



INTRAORAL SCANNERS FOR EROSIVE TOOTH WEAR IN PRIMARY DENTITION

S. DANCY, S. RAMOS-DÍAZ, D. SARDANA, A. HARA, B. SANDERS, G. ECKERT, A. CASTILHO
 Indiana University School of Dentistry, Indianapolis, Indiana – Riley Hospital for Children

ABSTRACT

Purpose: To evaluate the performance of intraoral scanners (IOS) in detecting erosive tooth wear (ETW) in primary teeth using the Basic Erosive Wear Examination (BEWE) index.

Methods: A cross-sectional clinical study was conducted involving 36 children aged 3–12 years. An average of 13 untreated primary teeth per participant was assessed across occlusal, buccal, and lingual surfaces using direct visual examination and indirect digital scanning, yielding 1,484 tooth surface observations. Agreement between methods was evaluated using percent agreement and Cohen's Kappa statistics ($\alpha = 0.05$).

Results: Overall agreement was 86%, with indirect assessments tending to under-score BEWE 3 lesions and over-score BEWE 1 lesions. Moderate to substantial agreement was observed ($\kappa = 0.69$; weighted $\kappa = 0.73$; $p < 0.001$). When BEWE scores were dichotomized as erosive tooth wear versus no erosive tooth wear, agreement ranged from 91–96%, with sensitivity of 68–94% and specificity of 90–97%.

Conclusion: Intraoral scanners demonstrated moderate to substantial agreement for the assessment of erosive tooth wear in primary dentition and may serve as a useful adjunctive diagnostic tool in pediatric dentistry.

STUDY DESIGN

- Cross-sectional design in which each participant's primary tooth underwent both a clinical visual examination (direct assessment) and evaluation using 3D digital images (indirect assessment) captured using the iTero Element (Align Technology, Inc., Tempe, AZ, USA). A total of 36 participants, with an average of 13 primary teeth, per participant, were included in the study. Overall, 1,484 tooth surfaces (buccal/facial, palatal/lingual, and occlusal/incisal surfaces) were assessed.
 - The study was approved by the Institutional Review Board (# 24373) and registered in Clinicaltrials.gov (NCT06829550). **Written informed consent was obtained** at the screening visit from the parent or legal guardian of each participant prior to study procedures. Participants received a small incentive upon completion of the study.
- Inclusion Criteria**
- Children between the ages of **3 and 12 years old**.
 - Children with at least one completely erupted **primary tooth**.
 - Children currently enrolled as patients at the Indiana University School of Dentistry or the Riley Pediatric Dental Clinic.
- Exclusion Criteria**
- Children with no primary teeth or presenting them partially erupted to avoid difficulties in assessment and inaccurate results.
 - Children with a history of a systemic condition that may affect oral health and enamel developmental disturbances, which could confound study outcomes.
 - Teeth with existing restorations (fillings, crowns, etc.).

ASSESSMENT

- Examiners and Calibration**
- Two examiners were trained on the **BEWE index** and Intraoral Scanner (IOS) usage prior to the study.
 - One examiner was randomly assigned to the direct assessment another examiner completed the indirect assessment for each patient.
- Clinical Assessment**
- Primary teeth were visually examined for Erosive Tooth Wear (ETW) using the **standardized BEWE index**.
- Direct Assessment**
- Teeth were cleaned with gauze, rinsed, and air-dried under overhead dental lighting to ensure clear visibility.
 - Examiners evaluated the **buccal/facial, palatal/lingual, and occlusal/incisal surfaces** of each erupted primary tooth.
 - Lesions were graded based on the specific criteria outlined in the study's reference table (Table 1).
- Indirect Assessment**
- Each tooth was scanned with the **iTero Element IOS** to create high-resolution 3D images for digital analysis of ETW.
 - Scanning was performed with the participant reclined for visibility, notably **without the use of additional overhead lighting**.
 - All tooth surfaces (lingual, buccal, and occlusal) were analyzed digitally using the **same BEWE criteria** as the direct assessment.

PHOTOS



RESULTS

A total of 36 participants were included, contributing 1,484 tooth surfaces for analysis. Most evaluated surfaces were classified as BEWE 0, whereas severe lesions (BEWE 3) represented a small proportion of the sample (Table 2). Overall agreement between the direct and indirect BEWE scores was 86%. Cohen's kappa indicated substantial agreement ($\kappa = 0.69$, 95% CI: 0.65–0.73), with a weighted kappa of 0.73 (95% CI: 0.70–0.77). The Cochran–Mantel–Haenszel chi-square test showed a statistically significant difference in the distribution of scores between the two assessments ($n < 0.001$). Disagreements were primarily observed between adjacent severity categories. The indirect assessment tended to over-score mild lesions (BEWE 1) and under-score severe lesions (BEWE 3), as detailed in Table 2. Agreement by severity category, including the direction of disagreement, is presented in Table 3. When BEWE scores were dichotomized into erosive tooth wear and no erosive tooth wear, agreement and diagnostic performance varied across severity thresholds. Lower sensitivity was observed at the highest severity cutoff (BEWE ≥ 3), whereas specificity remained consistently high across thresholds, as shown in Table 4.

TABLES

Table 1: BEWE Index

Index	Code	Description
	0	No erosive tooth wear
	1	Mild erosive tooth wear: Initial loss of surface texture.
	2	Moderate erosive tooth wear: Distinct defect: hard tissue loss involving less than 50% of the surface area.
	3	Severe erosive tooth wear: Hard tissue loss involving more than 50% of the surface area. Moderate and severe levels may involve dentine exposure.

* BEWE: Basic Erosion Wear Examination

Table 3. Agreement between direct and indirect BEWE scores by severity category

ETW Cutoff	% Agreement	Specificity	Sensitivity	Kappa (95% CI)	p-value
BEWE ≥ 1	91	90	94	0.78 (0.74–0.81)	<0.001
BEWE ≥ 2	91	90	93	0.72 (0.68–0.77)	<0.001
BEWE ≥ 3	96	97	68	0.53 (0.42–0.65)	0.002

Table 2. Cross-tabulation of BEWE scores from direct and indirect assessments (n = 1,484 tooth surfaces).

	INDIRECT				
	0	1	2	3	Total
DIRECT 0	999 (67%) [90%]	9 (1%) [9%]	11 (1%) [5%]	2 (<1%) [4%]	1021 (69%)
DIRECT 1	28 (2%) [3%]	60 (4%) [58%]	5 (<1%) [2%]	1 (<1%) [2%]	94 (6%)
DIRECT 2	71 (5%) [6%]	31 (2%) [30%]	186 (13%) [84%]	12 (1%) [26%]	300 (20%)
DIRECT 3	14 (1%) [1%]	4 (<1%) [4%]	19 (1%) [9%]	32 (2%) [68%]	69 (5%)
Total	1112 (75%)	104 (7%)	221 (15%)	47 (3%)	1484

Table 4. Diagnostic performance of indirect assessment at different BEWE thresholds

Direct	% Agreement with indirect	% Under-scored (Indirect)	% Over-scored (Indirect)
0	90	—	10
1	58	9	34
2	84	7	9
3	68	32	—

REFERENCES

