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Quantification of incisal tooth wear in upper anterior teeth: Conventional vs new method using toolmakers microscope and a three-dimensional measuring technique

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ABSTRACT

Objectives: This study aimed to quantify tooth wear in upper anterior teeth using a new CAD-CAM Laser scanning machine, tool maker microscope and conventional tooth wear index.
Methods: Fifty participants (25 males and 25 females, mean age = 25 ± 4 years) were assessed for incisal tooth wear of upper anterior teeth using Smith and Knight clinical tooth wear index (TWI) on two occasions, the study baseline and 1 year later. Stone dies for each tooth were prepared and scanned using the CAD-CAM Laser Cercon System. Scanned images were printed and examined under a toolmaker microscope to quantify tooth wear and then the dies were directly assessed under the microscope to measure tooth wear. The Wilcoxon Signed Ranks Test was used to analyze the data.
Results: TWI scores for incisal edges were 0–3 and were similar at both occasions. Score 4 was not detected. Wear values measured by directly assessing the dies under the toolmaker microscope (range = 113–150 μm, mean = 130 ± 20 μm) were significantly more than those measured from Cercon Digital Machine images (range = 52–80 μm, mean = 68 ± 23 μm) and both showed significant differences between the two occasions.
Conclusions: Wear progression in upper anterior teeth was effectively detected by directly measuring the dies or the images of dies under toolmaker microscope. Measuring the dies of worn dentition directly under tool maker microscope enabled detection of wear progression more accurately than measuring die images obtained with Cercon Digital Machine. Conventional method was the least sensitive for tooth wear quantification and was unable to identify wear progression in most cases.

1. Introduction

Tooth wear is an irreversible condition with multifactorial aetiology that may progress in severity if its causes are not identified and dealt with.[1–3] The basis for tooth wear management should include early diagnosis, prevention and intervention to avoid extensive and complex treatments.[1–4]

Many methods were developed and used to quantify tooth wear. Probably the most popular method is using conventional

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clinical tooth wear indices (TWIs).[5–9] They are readily available and does not require special equipments. Nevertheless, TWIs are subjective, not capable of measuring initial and minimal wear changes, and take long time to get significant results.[10–12] Also; the presence of many TWIs caused problems in the reliability of diagnosis, standardization, and quantification of tooth wear, which in turn made it difficult to compare the results of various epidemiological studies.[11]

In an attempt to overcome flaws of clinical wear assessment using TWIs; indirect and mechanical evaluation techniques were devised. Some techniques compared tooth surface loss on cast replicas according to a set of standards.[13–15] However, Wetselaar et al.[16] concluded that clinical assessment of tooth wear was more reliable than the grading of dental casts especially for nonocclusal/nonincisal surfaces.

Other methods were also developed and utilized for more accurate wear quantification. These include direct cusp height measurement[17], image analysis[18,19], scanning electron microscopy[20], computer graphics and profilometry[21–23]. Unfortunately, such methods are not easy to handle and require measuring dental casts as well as subjective evaluation of wear by examiner.[24] Moreover, indirect approaches such as grading of dental casts or epoxy models by means of visual inspection[9,25,16] or computer analyses[26] have limited applicability to the everyday dental practice because that the identification of dentine exposure is difficult or even impossible to achieve.

The above methods used more advanced measuring tools including stereo microscope, customized/commercial profilometer, computerized 3D measuring microscope, laser profilometer, profile projector, vernier calliper, and tool maker microscope.[27] Disadvantages of them include inaccurate replicas (which cause high standard deviations of measurements), repositioning problems, and measuring device restrictions.[28]

Also, advanced 3D measuring techniques were utilized in clinical studies and were capable to differentiate between early wear behaviour of restorative materials as well as identification of wear within 10 μm.[15,22,27,29] Such systems should be time effective, highly accurate, allow 3D scanning of the entire tooth surface, and do not affect tooth structure.[22] However, 2D and 3D methods of image analysis are time consuming and have high cost.[30] Moreover, Computer-aided analysis of direct imaging of the affected teeth, impressions or study models has not yet reached the stage of being a useful clinical tool for general practice.[31,32]

However, DeLong[33] concluded that comparing sequential 3D images of surface topologies is the most accurate method for measuring wear. Three-dimensional images are obtained using contact profilers, non-contact white light, micro/cone CT scanners, laser scanners, and CAD/CAM systems.

Three-dimensional scanning is the preferred technique to measure wear because it is accurate, quantitative, applicable to both the clinic and the laboratory, and offers storing 3D databases that enable comparison to other 3D databases.[27,34] However; 3D scanning is costly and requires a specialized hardware and software. Nevertheless, with the dropping of cost of scanners and the increased number of scanning services, an increasing number of clinical studies will possibly use this technology in the future.

This study aimed to quantify tooth wear in upper anterior teeth over a 1-year period using three methods including a new CAD-CAM Laser scanning machine (Cercon Brain, Cercon Smart Ceramics, DeguDent, Germany) with toot maker microscope, directly measuring tooth stone dies with tool maker microscope and clinically evaluating wear using Smith and Knight conventional tooth wear index. Also, to compare the ability of the three methods to quantify wear.

The null hypothesis was set to be that there are no differences in the ability of the three tested methods to quantify tooth wear.

2. Materials and methods

Fifty consecutive participants (25 males and 25 females) were recruited into this study. Participants' ages ranged between 21 and 29 years old (mean = 25 ± 4 years). All participants were undergraduate students enrolled in Jordan University of Science & Technology (JUST), Irbid, Jordan.

Participants were included in the study if they have no periodontal disease, have all upper anterior teeth present without restorations or caries, and have tooth wear involving their anterior teeth.

Patients with periodontal disease, missing upper anterior teeth, badly carious, or restored anterior teeth were excluded from the study. Also, participants with orthodontic appliances, fixed or removable prosthodontic prostheses and/or those who had any dental treatment during the one year interval of the study were excluded.

The study was ethically approved by the committee of studies on humans, Deanship of Research, Jordan University of Science & Technology. Informed consents were obtained from the participants after they received full explanation of the study.

In total, 52 participants agreed to participate in the study and 2 were excluded; one male participant was excluded due to leaving the country and one female participant was excluded due to having fixed prosthodontic treatment to restore her upper anterior teeth during the one year interval of the study.

Patients were told to maintain good oral hygiene to avoid changes in gum level and their oral hygiene was monitored throughout the study. The methods in this study followed those applied in a previous study by AL-Omiri et al. 2010.[35]

2.1. *Patient assessment using tooth wear assessment questionnaire*

A modified Tooth wear Assessment Questionnaire was completed for each patient.[12,36] The questionnaire targeted potential risk and protective factors for all types of tooth wear, as well as patients' personal and demographic data. The questionnaire included demographic data (such as name, gender, age, education, marital status, occupation and residency) and clinical data (such as frequency of dental visit, oral hygiene practice, clenching/grinding, and tooth brushing habits). It also, included a thorough review of the patient's medical history, dental history, diet and fluid intake, and potential occupational factors and/or habits.