (sensitivity = 0.875, specificity = 0.703) (Table 3). When the mean wear score (either with or without matched wear facets) was analyzed with respect to Brux Checker® perforation, it was found that none of the cut-off scores showed significant predictive values (p>0.05) (Tables 4, 5).

At tooth level, the presence of upper canine's wear

Table 1. The number of SB and non SB patients diagnosed by ICSD-3 criteria, Brux Checker abrasion proposed by Sato[9], Brux Checker® perforation P1, P2, and P7

	Diagnostic criteria				
	ICSD-3	Sato (2005)	P1	P2	P7
Non-bruxer	64	35	70	61	51
Bruxer	16	45	10	19	29

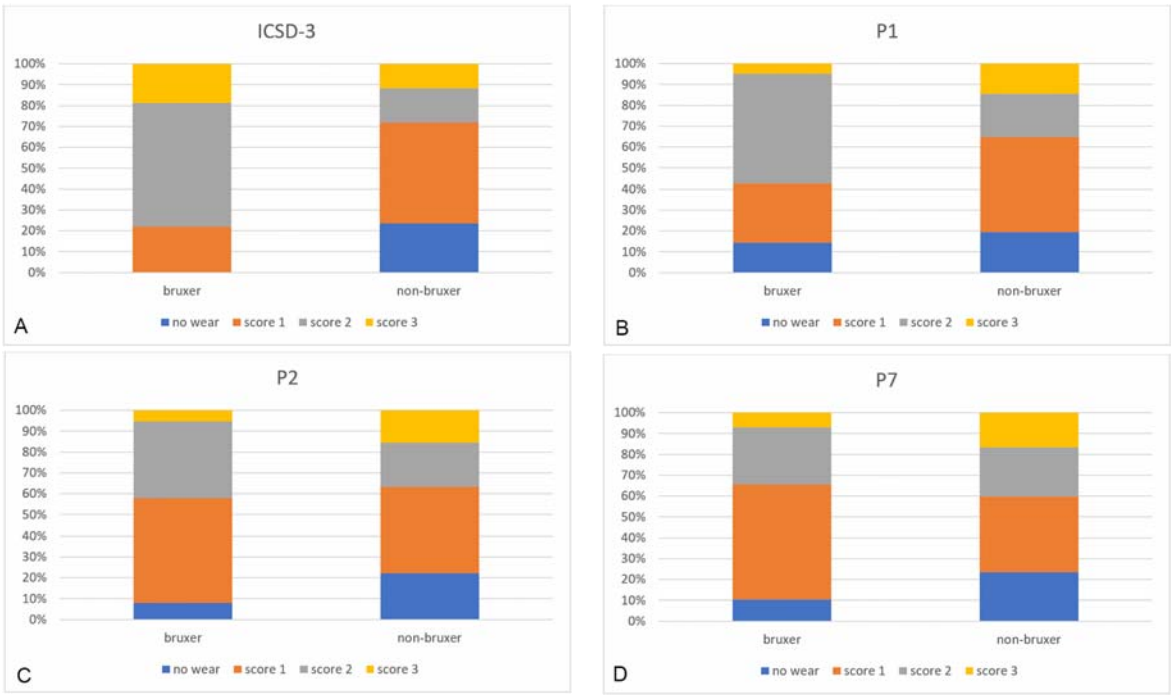

Figure 1. Distribution of wear scores of the upper canine's cusp tip in bruxers and non-bruxers as diagnosed by (A) ICSD-3 criteria, (B) Brux Checker® perforation by day 1 (P1), (C) Brux Checker® perforation by day 2 (P2), (D) Brux Checker® perforation by day 7 (P7).

Table 2. Sensitivity, specificity and AUC of Brux Checker® perforation compared to ICSD-3 criteria

	Sensitivity	Specificity	AUC	*p*-value
P1	0.875	0.672	0.773	0.001
P2	0.438	0.797	0.617	0.149
P7	0.188	0.906	0.547	0.564

Table 3. Sensitivity, specificity and AUC of using mean wear score of the upper canines' cusp tip only and when combined with matched wear facets, with respect to ICSD-3 criteria

	Cut-off score	Sensitivity	Specificity	AUC	*p*-value
Cusp-tip wear only					
	0.5	1.000	0.156	0.578	0.336
	1	1.000	0.312	0.656	0.054
	1.5	0.938	0.641	0.789	<0.001
	2	0.625	0.797	0.711	0.009
	2.5	0.188	0.844	0.516	0.847
	3	0.188	0.922	0.555	0.501
Cusp-tip wear & matched facets					
	0.5	0.938	0.422	0.680	0.027
	1	0.938	0.484	0.711	0.009
	1.5	0.875	0.703	0.789	<0.001
	2	0.563	0.812	0.688	0.021
	2.5	0.188	0.859	0.523	0.773
	3	0.188	0.922	0.555	0.501

regardless of the wear score was unable to predict Brux Checker® perforation (Table 6). However, when the presence of matched facet was analyzed, the presence of canine's wear score ≥1 could predict P2 (sensitivity = 0.842, specificity = 0.410 AUC = 0.629), and P7 (sensitivity = 0.776, specificity = 0.422, AUC = 0.599) (Table 7).

Discussion

This was the first study using wear at the upper canine's cusp tip to predict the presence of SB. Although there have been many previous studies on the association between tooth wear and SB, the assessment of tooth wear was performed in a non-specific manner in all teeth[10,11]. Since tooth wear is the result of both functional and parafunction jaw movements, the assessment of generalized tooth wear could not be accurate in the diagnosis of SB. The non-specific assessment of tooth wear might explain the controversial findings regarding tooth wear and SB. Abe et al[5] investigated the validity of using tooth wear score on pooled and individual tooth types to discriminate between

Table 4. Sensitivity, specificity, and AUC of using mean wear score of the upper canines' cusp tip only with respect to Brux Checker® perforation

	Cut-off score	Sensitivity	Specificity	AUC	*p*-value
P1	0.5	0.867	0.123	0.495	0.951
	1	0.800	0.262	0.531	0.712
	1.5	0.600	0.554	0.577	0.355
	2	0.400	0.738	0.569	0.405
	2.5	0.067	0.815	0.441	0.478
	3	0.000	0.877	0.438	0.460
P2	0.5	0.923	0.148	0.536	0.608
	1	0.846	0.296	0.571	0.304
	1.5	0.500	0.537	0.519	0.789
	2	0.308	0.722	0.515	0.829
	2.5	0.077	0.796	0.437	0.361
	3	0.038	0.870	0.454	0.511
P7	0.5	0.914	0.156	0.535	0.594
	1	0.857	0.333	0.595	0.146
	1.5	0.457	0.511	0.484	0.808
	2	0.286	0.711	0.498	0.981
	2.5	0.114	0.800	0.457	0.513
	3	0.057	0.867	0.462	0.561

Table 5. Sensitivity, specificity, and AUC of using mean wear score of the upper canines' cusp tip combined with matched wear facets with respect to Brux Checker® perforation

	Cut-off score	Sensitivity	Specificity	AUC	*p*-value
P1	0.5	0.800	0.385	0.592	0.267
	1	0.733	0.431	0.582	0.324
	1.5	0.533	0.615	0.574	0.371
	2	0.333	0.754	0.544	0.600
	2.5	0.067	0.831	0.449	0.538
	3	0.000	0.877	0.438	0.460
P2	0.5	0.769	0.407	0.588	0.203
	1	0.731	0.463	0.597	0.162
	1.5	0.462	0.611	0.536	0.600
	2	0.269	0.741	0.505	0.943
	2.5	0.077	0.815	0.446	0.435
	3	0.038	0.870	0.454	0.511
P7	0.5	0.743	0.422	0.583	0.207
	1	0.714	0.489	0.602	0.121
	1.5	0.429	0.600	0.514	0.827
	2	0.257	0.733	0.495	0.942
	2.5	0.114	0.822	0.468	0.628
	3	0.057	0.867	0.462	0.561

SB and normal subjects diagnosed with polysomnography. They have shown good discriminative and predictive values for SB when pooled sum of wear scores and the wear score in molar teeth were analyzed. However, Abe et al[5] presumably obtained the wear score from overall incisal/occlusal areas which could be both functional and parafunctional. During

Table 6. Sensitivity, specificity, and AUC of using 'tooth-level' wear score of the upper canines' cusp tip only with respect to Brux Checker® perforation on the same side

	Sensitivity	Specificity	AUC	*p*-value
P1				
Score ≥1	0.857	0.194	0.526	0.705
Score ≥2	0.571	0.647	0.609	0.106
Score ≥3	0.048	0.856	0.452	0.478
P2				
Score ≥1	0.921	0.221	0.571	0.186
Score ≥2	0.421	0.631	0.526	0.628
Score ≥3	0.053	0.844	0.448	0.338
P7				
Score ≥1	0.897	0.235	0.566	0.166
Score ≥2	0.345	0.598	0.471	0.549
Score ≥3	0.069	0.833	0.451	0.305

Table 7. Sensitivity, specificity, and AUC of using 'tooth-level' wear score of the upper canines' cusp tip combined with matched wear facets with respect to Brux Checker® perforation on the same side

	Sensitivity	Specificity	AUC	*p*-value
P1				
Score ≥1	0.810	0.374	0.592	0.176
Score ≥2	0.524	0.705	0.614	0.091
Score ≥3	0.048	0.871	0.459	0.546
P2				
Score ≥1	0.842	0.410	0.626	0.019
Score ≥2	0.368	0.689	0.528	0.597
Score ≥3	0.026	0.852	0.439	0.260
P7				
Score ≥1	0.776	0.422	0.599	0.038
Score ≥2	0.310	0.667	0.489	0.809
Score ≥3	0.052	0.843	0.447	0.270

mastication, the anterior tooth guidance in Class I Angle relationship usually occurs between the lingual inclines of upper anterior teeth and the incisal/cuspal edges of the lower anterior teeth whereas the cusp tip of upper canine is usually free from contact. It is, therefore, reasonable to assume that the presence of wear at the cusp tip of upper canines is likely to be associated with parafunctional habits. This is confirmed by the distribution of wear scores in which wear score 0 was not observed in any bruxers identified by ICSD-3 criteria and the percentage of wear score ≥2 tended to be decreased in bruxers identified by P1, P2, and P7 respectively (Figure 1).

Although polysomnography is considered the gold standard of current SB, it was not practical in our hospital-based setting. Initially, the observation of peeled areas on Brux Checker® according to Sato[9] was planned to be used as the indicator of SB. Unexpectedly, the authors have found an abnormally large proportion of SB patients (45 bruxers vs.

35 non-bruxers, Table 1) and finally decided to use perforated areas as the indicator of SB instead[12]. The perforations seen on Brux Checker® within 1-2 nights should definitely indicate current SB habit since other types of nocturnal jaw movements (e.g. swallowing, chewing-like movement) are unlikely to cause perforated areas. However, it is possible that some SB patients might not brux heavily enough to penetrate the foil. It has been shown that when the amplitude of SB bursts is below 20% MVC the peeled area might not be observed[13].

The proportion of SB vs non-SB patients was rather similar between P1, P2 and ICSD-3 criteria. The proportion of SB was increased when diagnosed by P7. This was probably explained by either the emergence of less aggressive SB patients or the accumulating damage caused by other jaw movements.

When the validity of Brux Checker® perforation was compared to ICSD-3 criteria, it was found that P1 showed rather good sensitivity (0.875) with moderate specificity (0.672). Our sensitivity was higher but specificity was lower than those shown in a previous study compared with ICSD-2 criteria (sensitivity = 0.33, specificity = 0.83)[12]. The moderate level of specificity found in our study is presumably because the ICSD-3 is rather based on past SB behavior whereas Brux Checker® perforation is based on current SB. The sensitivity of ICSD-3 criteria vs. 2-night polysomnography has been shown to be 0.7 and 0.6 with the specificity of 0.7 and 0.9 assessed by the presence of tooth wear plus self-reported SB for 1 night/week and 4 nights/week respectively[14]. The ICSD-3 criteria with self-reported SB of at least 3 nights/week used in the present study could therefore be considered to have a high specificity compared with polysomnography.

The cut-off wear score of 1.5 seemed to have good validity (AUC = 0.789) compared to ICSD-3 criteria. The cut-off score did not seem to change when mean wear score was combined with matched wear facets. However, the mean wear score of both upper canines was not able to predict the presence of SB as indicated by Brux Checker® perforation (either P1, P2, or P7). This suggested that the mean wear score could reflect the 'history' of SB rather than 'current' SB. When the wear score was evaluated in each individual canine combined with the presence of matched wear facets, wear scores greater than 1, could predict the presence of SB, identified by P2 and P7 (AUC = 0.626 and 0.599 respectively). In other words, the wear of individual upper canine's cusp tip combined with the presence of matched wear facets could better reflect 'current' SB.

The present study has some limitations. First, the standard diagnosis was done by Brux Checker®, not polysomnography. Second, all patients had Class I Angle's classification with normal overjet an overbite so the findings cannot be generalized. Nevertheless, we have demonstrated that the assessment of upper canines' cusp-tip wear could be used in screening SB patients with moderate to good validity. The mean wear score (≥1.5) seems to be a good indicator of SB according to ICSD-3 criteria with a 'high' sensitivity whereas individual tooth wear score (≥1) combined with matched wear facets could be a fair indicator of SB indicated by Brux Checker® perforation especially P2 with rather 'good' sensitivity.

Conclusion

Based on ICSD-3 criteria and Brux Checker® perforation, wear at the upper canine' cusp tips can be used in the screening of SB patients with moderate to good validity. Mean wear score seems to reflect SB 'history' whereas individual wear combined with the presence of matched wear facets seems to be a fair indicator of 'current' SB.

What is already known on this topic?

The gold standard in the diagnosis of SB is polysomnography which is not practical in clinical practice. Screening of SB is usually based on history taking and clinical examination. ICSD-3 criteria have been established to help dentists more accurately diagnose SB patients. However, the history-based nature of ICSD-3 may limit the accuracy diagnosis of current SB patients.

What this study adds?

The mean wear score of upper canine's cusp tips (≥1.5) seems to be a good indicator of SB according to ICSD-3 criteria with 'high' sensitivity whereas individual tooth wear score (≥1) combined with matched wear facets could be a fair indicator of SB according to Brux Checker® perforation with rather 'good' sensitivity and might be useful in identifying patients with 'current' SB.

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Potential conflicts of interest

The authors declare no conflicts of interest.

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ความถูกต้องของการใช้รอยสึกที่ปลายฟันเขี้ยวบนเพื่อทำนายการนอนกัดฟัน

วิศิษฎ์ ปิยะวัฒนาถาวร, มุขดา ศิริเทพทวี, สุภาภรณ์ ฉัตรชัยวิวัฒนา, จรินทร์ ปภังกรกิจ

ภูมิหลัง: การนอนกัดฟันส่งผลกระทบต่อฟันและอาจเป็นสาเหตุของความผิดปกติของระบบกล้ามเนื้อและข้อต่อขากรรไกร การวินิจฉัยการนอนกัดฟันมักได้จากการซักประวัติจากผู้ป่วยและคนที่นอนด้วย จึงยังมีความจำเป็นในการพัฒนาวิธีการตรวจทางคลินิกที่เชื่อถือได้เพื่อยืนยันการวินิจฉัย

วัตถุประสงค์: เพื่อศึกษาความถูกต้องของการใช้รอยสึกที่ปลายฟันเขี้ยวในการวินิจฉัยการนอนกัดฟัน โดยใช้แผ่น Brux Checker® เป็นมาตรฐานในการวินิจฉัย

วัสดุและวิธีการ: อาสาสมัครประกอบด้วยผู้ป่วยทันตกรรมจำนวน 80 คน ทำการตรวจคัดกรองการนอนกัดฟันด้วยเกณฑ์ ICSD-3 ร่วมกับการตรวจประเมินรอยสึกที่ปลายฟันเขี้ยวด้วยเกณฑ์ของ Johansson et al (1993) จากนั้นให้ผู้ป่วยใส่แผ่น Brux Checker® ต่อเนื่องกันเป็นเวลา 7 คืน นำมาวิเคราะห์ความไว ความจำเพาะ และ AUC ของกราฟ ROC ของระดับการสึก เปรียบเทียบกับเกณฑ์ ICSD-3 และรอยทะลุที่ตรวจพบบนแผ่น Brux Checker® ณ วันที่ 1, 2 และ 7 (P1, P2, P7)

ผลการศึกษา: พบความสามารถในการทำนายระดับความไวที่ดี (0.875) ในการใช้รอยทะลุของแผ่น Brux Checker® เทียบกับเกณฑ์ ICSD-3 (AUC = 0.773) ค่าเฉลี่ยของรอยสึกสามารถทำนายการนอนกัดฟันที่วินิจฉัยด้วยเกณฑ์ ICSD-3 (AUC = 0.789; sensitivity = 0.789 ถึง 0.875, specificity = 0.641 ถึง 0.703) แต่ไม่สามารถทำนายรอยทะลุบนแผ่น Brux Checker® ได้ อย่างไรก็ตามการสึกในระดับซี่ฟันที่มากกว่าระดับ 1 ร่วมกับการมีรอยสึกที่รับกันสามารถทำนายรอยทะลุบนแผ่น Brux Checker® (P2, P7) ได้ (AUC = 0.599 ถึง 0.626; sensitivity = 0.776 ถึง 0.842, specificity = 0.410 ถึง 0.422)

สรุป: ระดับการสึกเฉลี่ยของปลายฟันเขี้ยวบนสามารถใช้บ่งชี้การนอนกัดฟันตามเกณฑ์ ICSD-3 ได้ในระดับดี ในขณะที่การสึกระดับซี่ฟันร่วมกับการพบรอยสึกที่รับกัน สามารถใช้ทำนายการนอนกัดฟันในปัจจุบันที่บ่งชี้โดยรอยทะลุบนแผ่น Brux Checker® ในระดับพอใช้