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# Impact of **Digital Dentistry on the Clinical Assessment and Management of Erosive Tooth Wear (ETW)**

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The below article features input from healthcare professionals from the US

## Introduction

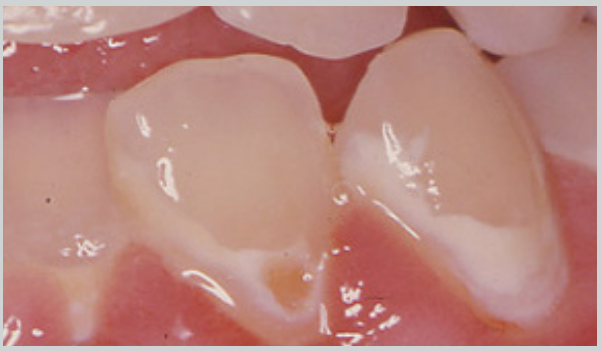
Erosive tooth wear (ETW) is a dental condition characterized by the clinical loss of dental hard tissue (enamel and/or dentin) that is chemically etched away from the tooth surface, primarily by the frequent exposure to acids in the mouth.[1] These acids can be of intrinsic (gastric juice) or extrinsic (acidic beverages and foods) nature and are different from those involved in the formation of dental cavities, which are produced by bacteria from the dental plaque. The marked clinical differences between these dental pathologies are illustrated in Fig 1.

### Fig 1. ETW vs. Dental Caries.

**a. Erosive Tooth Wear**

- Occurs on plaque-free surface
- Involves softening of the surface
- Acids are relatively strong

**b. Dental Caries**



- Plaque is a pre-requisite
- Involves subsurface demineralization
- Acids are relatively weak (lactic acid)

The prevalence of ETW has been reported to be high. A nation-wide evaluation has shown that approximately 46% of teenagers and 80% of adults were affected by this condition in the U.S., in the early 2000s.[2,3] While more recent data is lacking, there is strong suggestion that these numbers either remain the same or have increased. Similar prevalence trends have been observed in European and South American countries. Several factors can contribute to these alarming numbers, including the high consumption of acidic beverages. Americans are notoriously known for their high soft drink intake, with estimated average consumption per capita of ~60 gallons (228 liters) per person, in a year.[4] Other recent acidic beverage types, such as energy drinks, sport drinks, fermented juices and teas have also become increasingly popular. This is concerning since scientific literature clearly shows a positive correlation between acidic drink consumption and ETW.[5-7] Another important aspect to consider is the cumulative nature of ETW. Counter intuitively, positive health indicators such as better oral hygiene - leading to improved teeth retention - and increased patient longevity can be considered risk factors for ETW, since the irreversible and cumulative loss of tooth structure tends to show more severe levels at older age.

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The successful clinical management of ETW should be heavily based on the early diagnosis, implementation of preventive measures and clinical monitoring. However, the early detection and differentiation of ETW lesions are not easy tasks. The early clinical signs of ETW are subtle and may not be perceived even by experienced and trained dentists.[8] They are characterized by the absence of the perichymata on the facial aspect of maxillary front teeth, and less defined groove-fossae system on the occlusal of permanent molars. In some cases, it is possible to visualize a cervical enamel band on the buccal and lingual surfaces of maxillary molars, from an incisal view angle. These characteristics are illustrated in Fig 2.

**Fig 2. Clinical characteristics of the very early stages of ETW[8]**

- Abscence of the perichymata (facial aspect of maxillary front teeth)

- Visualization of a cervical enamel band (buccal/lingual of maxillary incisors)

Perhaps the biggest challenge faced by clinicians is that the clinical assessment of the presence and severity of ETW is determined mainly by visual examination of the tooth surfaces, using subjective indices. Although useful to identify major changes in tooth structure loss qualitatively, these visual indices have major limitations. They are not able to objectively monitor ETW progression and allow for disagreement among dentists. These limitations can directly affect their clinical performance and use for the detection and management of ETW. Current advances in digital dentistry, specifically on 3D digital intra-oral scanners (IOS) have the potential to positively impact this field.

## Digital Dentistry Current Status and Future

Digital dentistry involves the use of technological tools, comprised by hardware devices and software solutions, to facilitate or improve dental care delivery by dental healthcare providers (DHP). Among those, the use of 3D digital intraoral scanners (IOS) stands out as a potential solution for the subjectivity involved in the clinical assessment of ETW. IOS are clinical tools that can capture the 3D morphology and color of tooth surfaces and surrounding structures. They utilize optical sensors that collect data that are further processed by dedicated software. Point clouds are generated and triangulated creating a 3D virtual model. These virtual models function as an alternative to the traditional physical (plaster) models, with the advantages of being more comfortable for the patient and time-efficient for the DHP, and eliminates the need for physical storage space. Over the last years, several manufacturers have introduced new IOS models on the dental market, which in addition to the increasing demand, has led to a decrease in the purchase costs and increased affordability. Therefore, this tool has become more common on dental practices. It is worth noting that an increasing number of dental schools and educational institutions have also incorporated IOS not only in dental specialty but also comprehensive care clinics.

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This current scenario creates exciting opportunities to effectively incorporate IOS in daily dental practice. IOS can be extremely useful tools in various fields of dentistry, including cariology, operative dentistry, prosthodontics, orthodontics and oral surgery.[9] Applications range from diagnosis, treatment planning and communication with patients, to fabrication of customized prosthetic restorations and orthodontic devices.

Specifically to the clinical management of ETW, the use of virtual 3D colored models can help the identification and objective determination of the severity level of ETW lesions[10] (Fig 3). It also facilitates the communication among DHPs – which is crucial for an exchange of information to improve ETW diagnostics and opinions – and between DHP and patients, who will become more aware of their dental conditions and involved with treatment.[11,12] It is known that one of the main challenges for the successful management of ETW is to increase patients' and DHPs' awareness of this condition. Previous studies have shown that less than 10% of patients and approximately 15% of DHPs were able to identify early stages of ETW.[13,14] In comparison, a significantly higher percentage of patients (75%) and DHPs (+90%) were able to correctly identify early stages of dental caries.[13,14]

The generation of 3D-colored digital dental images using IOS can be used as a tool for the education of patients and communication among DHPs, therefore showing the potential to improve ETW awareness and close this knowledge gap. In fact, with the use of 3D dental imaging, patients can understand and feel more emotionally involved with their dental problem, enhancing adherence to their preventive and therapeutic measures.[9]

## % of patients and DHPs able to identify early stages of ETW vs dental caries

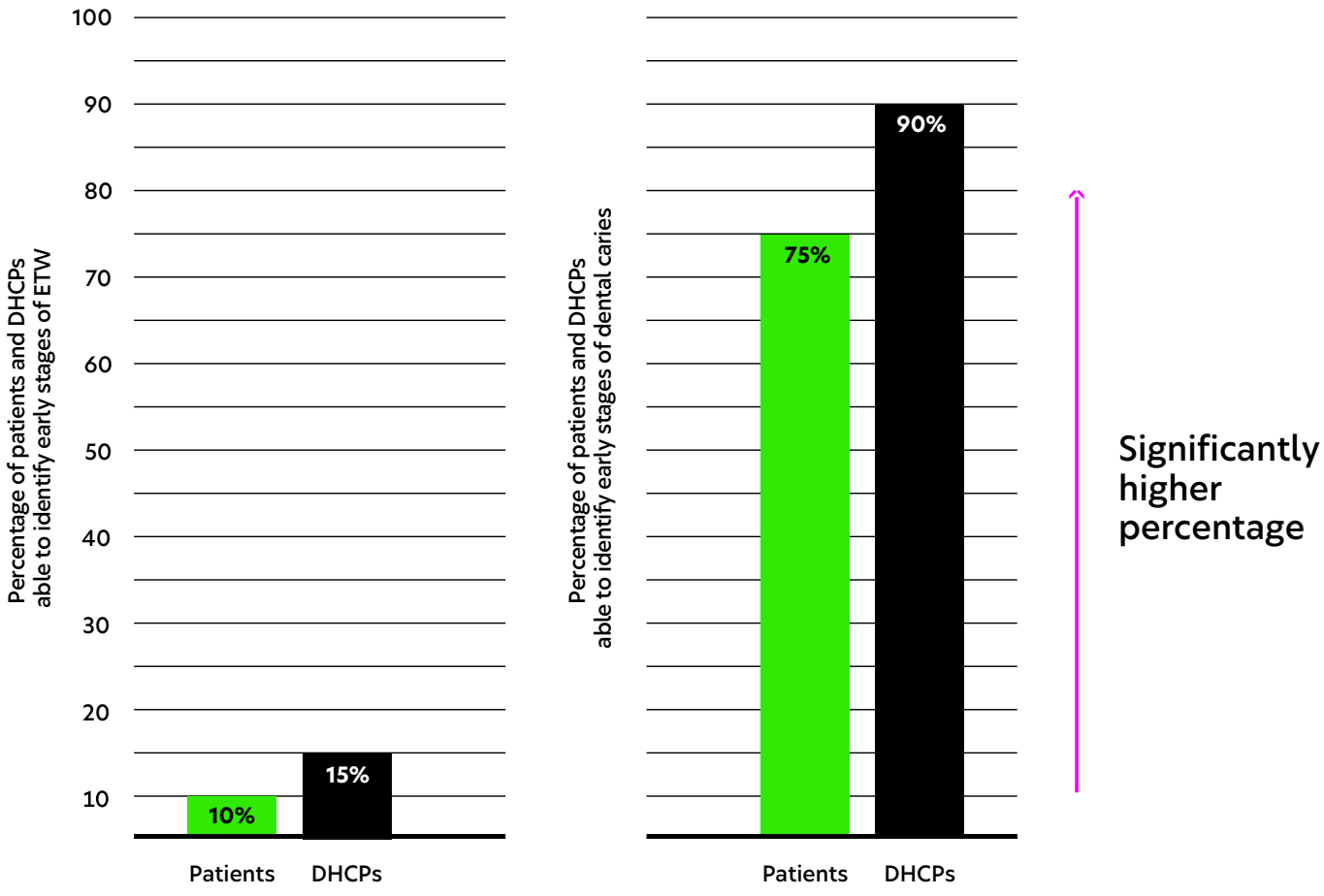

**Fig 3. Different views of an extracted molar with severe ETW captured by photographic camera and IOS (credits: Giovanna Denucci).**

**a. Photographic camera**

**b. Intra-oral scanner**

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Laboratory studies have verified the ability of IOS to be used for the assessment of ETW and have shown that IOS can identify ETW at advanced stages[15,16] and potentially even at earlier stages,[17] when this condition may be unnoticed by unaware DHPs. In principle, the generated 3D digital images of the same tooth at different time points can be analyzed for tooth wear by superimposition with the aid of computer software, where differences on tooth morphology – caused by wear processes – can be quantified by subtraction.[18] More recently, clinical investigations have corroborated the laboratory observations, indicating that IOS can be a reliable tool for the ETW assessment in vivo[19,20] with high percentages of sensitivity and specificity.[12] In a rough comparison to the visual clinical indices, it is possible to suggest that IOS allows DHPs to measure macroscopic changes on the tooth due to ETW. Even though existing IOS may still not present resolution levels high enough to display tooth wear at the microscopic level, their current performance is already a significant improvement to the current standard of care – the visual examination. Moreover, IOS resolution is likely to improve, along with future technologies.

The creation of electronic datasets for dental hard-tissue conditions, including ETW, is a fundamental step towards the future. It opens several opportunities for the use of artificial intelligence applications to improve diagnostic performance based on the morphology and surface characteristics of the tooth. Computers and machine learning algorithms can analyze and interpret massive amount of data significantly faster and more accurately than humans, identifying patterns and aiding not only on dental-hard tissue diagnosis but also on the management and clinical outcomes prediction.

## Summary and Conclusion

IOS have advanced significantly over the last years and have positively impacted different fields of dentistry. They have become more accessible and therefore can be considered realistic and valuable tools to help dentists provide improved dental health care for patients. The 3D digital images generated by the IOS can impact the clinical management of ETW in the specific aspects highlighted below and will benefit from its association with artificial intelligence.

- Early detection of ETW lesions, identifying loss of natural dental surface texture
- Ability to differentiate ETW from other dental hard-tissue conditions (e.g. caries, fluorosis, etc)
- Objectively determine the ETW severity level
- Patient teaching, education and motivation
- Implementation of ETW preventive measures
- Treatment delivery with the help of computer-aided tools (e.g. restorative treatment)
- Objective clinical monitoring of ETW progression
- Prediction of ETW progression (integrated with artificial intelligence)
- Advance on ETW objective outcomes in clinical research

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## References


1. Schlueter N, Amaechi BT, Bartlett D, Buzalaf MAR, Carvalho TS, Ganss C, Hara AT, Huysmans MDNJM, Lussi A, Moazzez R, Vieira AR, West NX, Wiegand A, Young A, Lippert F. Terminology of Erosive Tooth Wear: Consensus Report of a Workshop Organized by the ORCA and the Cariology Research Group of the IADR. Caries Res. 2020;54(1):2-6. doi: 10.1159/000503308.
2. Okunseri C, Wong MC, Yau DT, McGrath C, Szabo A. The relationship between consumption of beverages and tooth wear among adults in the United States. J Public Health Dent. 2015 Fall;75(4):274-81. doi: 10.1111/jphd.12096.
3. McGuire J, Szabo A, Jackson S, Bradley TG, Okunseri C. Erosive tooth wear among children in the United States: relationship to race/ethnicity and obesity. Int J Paediatr Dent. 2009 Mar;19(2):91-8. doi: 10.1111/j.1365-263X.2008.00952.x.
4. Sanrachna Foundataion: https://www.sanrachna.foundation/global-soft-drink-consumption/
5. Li H, Zou Y, Ding G. Dietary factors associated with dental erosion: a meta-analysis. PLoS One. 2012;7(8):e42626. doi: 10.1371/journal.pone.0042626.
6. Salas MM, Nascimento GG, Vargas-Ferreira F, Tarquinio SB, Huysmans MC, Demarco FF. Diet influenced tooth erosion prevalence in children and adolescents: Results of a meta-analysis and meta-regression. J Dent. 2015 Aug;43(8):865-75. doi: 10.1016/j.jdent.2015.05.012.
7. Chan AS, Tran TTK, Hsu YH, Liu SYS, Kroon J. A systematic review of dietary acids and habits on dental erosion in adolescents. Int J Paediatr Dent. 2020 Nov;30(6):713-733. doi: 10.1111/ipd.12643.
8. Carvalho JC, Scaramucci T, Aimée NR, Mestrinho HD, Hara AT. Early diagnosis and daily practice management of erosive tooth wear lesions. Br Dent J. 2018 Mar 9;224(5):311-318. doi: 10.1038/sj.bdj.2018.172.
9. Mangano F, Gandolfi A, Luongo G, Logozzo S. Intraoral scanners in dentistry: a review of the current literature. BMC Oral Health. 2017 Dec 12;17(1):149. doi: 10.1186/s12903-017-0442-x.
10. Ganss C, Lussi A. Diagnosis of erosive tooth wear. Monogr Oral Sci. 2014;25:22-31. doi: 10.1159/000359935.
11. Touati R, Sailer I, Marchand L, Ducret M, Strasding M. Communication tools and patient satisfaction: A scoping review. J Esthet Restor Dent. 2022 Jan;34(1):104-116. doi: 10.1111/jerd.12854.
12. García VD, Freire Y, Fernández SD, Murillo BT, Sánchez MG. Application of the Intraoral Scanner in the Diagnosis of Dental Wear: An In Vivo Study of Tooth Wear Analysis. Int J Environ Res Public Health. 2022 Apr 8;19(8):4481. doi: 10.3390/ijerph19084481.
13. Goldfarb MB, Maupomé G, Hirsh AT, Carvalho JC, Eckert GJ, Hara AT. Dentists clinical decision-making for erosive tooth wear: An online pilot study. J Dent. 2020 Sep;100:103424. doi: 10.1016/j.jdent.2020.103424.
14. Goldfarb MB, Hara AT, Hirsh AT, Carvalho JC, Maupomé G. Are dental patients able to perceive erosive tooth wear on anterior teeth?: An internet-based survey assessing awareness and related action. J Am Dent Assoc. 2020 Jan;151(1):10-15. doi: 10.1016/j.adaj.2019.07.036.
15. Kumar S, Keeling A, Osnes C, Bartlett D, O'Toole S. The sensitivity of digital intraoral scanners at measuring early erosive wear. J Dent. 2019 Feb;81:39-42. doi: 10.1016/j.jdent.2018.12.005.
16. Marro F, Jacquet W, Martens L, Keeling A, Bartlett D, O'Toole S. Quantifying increased rates of erosive tooth wear progression in the early permanent dentition. J Dent. 2020 Feb;93:103282. doi: 10.1016/j.jdent.2020.103282.
17. Michou S, Vannahme C, Ekstrand KR, Benetti AR. Detecting early erosive tooth wear using an intraoral scanner system. J Dent. 2020 Sep;100:103445. doi: 10.1016/j.jdent.2020.103445.
18. O'Toole S, Osnes C, Bartlett D, Keeling A. Investigation into the validity of WearCompare, a purpose-built software to quantify erosive tooth wear progression. Dent Mater. 2019 Oct;35(10):1408-1414. doi: 10.1016/j.dental.2019.07.023.
19. Travassos da Rosa Moreira Bastos R, Teixeira da Silva P, Normando D. Reliability of qualitative occlusal tooth wear evaluation using an intraoral scanner: A pilot study. PLoS One. 2021 Mar 25;16(3):e0249119. doi: 10.1371/journal.pone.0249119.
20. Schlenz MA, Schlenz MB, Wöstmann B, Jungert A, Ganss C. Intraoral scanner-based monitoring of tooth wear in young adults: 12-month results. Clin Oral Investig. 2022 Feb;26(2):1869-1878. doi: 10.1007/s00784-021-04162-6.


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