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Diagnostic Value of the Basic Erosive Wear Examination for the Assessment of Dental Erosion on Patients, Dental Photographs, and Dental Casts

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Clinical Relevance

The assessment of the basic erosive wear examination (BEWE) on patients and on dental photographs seems to yield comparable results and therefore may be a suitable tool for longitudinal monitoring of dental erosion. The assessment of BEWE on dental casts may better be used for laboratory techniques.

SUMMARY

Objectives: The aim of this trial was to investigate the diagnostic value of the basic erosive wear examination (BEWE) in clinical use, on dental photographs, and on dental casts over a two-year follow-up period (2013-2015). According to the main hypothesis for longitudinal monitoring of dental erosion, the BEWE is equally reproducible by the three assessment methods.

Methods and Materials: The clinical assessment included intraoral photographic documentation, dental impressions, oral examination, and assessment of BEWE. Clinical assessment of BEWE was done by one blinded examiner, whereas assessment on photographs and dental casts was performed by three calibrated examiners and repeated after 14 days. The three assessment methods were analyzed separately by longitudinal agreement and inter- and intrarater reliability (in-

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traclass correlation coefficient) alongside 95% confidence intervals (CIs).

Results: Comparing the longitudinal data of the years 2013-2015, clinical use and photographs showed no significant difference (p=0.0681-0.9963), whereas the statistical analysis showed a significant difference for dental casts by comparing data from 2013 vs 2014 (p=0.0266) as well as data from 2013 vs 2015 (p=0.0001). Statistical evaluation of overall BEWE showed an intrarater reliability of 0.79-0.91 for photographs and 0.60-0.87 for dental casts. The interrater reliability was 0.77 (95% CI=[0.69; 0.84]) for photographs and 0.63 (95% CI=[0.52; 0.72]) for dental casts.

Conclusion: This investigation showed that in longitudinal clinical monitoring, the assessment of the BEWE on patients and dental photographs yielded comparable results. In addition, based on these findings, the assessment of the BEWE on dental casts showed moderate reproducibility. Therefore, dental casts may be better used for laboratory assessment techniques.

INTRODUCTION

Recent data suggest that oral health, especially caries prevalence, is improving: young adults as well as children experience less caries, and the number of remaining teeth in the elderly population is increasing.[1,2] Therefore, noncarious lesions are brought to focus. In recent years, there has been a rising interest in erosive tooth wear, because the prevalence of dental erosion throughout the European population is high,[3] seems to be increasing,[4] and treatment management is complex because of a multifactorial etiology.

The dentition experiences multifactorial physiological and nonphysiological wear over time, such as attrition, abrasion, or erosion. Dental erosion is a nonbacterial-associated loss of tooth structure and is defined as (partial) demineralization of enamel or dentin by intrinsic[5-7] or extrinsic acids.[8,9] Owing to the multifactorial etiology, the distinguishing acid-induced tissue loss can manifest itself in different ways.[10] Characteristic signs of erosive tooth wear are loss of surface contour, shallow concavities on smooth surfaces, cupping and grooving on occlusal/incisal surfaces, and "proud" restorations.[11] In addition, erosive tooth wear is defined as the accelerated loss of dental hard tissue through the combined effect of erosion and mechanical wear (abrasion and attrition).[4] Thus, early diagnosis is particularly challenging, because of the multifactorial combination of wear.

As pathological tooth wear is defined as an unacceptable level of progressive wear,[12] there is both a clinical and scientific need to be able to measure and monitor erosive tooth wear, and the literature abounds with many methods. Today, practitioners are given myriad different diagnostic tools and grading scales for qualitative and quantitative assessment of dental erosion to be used either chairside, on dental casts, on three-dimensional (3D) models, and/or on intraoral photographs. The four most commonly used evaluation systems are the tooth wear index,[13] the Eccles index,[8] the Lussi index,[14] and the basic erosive wear examination (BEWE).[10,15] They vary, for example, in type of assessment, diagnostic criteria, thresholds, and choice of teeth; therefore, a wide range of prevalence of erosive wear (4%-82% in adults) is present in the literature. Finally, this abundance of diagnostic tools and grading scales results in noncomparability of the different indices.[4,16] In 2008, Bartlett and others[15] introduced the BEWE. It was developed to provide a simpler way to monitor and record the severity and progression of erosive tooth wear in general practice as well as in education and research and in turn increased the awareness of dental erosion. Furthermore, the BEWE aims to be reproducible and comparable to other more discriminative indices. It is supposed to be used chairside, on dental casts and dental photographs in equal measure.[15]

Since its introduction, the scientific community has approved the BEWE for clinical use and epidemiological research, although the data concerning reliability and validity are still rare. Moderate to good reliability has been reported for chairside examination.[17-19] As far as we know, only one study has reported the reliability of scoring dental erosion on intraoral photographs. Mulic and others[19] showed the BEWE to be acceptable for evaluating erosive wear on photographs, being possibly on par with the clinical examination. Originally, it was developed as a tool for grading dental casts as well[15]; however, at the moment, there is only one study demonstrating its moderate reliability on dental casts.[17] A Finnish study published data on the measure's reliability on digital 3D models, finding the BEWE index to be reliable but that it may not be entirely comparable with the clinical assessment of erosive wear.[20]

To the best of our knowledge, no longitudinal study has been conducted comparing the diagnostic value of the BEWE for assessing and monitoring

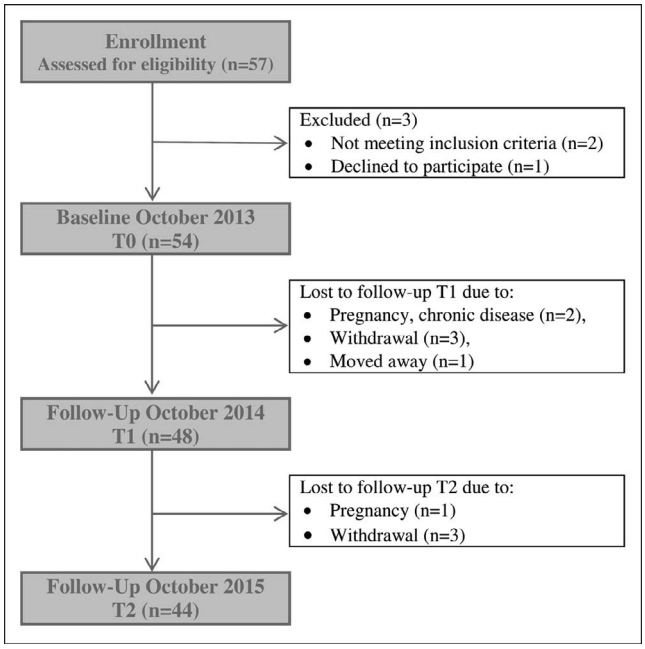

Figure 1. *Flowchart dropouts.*

dental erosion on patients, on photographs, and on dental casts.

In consideration of the scarce literature on the reliability of the BEWE index, the aim of this study was to assess the diagnostic value of the BEWE in clinical use, on dental casts, and on dental photographs over a two-year follow-up period. Accordingly, the null hypotheses were that 1) there is no longitudinal agreement of the three diagnostic methods and 2) that in a comparison of the three diagnostic methods, the BEWE is not reproducible by different examiners in longitudinal follow-up.

METHODS AND MATERIALS

Clinical Investigation

This investigation is part of a monocentric, prospective clinical cohort trial that was conducted after obtaining approval from the local medical ethics committee (S-566/2012). The study was registered at the German Clinical Trials Registry Platform (DRKS00005019) that is linked to the International Clinical Trials Registry Platform of the World Health Organization. In this clinical investigation, a formerly identified group of patients with a moderate to high risk of dental erosion (endurance athletes, 18 years of age or older, in good general health, not pregnant/nursing, not restricted in practicing oral hygiene, no signs of severe oral diseases, no dental staff or dental student, no intake of antibiotics during the past 30 days, no participation in another clinical trial within 30 days) was chosen.[21] Written, informed consent was obtained from all participants. While in 2013 there were 54 participants in the investigation, the number was reduced to 48 in 2014 and even further to 44 in 2015 because of subjects abandoning the study (see Figure 1).

The workflow is shown in Table 1. Clinical examination was performed between October 2013 and October 2015. Every year, one blinded examiner (TW) performed the standardized clinical examination. The study protocol included medical history, intraoral examination, assessment of dental erosion (BEWE), standardized photographs, and dental impressions (Impregum Penta Soft, 3M ESPE, Neuss, Germany). After professional tooth cleaning, the intraoral examination was performed by blow drying the teeth and using a dental operating light, an additional portable light-emitting diode illumination system (Bajohr LED Powerlight, Bajohr GmbH & Co. KG, Einbeck, Germany), binocular loupes (magnification 2.5×), plain mirrors, and diagnostic probes.

Clinical Assessment and Calibration

The clinical assessment and calibration are shown in Table 1. Prior to the study, all three examiners (CF, TW, and SF) respectively completed an e-learning training program successfully educating them in how to use the BEWE and ensuring they had similar theoretical knowledge (http://elearningerosion.com/de/elearning_erosion.html). To standardize the clinical investigation, 16 patients were assessed by two examiners (CF and TW) using the BEWE index (see Table 1). In the exact same manner, the BEWE was assessed on each of 20 photographs and dental casts by all three examiners (CF, TW, and SF; see Table 1).

BEWE

For assessment of erosive tooth wear, the BEWE was performed. The severity of erosive tooth wear was graded by a four-level scoring system (0-3) relying on appearance (see Table 2). In this investigation, the sextant-scoring method was performed. This means that the examination was conducted on all teeth, but only the surface with the highest score within one sextant was recorded. Fully restored surfaces were excluded. In case of doubt, the examiners were told to choose the lower of two scores. Once all the sextants had been assessed, an overall score was calculated for each patient by adding the highest

Table 1: *Flowchart Calibration and Assessment*

Clinical calibration n = 16	Calibration for standardized intraoral photographs n = 20	Calibration for dental casts n = 20
October 2013: 1. clinical investigation + dental impression + photographic documentation n = 54	1. assessment of photographs 2013 (n = 54) 1. assessment of dental casts 2013 (n = 53)	
	2. assessment of photographs 2013 (n = 54) 2. assessment of dental casts 2013 (n = 53)	
October 2014: 2. clinical investigation + dental impression + photographic documentation n = 48	1. assessment of photographs 2014 (n = 48) 1. assessment of dental casts 2014 (n = 47)	
	2. assessment of photographs 2014 (n = 48) 2. assessment of dental casts 2014 (n = 47)	
October 2015: 3. clinical investigation + dental impression + photographic documentation n = 44	1. assessment of photographs 2015 (n = 44) 1. assessment of dental casts 2015 (n = 44)	
	2. assessment of photographs 2015 (n = 44) 2. assessment of dental casts 2015 (n = 44)	

scores of each sextant and matching the result to an individual risk level.[15]

Assessment on Photographs and Dental Casts

The workflow is shown in Table 1. To guarantee standardization of intraoral photographs, the shutter speed of the camera was set to 1/125s and the aperture value to f27. The teeth were blow dried, and dental photo mirrors helped to ensure a comprehensive view of either the mandible or maxilla. For the assessment of the BEWE, at least one overview of the frontal and lateral aspect of a jaw were taken.

In 2013, 53 dental casts were made and 54 intraoral images taken; in 2014, 47 dental casts and 48 intraoral images were taken; and in 2015, 44 dental casts and intraoral images alike were taken (Table 1).

Table 2: *Visible Criteria of Basic Erosive Wear Examination (BEWE) Coding System*

Code	Visible Criteria
0	No sign of erosive tooth wear/surface loss
1	Initial loss of surface texture
2[a]	Distinct defect, hard tissue loss <50% of the surface area
3[a]	Hard tissue loss ≥50% of the surface area

[a] *In scores 2 and 3, dentin is often involved.*

Three blinded examiners (CF, TW, and SF) assessed erosive tooth wear by using the BEWE index on dental casts and standardized intraoral photographs. By reassessing the dental casts and standardized photographs again after 14 days, the intrarater reliability was evaluated (Table 1).

Statistical Analysis

The data were analyzed using descriptive statistics evaluating means and standard deviation. The primary measurement outcome was the reliability of the assessment of erosive tooth wear on dental casts and standardized intraoral photographs. Thus, the statistical analysis of the BEWE sextant score was evaluated by calculating the cumulative BEWE sum score using the results of the assessment of dental erosion on dental casts and photographs. The clinical examination was used as validation and considered as the gold standard. The extent of inter- and intrarater agreement as well as the intermethod agreement was analyzed using the intraclass correlation coefficient (ICC). The ICC values were interpreted as suggested: <0.5, poor; 0.5-0.75, moderate; 0.75-0.90, good; and 0.90-1, excellent.[22]

Table 3: *Assessment Results of the BEWE on the Three Diagnostic Methods From 2013 to 2015 Are Depicted in Mean Values (MV) and Standard Deviations (SD). Statistically significant differences were calculated between the results of the clinical assessment and, respectively, the evaluations of photographs and dental casts (*p*-value based on* t*-test for dependent samples).*

	Year	n	MV	SD	*p*-value
2013					
	BEWE score patients	54	8.396	± 3.047	—
	BEWE score photographs	54	9.25	± 2.855	0.0681
	BEWE score dental casts	54	8.698	± 3.058	0.5209
2014					
	BEWE score patients	48	7.958	± 3.696	—
	BEWE score photographs	48	8.802	± 2.692	0.1424
	BEWE score dental casts[a]	48	9.378	± 3.038	**0.0167[a]**
2015					
	BEWE score patients	44	9.295	± 3.137	—
	BEWE score photographs	44	9.293	± 2.471	0.9963
	BEWE score dental casts	44	9.869	± 2.843	0.2733

[a] *Comparing the cumulative BEWE score of dental casts in 2014 with the corresponding BEWE score of the clinical assessment, there was a statistically significant difference.*

BEWE scores were also compared between assessment methods and time points using (descriptive) *t*-tests for dependent samples. *p*-values smaller than 0.05 were regarded as statistically significant. The analysis was carried out using R 3.2.2 (http://r-project.org) and the package "psych."

RESULTS

General Data

Recruitment of patients was done between March and October 2013. The baseline examination took place in October 2013. Follow-up appointments were carried out in October 2014 and 2015. The workflow is shown in Table 1.

Of 54 participants, 13 were female and 41 were male. At the beginning of the trial, the mean age of the participants was 36.53 ± 9.49 years (range, 20-60 years).

The annual dropout rate was 11.11% from 2013 to 2014 and 8.33% from 2014 to 2015, as shown in Figure 1. Some of the patients were either university students who moved away or were unwilling to participate in the study any longer. Two participants had to discontinue their participation because of pregnancy and one due to chronic disease (Figure 1).

Table 4: *Statistically Significant Differences Were Calculated From the Results of Applying the BEWE in Clinical Examinations on Photographs and Dental Casts, Respectively (*p*-Value Based on* t*-Test for Dependent Samples)*

	Clinical Examination, *p*-Value	Photographs, *p*-Value	Dental Casts, *p*-Value
2013 vs 2014	0.52	0.1038	**0.0266***
2013 vs 2015	0.1579	0.8732	**0.0001***
2014 vs 2015	0.064	0.0697	0.1116

** Statistically significant difference.*

Calibration

The interrater reliability regarding clinical examination was good (0.88; 95% confidence interval: 0.70-0.95). The agreement between all the raters regarding intraoral photographs was moderate (0.60; 95% confidence interval: 0.23-0.81), and the interrater agreement for dental casts was good to excellent (0.90; 95% confidence interval: 0.77-0.96).

Longitudinal Agreement of the Three Methods

The results of the cumulative BEWE for all three methods are depicted as a mean value and standard deviation in Table 3. At baseline, the mean cumulative BEWE of the clinical examination was 8.396 ± 3.047 and reached 9.295 ± 3.137 after two years. The mean cumulative BEWE of intraoral photographs and dental casts at baseline were 9.25 ± 2.855 and 8.698 ± 3.058; after two years they were 9.293 ± 2.471 and 9.869 ± 2.843. Comparing the cumulative BEWE of photographs and dental casts with the corresponding BEWE of clinical examination, the assessment of dental erosion on dental casts showed a statistically significant difference in the 2014 follow-up examination (p=0.0167; Table 3).

The results of the longitudinal comparison of the three diagnostic methods are depicted in Table 4 and Figure 2. Between 2013 and 2015, the assessment of the BEWE during clinical examination showed no statistically significant increase in dental erosion (p=0.1579; see Table 4 and Figure 2). In addition, no significant increase in dental erosion could be observed in the mean BEWE score of intraoral photographs over a period of two years (p=0.8732). On the contrary, the mean BEWE score for the assessment on dental casts showed a linear trend and increased significantly after one year (p=0.0266); in addition, a highly significant increase in dental erosion was detected after two years (p=0.0001; see Figure 2 and Table 3). Null hypothesis 1 could in parts be rejected.

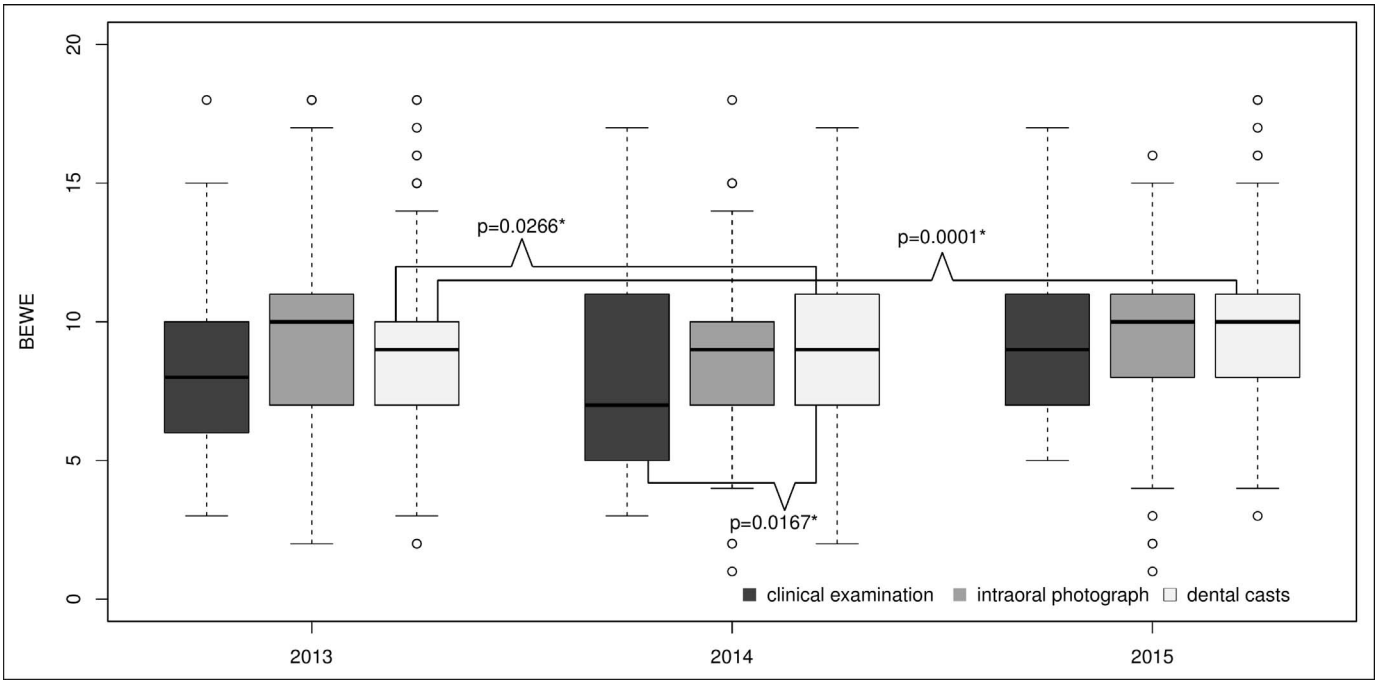

Figure 2. *Box plot of cumulative BEWE score sum of clinical examination, intraoral photographs, and dental casts over time (2013-2015). *Significant difference in the BEWE was shown for the dental casts of 2013 vs 2014 (*p*=0.0266 for paired* t*-test) and 2013 vs 2015 (*p*=0.0001 for paired* t*-test).*

Intrarater Reliability

The results of overall intrarater reliability are depicted in Table 5 and visualized in Figure 3. BEWE was assessed on intraoral photographs and dental casts, respectively. After two weeks, the assessment of the same photographs and dental casts was repeated. In the year 2015, the intrarater reliability on intraoral photographs was good to excellent (0.79-0.91), whereas the intrarater reliability performing BEWE on dental casts varied from moderate to good (0.60, 0.67, and 0.87). In the maxilla, the results varied from good to excellent (0.78-0.91) on intraoral photographs and from moderate to good (0.51-0.78) on dental casts. In the

Table 5: *Intrarater Reliability Was Calculated for the Assessment of the BEWE (Complete Dentition, Maxilla, and Mandible) on Photographs and Dental Casts of the Years 2013 to 2015. The mean cumulative BEWE sum score of intraoral photographs and of dental casts were compared within one rater.*

	Intrarater Reliability on Intraoral Photographs	95% CI	Intrarater Reliability on Dental Casts	95% CI
Complete dentition				
Rater 1	91.51%	[84.93%; 95.3%]	**67.79%**[a]	[47.85%; 81.12%]
Rater 2	85.97%	[75.66%; 92.13%]	87.25%	[77.77%; 92.87%]
Rater 3	79.35%	[65.08%; 88.23%]	**60.95%**[a]	[38.33%; 76.71%]
Maxilla				
Rater 1	91.56%	[85.02%; 95.33%]	**66.77%**[a]	[46.68%; 80.34%]
Rater 2	85.34%	[74.62%; 91.76%]	78.90%	[64.59%; 87.88%]
Rater 3	78.60%	[63.92%; 87.78%]	**51.21%**[a]	[25.90%; 70.00%]
Mandible				
Rater 1	**73.10%**[b]	[55.57%; 84.43%]	**62.29%**[b]	[40.47%; 77.45%]
Rater 2	**70.71%**[b]	[52.06%; 82.95%]	81.98%	[69.4%; 89.72%]
Rater 3	**72.63%**[b]	[54.88%; 84.15%]	**72.28%**[b]	[54.61%; 83.82%]

[a] *After 2 weeks, the assessment of dental erosion on dental casts merely showed moderate reliability.*
[b] *After 2 weeks, the assessment of dental erosion on dental casts and intraoral photographs showed moderate reliability.*

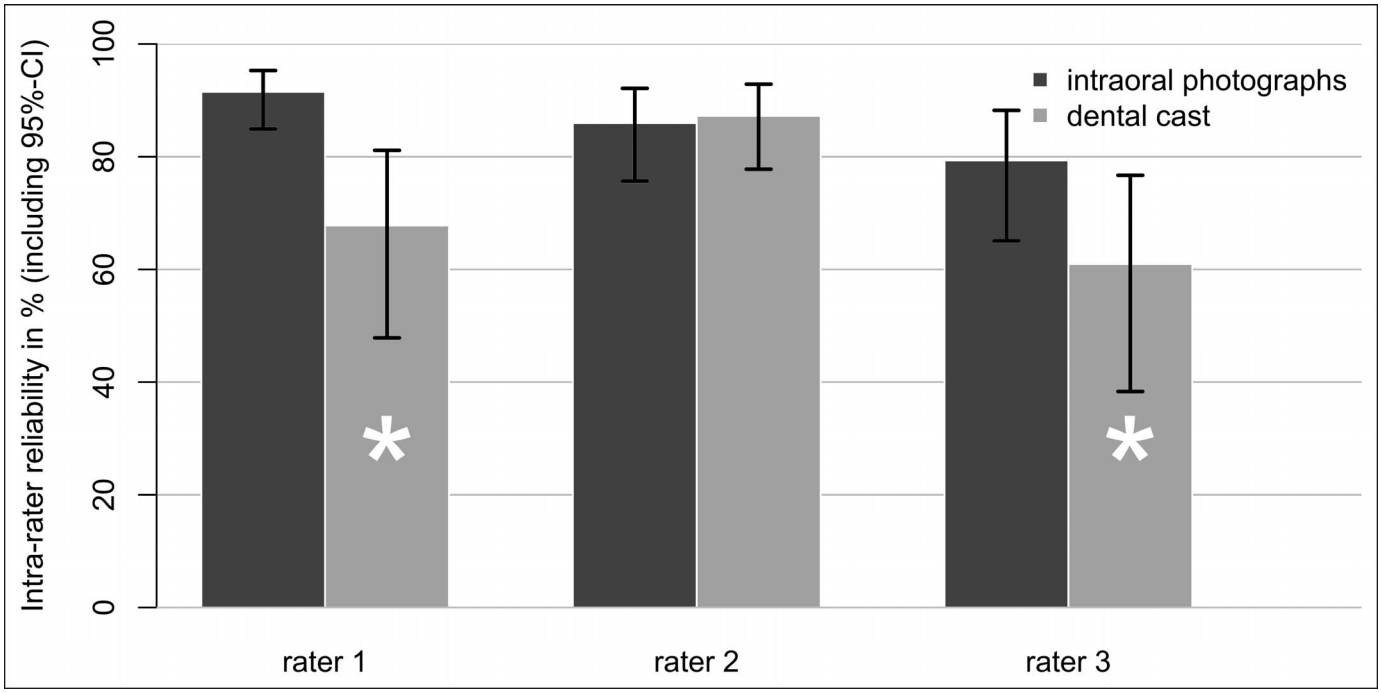

Figure 3. *Comparison of the intrarater reliability of rater 1 (CF), rater 2 (TW), and rater 3 (SF). *After two weeks, the assessment of dental erosion on dental casts merely showed moderate reliability.*

mandible, results showed a moderate intrarater reliability on intraoral photographs (0.70-0.73), and a moderate to good intrarater reliability on dental casts (0.62-0.81; see Table 5).

Interrater Reliability

The overall results of all three raters for the assessment of the BEWE on photographs and dental casts were compared with each other and are depicted in Table 6. Interrater agreement could not be calculated for the assessment of the BEWE on patients, because the clinical study protocol allowed only one blinded examiner. The statistical evaluation showed an interrater reliability on intraoral photographs between 0.67 and 0.84 and therefore was rated good. On the other hand, the interrater reliability on dental casts was moderate (0.57-0.67). In the maxilla, the statistical analysis showed a moderate to good interrater reliability on intraoral photographs (0.71-0.83). The interrater reliability on dental casts was moderate (0.55-0.66). In the mandible, a moderate to good interrater reliability on intraoral photographs (0.56-0.75) and a poor to moderate interrater reliability on dental casts (0.45-0.60) was shown.

DISCUSSION

Erosive tooth wear is a clinical condition that calls for the increased attention of the dental community and provides a challenge in forming cooperation with other medical specialties.[23] The management of erosive tooth wear needs to be preceded by an accurate diagnosis and documentation of its severity. Accurate techniques for measuring erosive tooth

Table 6: *Overall Interrater Reliability Was Calculated for the Assessment of the BEWE on Photographs and Dental Casts of the Years 2013-2015. The mean cumulative BEWE sum score of intraoral photographs and dental casts were compared between the three raters (t-test).*

	Intraoral Photographs	95% CI	Dental Casts	95% CI
Rater 1 vs rater 2	67.74%	[54.48%; 77.7%]	57.97%	[42.09%; 70.42%]
Rater 1 vs rater 3	77.58%	[67.58%; 84.78%]	67.67%	[54.39%; 77.65%]
Rater 2 vs rater 3	84.72%	[77.5%; 89.76%]	64.70%	[50.57%; 75.47%]
Rater 1 vs rater 2 vs rater 3	**77.18%**[a]	[69.37%; 83.63%]	**62.87%**[b]	[52.00%; 72.48%]

[a] *The evaluation of intraoral photographs showed good interrater reliability.*
[b] *The evaluation of the dental casts showed only moderate interrater reliability.*

surface loss have yet to be successfully adapted to clinical settings.[17] The European Federation of Conservative Dentistry recommends the BEWE index for classifying erosive tooth wear.[23] In 2008, Bartlett and others[15] presented the BEWE with the intention to initiate the development of an international accepted index, but little research has been done so far.

This study is the first investigation to evaluate the reliability of the BEWE index on dental casts, dental photographs, and in clinical examination, respectively, and therefore aims to contribute to the continued evaluation and further development of the BEWE system as an international standard. The study compares erosive wear assessment and monitoring using outcomes of analyses of dental casts, photographs, and clinical examination over a two-year period. Therefore, this investigation additionally assessed the longitudinal agreement of three diagnostic methods over a limited period of time. To the best of our knowledge, no comparable study exists in the literature so far.

Previously, the literature has shown the BEWE index to be valid and acceptable for recording dental erosion clinically,[17-19] on dental casts,[17] on 3D models,[20] as well as on dental photographs.[19] Nevertheless, publications engaging the BEWE index are few and far between. The particular strength of our investigation lies in the same three examiners assessing erosive tooth wear on photographs as well as on dental casts in the years 2013-2015. Because of the study protocol, the clinical examination could be performed by only one of the three calibrated examiners. To standardize the assessment, all three examiners were subjected to calibration. This seems to be important and may be an attempt to avoid diagnostic uncertainties.[19,24] In addition, the moderate to excellent interrater reliability during the calibration process (0.60-0.90) supports this fact.

With special regard to the different diagnostic methods, Hove and others[24] reported low to moderate intermethod agreement when assessing dental erosion (κ_w=0.43-0.52 using the VEDE index) by indirect methods, such as on dental casts and photographs, in comparison with clinical examination. On the other hand, where the BEWE index is concerned, it was recently shown that it can be used reliably both at the chair side and on photographs, and furthermore, when comparing the results of the latter two applications, equal grades were obtained.[19] The data of the present study support this assumption and showed no statistically significant difference between scoring dental erosion on patients and on photographs using the cumulative BEWE sum score (0.0681/0.1424/0.9963; Table 3; Figure 2). The BEWE sum score was evaluated over time using the results of the baseline examinations in 2013 and follow-up appointments (2014 and 2015), respectively (Table 3). Comparing the cumulative BEWE sum score of dental casts in 2014 with the corresponding BEWE sum score of the clinical assessments, a statistically significant difference was found (p=0.0167; Table 3). In addition, the analysis of the longitudinal agreement of the three methods showed that no statistically significant difference was detected between clinical examination and the assessment of dental photographs, although dental photographs showed a decrease in severity between 2013 and 2014. However, results of assessing erosive tooth wear on dental casts showed highly significant differences over the whole observation period (p=0.001) as well as between baseline examination and first follow-up appointment (p=0.0266; Figure 2; Table 4). According to this, the longitudinal assessment of the BEWE is considered to be more reliable on intraoral photographs than on dental casts. Therefore, photographs have been shown to be superior when using BEWE as an assessment tool during longitudinal follow-up. Dental casts should be used for longitudinal documentation and various methods of laboratory analysis of dental erosion.

In the present study, the level of intrarater reliability showed a good to excellent intrarater agreement in the assessment of dental erosion on intraoral photographs using the BEWE index. The raters graded the lesions with very high consistency (0.79, 0.85, 0.91), and thus it appears that the use of the BEWE index on intraoral photographs seems an eligible tool, when it comes to the assessment of erosive tooth wear and its progression. The two-week gap was considered to be an adequate period of time to avoid bias by the first assessment. However, little literature can be found considering intraexaminer agreement on photographs. The present findings coincide with current studies, which found that the assessment of the BEWE index on photographs (κ_w=0.63; κ_w=0.66-0.95) was good to excellent.[19,24] On the other hand, when assessing erosive tooth wear by using the BEWE index on dental casts, the intrarater reliability tends to show a moderate to good agreement (0.60, 0.67, 0.87; see Table 5 and Figure 3). These findings are in line with the present literature as well, which assumes that assessing erosive tooth wear on dental casts by means of the BEWE might be more difficult: moderate intrarater reliability (κ_w=0.57 and κ_w=0.60) was shown.[17,24]

With special regard to the interrater reliability, recent findings could also be confirmed. By comparing the results of the raters derived from applying the BEWE on dental casts as well as on photographs, moderate to good interrater reliability was shown for intraoral photographs (0.67-0.84), whereas the assessments of the raters concerning the use of the BEWE on dental casts yielded moderate results (0.57-0.67; see Table 6). However, there is evidence that erosive tooth wear can be graded independently of rater using the BEWE index on intraoral photographs and with a higher consistency than on dental casts. Mulic and others[19] detected similar reliability on photographs (κ_w=0.58-0.91). The wider range of results by Mulic could be a result of the lack of proper validation.[19]

In contrast to the suggestion of Bartlett and others,[15] this study claims that in longitudinal observation, the performance of BEWE on dental casts is inferior than on intraoral photographs. One of the advantages of intraoral photographs might be the display of shade and color. On one hand, restorations are detectable more easily, and on the other hand, the appearance of smooth, dull, and/or shiny surfaces can be detected on photographs more easily. As a matter of fact, changes in morphology do occur only in the more advanced stages.[25] The BEWE system does not distinguish between enamel loss and exposed dentin, which could be regarded as a way to avoid diagnostic uncertainties[15] and furthermore allows it to be used for the assessment of dental erosion on dental casts. Dental casts may have the ability to give good quantitative measurements[24] and offer the opportunity to inspect the teeth three-dimensionally from many angles. However, as it is reflected on the minor intermethod agreement, the type of surface loss (eg, caries, abfraction, attrition, abrasion, erosion) on dental casts might be difficult to differentiate correctly because of the lack of color and shade.

CONCLUSION

Based on these findings, it seems that there is evidence that the diagnostic value of the BEWE in longitudinal assessment and monitoring of erosive tooth wear yields comparable results for intraoral photographs and the clinical examination. The assessment of the BEWE on dental casts was not entirely comparable in this setting. In addition, the BEWE has been shown to be independent of rater using BEWE on photographs and on patients. Because of the moderate reproducibility, dental casts are inferior to clinical examination and intraoral photographs. Therefore, dental casts should be used for longitudinal clinical documentation, profilometry, and other 3D measurement techniques of erosive tooth loss.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the University of Heidelberg, Medical Faculty, Ethics Committee (German: Ethikkommission der Medizinischen Fakultät Heidelberg, Universitaet Heidelberg, Germany). The approval code for this study is S-566/2012.

Author Contributions

TW wrote the first draft of the publication, is responsible for the content as guarantor, and conducted the clinical examination. CF planned the study and provided expertise in the interpretation of the data and final manuscript. CF, SF, and TW conducted the assessment on dental casts and standardized intraoral photographs. DS carried out the data analysis. DW co-developed the study and worked on subsequent publication drafts.

Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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