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Clinical Association between Dental Caries and Diabetes Mellitus among Children and young adults: ICDAS and Microbiological Assessment

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Abstract

Objective: Diabetes mellitus (DM) is a common systemic disease which usually combined with various oral consequences among the diabetic population. However, there was a high risk of caries incidence among the diabetic population. Therefore, this study aimed to correlate the incidence of dental caries and this systemic disease, using a new caries assessment system known as International Caries Detection and Assessment System (ICDAS).

Subject and methods: A total of four hundred Egyptian children and young adults aged between 5-16 years was enrolled in this study. Designed criteria were outlined during the selection of the enrolled subjects. The enrolled subjects were divided into a healthy "control group", and subjects with DM "studied group".

Results: ICDAS results revealed a significantly higher caries incidence among the subjects with DM with significantly higher dentine defects. However, the microbiological results showed a significant increase in the *Streptococcus mutans* and *Lactobacilli* bacterial count.

Conclusion: Children and young with DM showed a significant increase in carious lesions and bacterial count.

Keywords: Caries, Diabetes mellitus, ICDAS, *Lactobacilli*, *Streptococcus mutans*

Introduction:

Diabetes mellitus is a general term that characterized a group of subjects with a chronic metabolic disorder that resulted in hyperglycemia [(1,2)]. Generally, there are two types of DM namely; juvenile/primary DM "type 1" and adult/secondary DM "type 2" [(3,4)]. Juvenile DM is induced from the lack of production of insulin, therefore it is called insulin dependent DM (IDDM), however, the adult DM resulted from insulin resistance and is called non-insulin dependent DM (non-IDDM) [(5,6)].

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Diabetes mellitus negatively impacts oral health and manifested orally with several diseases such as dental caries, xerostomia "dry mouth", periodontitis, gingival inflammation, and mucosal infections [7,8]. There was a complicated relationship between DM and dental caries [1]. However, it was concluded that the use of tooth brushing for mechanical removal of the adhered biofilm and other different oral hygiene measures could promote a significant reduction in dental caries among diabetic patients [1,9].

Some researchers reported a correlation between DM and the growth of bacteria that cause the development of carious lesions such as acidogenic and aciduric bacteria due to leakage of glucose in the oral cavity [10,11]. This may be because of hyperglycemia which causes a reduction in the rate of salivary flaw "xerostomia" [1,2]. However, the negative effect of salivary flaw reduction and high glucose content could be controlled or prevented via following the proper metabolic diet which resulted in slow down the proliferation of the acidogenic bacteria and hence decreases carious lesions [4,12].

Some authors reported an increase in dental caries among diabetic patients with the uncontrolled metabolic diet with a significant increase in *Streptococcus mutans* counts [13]. However, Miko et al, [9] found that the following proper oral hygiene measures in combination with the following of appropriate metabolic diet could reduce or prevent the occurrence of carious lesions in young adults with type 1 diabetes mellitus. Also, the absence of protective mechanisms in the saliva of patients with diabetes mellitus together with the impaired buffering and cleansing action of saliva could be the causative factors for the bacterial growth and hence the development of dental caries [14,15].

The increased demand toward the detection and diagnosis of caries in an early stage and at different conditions resulted in the development of a new caries assessment system known as ICDAS [16]. ICDAS was innovated to improve the understanding of the process of caries initiation and propagation and to support the clinician's diagnostic pathway [17,18]. Moreover, the ICDAS system provides important information about the severity of caries lesions and if it is cavitated or non-cavitated [19].

Therefore, this study aimed to clinically correlate the prevalence of dental caries bacterial count of *Streptococcus mutans* and *Lactobacilli* among children and young adults with diabetes mellitus aged between 5-16 years via using the ICDAS system and microbiological assessment.

Subject and Methods:

A total of four hundred Egyptian children and young adults aged between 5-16 years were enrolled in this study. Children or young adults were recruited from outpatients' clinics of the university and general hospitals as follows; Al-Zahraaa hospital (Al-Azhar University Cairo, Egypt), Al-Hussein hospital (Al-Azhar University Cairo, Egypt), and Out-patients of pedodontics and oral health department, Faculty of Dentistry (Al-Azhar University, Assiut Branch). The enrolled children and young adults were examined over the period from December 2019 to October 2020. The enrolled subjects were medically free and recruited as "control group" or having diabetes mellitus and recruited as "study groups".

- **Eligibility criteria of population:**

All enrolled subjects were selected according to designed inclusion and exclusion criteria:

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- **Inclusion Criteria:**
  - For diabetes mellitus subjects;
    1. All enrolled subjects ranged from 5-16 years old.
    2. Caregivers approval.
    3. Duration of medical treatment at least 6 months.
    4. No history of another systemic disease.
  - For medically free subjects;
    1. History-free of antibiotic medication for at least two weeks before investigation.
    2. History-free of any acute oral or salivary glands infections for at least three months before the dental examination.
    3. Medically free.
    4. History-free of regular medication.
- **Exclusion criteria:**
- For diabetes mellitus subjects;
    1. Caregivers' refusal.
    2. Duration of medical treatment less than 6 months.
    3. Subjects medically complicated with another systemic disease.
- For medically free subjects;
    1. A history of regular medication or antibiotic medication for the last two weeks before investigation.
    2. A history of any acute oral or salivary glands infections preceding the dental examination for at least three months.
- **Ethical Consideration:**

This study was approved by Institutional Ethics Committee (EC Ref No: 164/230/8/7/19). All procedures were following the ethical standards of the responsible committee on human experimentation (institutional or regional). Detailed informed consent was signed by caregivers for including their children in this study.

- **Procedures:**
  - **History of the enrolled subjects:**

Complete medical and medication history, as well as dental history, were collected before selection/inclusion of the enrolled subjects in this study.

- **Dental Examination:**

All tooth surfaces should be cleaned before the beginning of any dental examination. According to World Health Organization (WHO) criteria; the dental examination was conducted under artificial light by using a dental probe and a plain mouth mirror [(20)]. During the clinical examination; all present teeth were taken into consideration and the dental examination starting with the upper right molars and ending with the lower right molars. [(21)]. The examination of cavities or enamel lesions was carried out with aid of a ball end probe [(22)].

- **Dental Assessment using ICADS II scoring:**

ICDAS II score was used to assess dental caries as follow [(23)]:

Code 0; Sound tooth surfaces No evidence of caries after 5-sec air drying.

Code 1; The first visual change in enamel: Opacity or discoloration (white or

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brown) is visible at the entrance to the pit or fissure seen after prolonged air drying.

Code 2; The distinct visual change in enamel visible when wet, the lesion must be visible when dry.

Code 3; Localized enamel breakdown (without clinical visual signs of dentinal involvement) seen when wet and after prolonged drying.

Code 4; Underlying dark shadow from dentin.

Code 5; Distinct cavity with visible dentin.

Code 6;
- Extensive (more than half the surface) distinct cavity with visible dentin.

- **Microbiological analysis:**

Unstimulated saliva samples were collected from each enrolled subject for *S. mutans* and *Lactobacilli* microbiological examination [(24)]. The enrolled subjects were asked to spit at least 1 ml in a sterilized container. The collected saliva samples were transported to the microbiology laboratory (Microbiology Department, Faculty of Medicine, Al-Azhar university for Girls) using the thioglycolate broth as a transfer medium and iced box. Before inoculation, the collected samples were vortexed for 15s and diluted 1:1000 in an isotonic saline solution [(25)]. After that, the saliva samples were spread over *Mitis Salivarius* agar and Rogosa agar to detect *S. mutans* and *Lactobacilli* count respectively. Then, the colonies were counted in samples and expressed in colony-forming unit/ milliliter (CFU/ml) [(25)]

- **Statistical analysis:**

All collected results were tabulated and statistically analyzed using software SPSS program (Statistical Package for Social Sciences), version 20. A chi-square test, and unpaired *t*-test to compare the two groups at a level of significance of $p<0.05$.

- **Results:**
- **ICDAS Results:**
  - **Caries pattern distribution as per ICDAS codes:**

The ICDAS results revealed that the caries prevalence among the tested subjects with DM was relatively high when compared to medically-free subjects (Figure 1). ICDAS results of the enrolled DM and medically-free subjects those never having experienced dental caries (code 0) of the total number of examined teeth were with the percentage of (44.86%) and (55.78%) respectively. While, for enamel defects detection (code 1), the first visual enamel changes represent a percentage of (4.57%) and (5.64%) for subjects with DM and medically-free respectively. While for ICDAS (code 2) the enrolled subjects with DM and medically-free subjects revealed a percentage of (4.50%) and (7.14%) of respectively. The results of ICDAS (Code 3) showed that the enrolled subjects with DM and medically-free subjects represent (3.29%) and (6.14%) respectively.

The results of ICDAS (code 4), (code 5), and (code 6) which represent dentine defects for the enrolled subjects with DM represents (7.93%), (13.55%), and (21.36%) respectively, while, for the medically-free subjects represent (6.93%), (7.5%), and (10.86) respectively.

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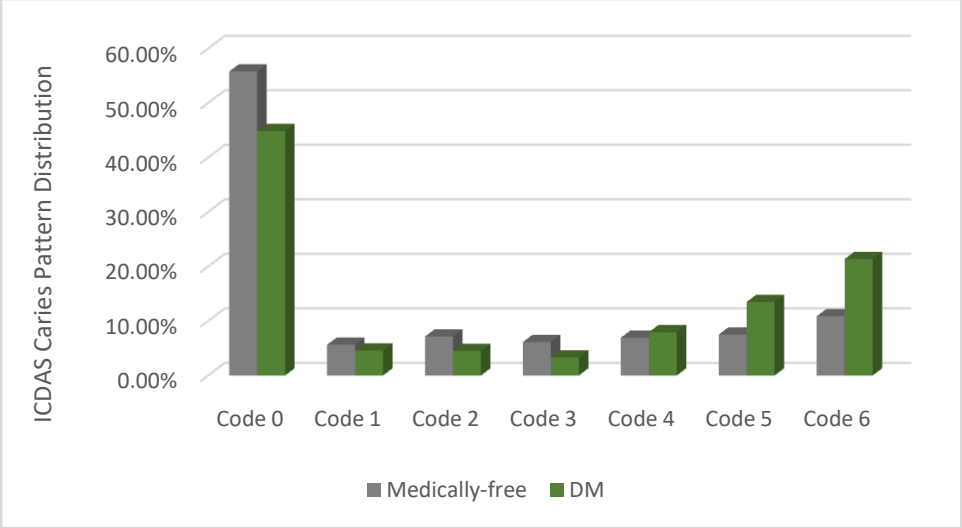

Figure 1: Caries pattern distribution as per ICDAS codes.

- **Degree of caries pre-ICDAS:**

Caries degree pre-ICDAS for the enrolled subjects with DM and healthy subjects along the study showed a statistically significant difference with a *p*-value of ($p < 0.00001$) as indicated by the Chi-Square test (Figure 2).

The teeth that had never experienced dental caries among the subjects with DM represent (44.86%), while, medically-free subjects represent (55.78%) of the total examined teeth. However, the teeth that experienced dental caries among the subjects with DM represent (55.4%), while, for medically-free subjects represents (44.21%) of the total examined teeth.

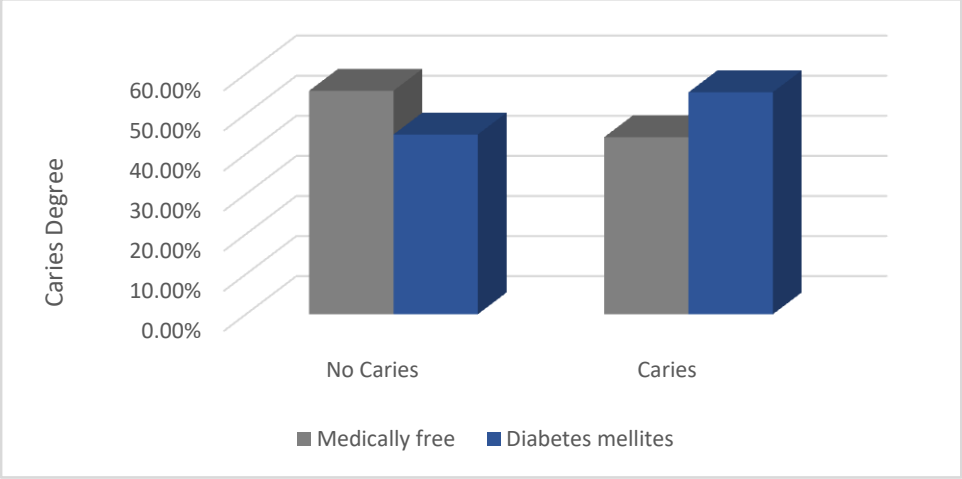

Figure 2: Degree of caries along with the study.

- **Caries distribution pre-ICDAS:**

Distribution of enamel and dentine caries pre-ICDAS along the study showed a statistically significant difference between subjects with DM and medically-free subjects with a level of significance of ($p< 0.00001$) as indicated by the Chi-Square test (Figure 3). The enrolled subjects with DM showed enamel and dentine caries distribution of (22.41%) and (77.59%)

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respectively. While the medically-free subjects showed enamel and dentine caries distribution of (42.81%) and (57.19%) respectively.

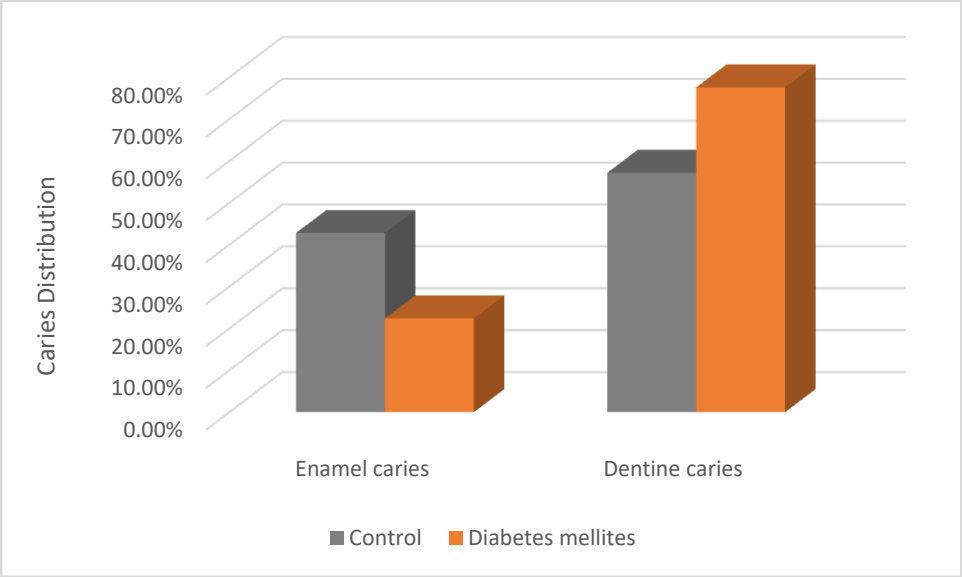

Figure 3: Caries distribution along with the study.

- **Microbiological results:**

Results of the microbiological analysis revealed a statistically higher *S. mutans* and *Lactobacilli* count (CFU/ml) among the diabetic subjects in comparison with medically-free subjects with *a* statistical significance of (*P*=0.0001) as indicated by unpaired *t*-test (Figure 4). The enrolled diabetic subjects showed a bacterial colony count of (5532±341.69) and (5929±125.47) for *S. mutans* and *Lactobacilli* respectively. While the healthy control children showed a bacterial colony count of (4599±127.32) and (5127±232.29) for *S. mutans* and *Lactobacilli* respectively.

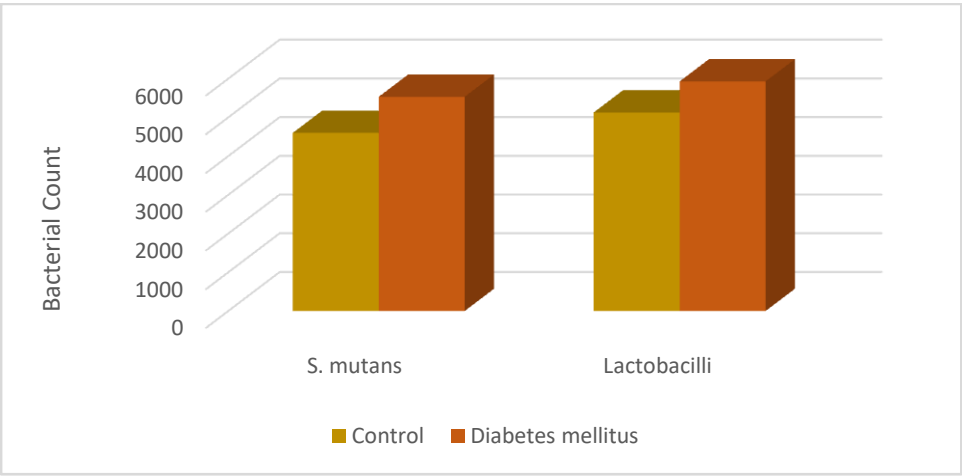

Figure 4: Bacterial count results.

Discussion:

Dental caries ranked as number-three between the non-communicable diseases according to the WHO [26]. Moreover, dental caries affects about 90% of schoolchildren over the world [27,28]. Therefore, this study was directed to monitoring the prevalence of dental caries among

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school children among the age of (5-16 years) thus medically compromised with diabetes mellitus.

The survey of dental caries usually performed when the lesion becomes cavitated as the clinician usually cannot assess the non-cavitated lesion with reliability [24]. However, for the prevented dentistry the inclusion of non-cavitated carious lesions is of great necessity as arrest the carious lesions in the beginning and lowering the cost of treatment [23,29]. Therefore, in this study, the ICDAS system was selected for the evaluation of dental caries to assess the cavitated and non-cavitated lesions in enamel and dentin and correlate them to the health status.

The results of this study highlighted that the prevalence and severity of dental caries among subjects with type 1 DM were significantly higher than that in healthy subjects. This agreed with the results of previous studies that showed that the prevalence of dental caries was highest among subjects with type 1 DM when compared to the medically-free group [30]. Moreover, the significant increase in dental caries among diabetic subjects maybe because of the decrease in the volume of excreted saliva and its buffer capacity due to hyperglycemia and insulin deficiency which resulted in a degenerative change of the salivary glands [30,31].

Generally, the cyclic decrease in salivary pH stimulates the proliferation of the aciduric bacteria and hence promotes the growth and proliferation of the acidogenic bacteria, while, it decreases the growth of the protective oral bacteria [1,15]. Therefore, this lower salivary pH resulted in an imbalance in the oral environment and shifting toward an environment that favorable for the growth of cariogenic microorganisms which further induces the incidence of dental caries [15]. This could explain the results of this study where the level of *S. mutans* and *lactobacilli* microorganisms in subjects with DM significantly higher than in control subjects.

The microbiological results of this study agreed with the results of the previous work of Siudikiene et al., [11] the diabetic subjects revealed higher levels of *S. mutans* and *lactobacilli* count when compared to the control "medically-free" group. The association between the bacterial count of S. *mutans* and *lactobacilli* with diabetes mellitus could be because these microorganisms exist normally in the oral cavity as a part of normal flora and its count increase with the increase of pH level [32].

- **Conclusion:**

Based on the results of this study, it was concluded that; ICDAS system could clinically differentiate between cavitated and non-cavitated carious lesions. Moreover, it could be concluded that diabetic children had significantly higher carious lesions as well as a higher bacterial count of *S. mutans* and *lactobacilli* than non-diabetic children.

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