JEMTAC
Journal of Emergency Medicine Trauma & Acute Care
A PEER REVIEWED JOURNAL

OPEN ACCESS

Research paper

# Association of dental caries in the era of COVID-19 with the number of occluded coronary vessels: A non-traditional risk factor in patients with acute coronary syndrome

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## ABSTRACT

**Background:** Dental caries and acute coronary syndrome (ACS) are prevalent chronic multifactorial disorders with several etiopathological risk factors. This study aims to assess the association between carious teeth and the number of coronary arteries identified by angiography among ACS patients.

**Material and Methods:** 118 patients with ACS were evaluated clinically by cardiologists. Participants' dental hygiene was assessed using the DMFT index. Before having their coronary angiography evaluated, all individuals had their urea, creatinine, and troponin serum levels checked. Echocardiography was also done. The relationship between the DMFT scoring index and echocardiographic and angiographic data was examined.

**Results:** All subjects studied had poor dental health overall (13.7±9.8), and their mean ages were 57.2±10.2 years. There were 118 participants in this study, and males made up 77.1% of the group. The majority of ACS (60.7%) had a high DMFT score (DMFT › 9), which in most cases indicated a significant number of missing teeth (10.9±8.9). Around half of the patients had poor carious status (DMFT › 10). The DMFT index and LVEF% measurements had non-significant positive relationships. According to the ROC curve, DMFT and its components lacked the diagnostic capacity to distinguish participants with one occluded coronary artery from ACS patients affected by multiple coronary arteries.

**Conclusion:** Although it cannot be used to predict the severity of the ACS, oral hygiene regarding dental status is related to the number of stenosed coronary arteries (but not LVEF%).

*Keywords:* acute coronary syndrome, angiography, COVID-19, myocardial infarction, LVEF%, dental health, DMFT index.

https://doi.org/10.5339/jemtac.2023.midc.8

Submitted: 18 April 2023
Accepted: 20 May 2023


Cite this article as: Al-Hindy HA-AM, Al-Mumin AS, Mousa MJ. Association of dental caries in the era of COVID-19 with the number of occluded coronary vessels: A non-traditional risk factor in patients with acute coronary syndrome. *Journal of Emergency Medicine, Trauma & Acute Care.* 2023(3):8 https://doi.org/10.5339/jemtac.2023.midc.8

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## INTRODUCTION

After a coronavirus was discovered to be the cause of an outbreak that may have been fatal in December 2019 in Wuhan, China, with unusual pneumonia, the illness was given the name "coronavirus disease 2019 (COVID-19)" [1-3]. Poor oral hygiene, dental loss, and periodontitis are most frequently associated with severe outcomes of COVID-19. This has suggested that there may be a link between systemic and dental health in COVID-19 individuals [4]. Research examining adult patients' dental health post-COVID-19 is scarce, with most studies focusing exclusively on children's oral hygiene [5].

Globally, the primary cause of mortality and debility is acute coronary syndrome (ACS), which is expected to cause 23.6 million fatalities by 2030(6). Along with unstable angina, ST and non-ST segment elevation MI are the three clinical subtypes of ACS [7-9]. Previous studies from significant referral centers showed the necessity of identifying risk factors for MI so that we can further lower its incidence rate [6]. T The known risk factors for ACS—including smoking, high blood pressure, obesity, and diabetes—are insufficient to explain its clinical and epidemiological presentations [3], highlighting the requirement to identify other probable MI risk factors.

A diagnostic procedure called angiography can be performed to assess the degree and severity of atherosclerosis in the coronary arteries by producing images of the anatomical and structural elements of the vascular system, including the heart chambers [10]. Over the past century, angiography underwent technological changes from its initial purpose as a diagnostic tool to its current function as a base for interventional therapy [11].

Since oral health is closely related to general well-being [8, 9, 12, 13] and severe community health problems, oral health has received significant attention from international health organizations [14]. The most crucial pointer used to assess oral hygiene status is the Decayed, Filled, and Missing teeth (DMFT) index [14, 15], and the WHO recognizes its use for analyzing the prevalence of tooth decay in a population.

Numerous research focuses on children, and the epidemiology of oral dental hygiene in the older demographic group is less comprehensive than those for children and the elderly [16]. There has been mounting evidence linking dental health to atherosclerosis via inflammatory or immunological pathways [17]. There has not been much research that specifically addressed the association between dental status and the degree of coronary artery disease as determined by angiography. However, more research is required to fully understand the causal relationship between oral hygiene and cardiovascular disease, particularly on the preceding; this will evaluate the association of angiographic findings with dental status as a non-traditional risk factor for ACS.

## METHODS AND OBJECTS

One hundred eighteen hospitalized patients from the Marjan Teaching Hospital who had a final diagnosis of ACS between March 2021 and March 2022 were included in this observational, single-center study. The cardiologists at the hospital reviewed the patient's history, clinical examination, laboratory testing, ECGs, and echocardiography investigations to confirm the clinical diagnosis of ACS. Cardiologists and competent blinded operators from the local heart center conducted the angiographic study using standardized procedures. According to local hospital procedures, the hematological studies that had been ongoing at the time of presentation comprised creatinine and urea. By using a CALBIOTECH® ELISA assay kit, troponin-I was evaluated. The biochemical investigations were completed as stated by the manufacturing instructions. All patients (or attendants) initially provided informed consent; simultaneously, the entire project was organized and permitted by the hospital's research ethics committee and the Faculty of Pharmacy/University of Babylon (FP-COVID-2021/Feb./Marj.22-CD). Every guideline in the Helsinki Declaration is followed in this study. The study's dental conditions patients were unknown to the lab staff, echocardiography examiners, and cardiologists.

Based on a well-known methodology, dental evaluations were assessed using the DMFT index: [the sum of D decayed, M missed, and F filled teeth] [18, 19]. The exteriors of the teeth that are smooth or occlusal have been cleansed using a soft brush, dried up, and checked through a dental mirror with Explorer. The DMF scoring scale will be used to interpret the DMFT scores.

Participants were divided into three groups based on their caries status, with DMFT values of [1–4] representing low carious status [5–9], representing moderate caries status, and values >9 representing high carious status [20, 21].

The echocardiographic study was conducted at the hospital's cardiac center by two different echocardiography examiners utilizing a Vivid®-III standard two-D thoracic (GE ultrasound system). When determining LVEF%, the "Modified Simpson's method" was used, and a cutoff limit of LVEF below 40% was chosen as a measurement to define systolic LV dysfunction. As a result, the AMI participants were divided once more into two groups: LVEF 40% compared to ›40% [22].

Students' t-tests for independent variables had finished the evaluations of continuous data (represented as mean ± SD). One-way ANOVA and Spearman correlation were used to analyze the relationships between the DMFT, demographic, and clinical factors. The "Cronbach's Alpha reliability" test result was › 0.83 for the study parameters. Once the p-value was 0.05, the differences and correlations among the parameters were considered significant statistically for all tests. SPSS, version-23 for Windows (IBM, USA), was used to analyze the statistical estimates.

## RESULTS

The average dental score across all study participants was (13.7±9.8), with a mean age of (57.2±10.2 years). There were 118 participants in this study, and males made up 77.1%. The majority of ACS (60.7%) had a high DMFT score (DMFT › 9), which in most cases indicated a significant number of missing teeth (10.9–8.9). However, the blood urea and creatinine levels were within acceptable ranges among the participants. Other risk factors for diabetes mellitus, hypertension, and smoking were present among ACS patients in addition to obesity (Table 1).

Aside from the incidence of smoking and hypertension, which were higher among the male patients(p-0.05), gender had no discernible effect on the study variables. The proportion of filled teeth was also much more significant in males (Table 2). According to ROC analysis, DMFT and its components did not have enough diagnostic capacity to distinguish ACS patients with one occluded vessel from those affected by many coronary arteries (Figure 1 and Table 3). In the ACS patients, there were no statistically significant relationships between the DMFT score and the measurements of troponin-I, LVEF%, age, and BMI (Table 4). ACS patients with reduced LV functions and those with maintained LV functions showed non-significant differences in the dental caries index (Table 5).

**Table 1. Essential characteristics of all subjects with acute coronary syndrome.**

| Variables | | Descriptive statistics |
|---|---|---|
| **Age/year** M±SD | | 57.2±10.2 |
| **BMI (kg/m²)** M±SD | | 27.2±5.2 |
| **Male sex** (No %) | | 91 (77.1%) |
| **Dental indices** No (%) | DMFT | 13.7±9.8 |
| | Decayed | 2.4±2.5 |
| | Missing | 10.9±8.9 |
| | Filled | 0.7±1.7 |
| **Classes of DMFT** No (%) | DMFT (‹ 1) | 11.6 (8.5) |
| | DMFT (1-4) | 23.2 (17.1) |
| | DMFT (5-9) | 18.6 (13.7) |
| | DMFT (›9) | 82.6 (60.7) |
| **Biochemical Analyses** M±SD | Serum troponin-I (ng/ml) | 9.1±0.2 |
| | Serum creatinine (mmol/L) | 79.3±30.4 |
| | Blood urea (mmol/L) | 15.8±26.3 |
| **LVEF %** M±SD | | 49.8 ± 30.4 |
| **Affected coronary vessels** No (%) | One | 39 (33.1) |
| | More than one | 79 (66.9) |
| **Risk Factors** (No %) | Diabetes mellitus | 50 (42.4%) |
| | Hypertension | 57 (48%) |
| | Smokers | 48 (40%) |

**Table 2. Gender variations of the study characteristics among the applicants.**

| Characteristics | Sex | Mean | P-Value |
|---|---|---|---|
| Age/years (Mean±SD) | M | 51.8 ± 15.3 | NS |
| | F | 54.1 ± 18.3 | |
| DMF-T Index (Mean±SD) | M | 11.2 ± 9.4 | NS |
| | F | 8.9 ± 9.2 | |
| LVEF% (Mean±SD) | M | 49.3 ± 13 | NS |
| | F | 52.7 ± 8.9 | |

**Table 3. ROC assays of DMFT index.**

| Predictability | AUC | P-value | Sensitivity | Specificity | 96% CI |
|---|---|---|---|---|---|
| DMFT | 0.589 | 0.260 | 0.482 | 0.623 | 0.433–0.728 |
| Decayed | 0.637 | 0.054 | 0.593 | 0.591 | 0.469–0.778 |
| Missed | 0.584 | 0.238 | 0.598 | 0.639 | 0.432–0.736 |
| Filled | 0.505 | 0.939 | 0.520 | 0.502 | 0.364–0.647 |

**Table 4. Correlation of DMFT index with LVEF%, ages, and BMI in ACS patients.**

| Variables | r | P |
|---|---|---|
| Troponin-I | -0.083 | 0.73 |
| LVEF % | -0.016 | 0.86 |
| Age (years) | 0.293 | 0.053 |
| BMI (kg/m$^2$) | 0.23 | 0.012 |

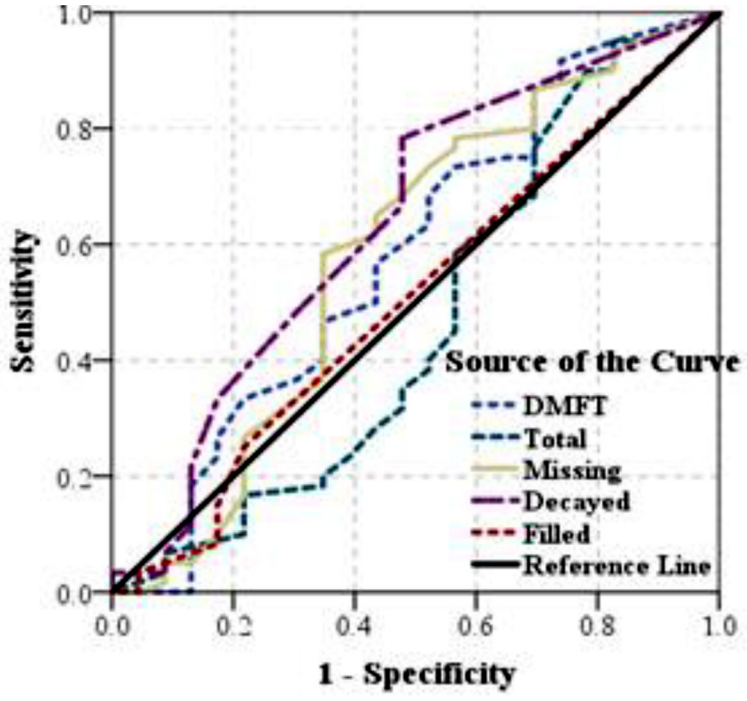


**Figure 1. Specificity vs. sensitivity of DMFT components.**

**Table 5. Comparison of the mean DMFT indices according to two categories of LVEF%.**

| Caries indices | LVEF Category | M ± SD | P-value |
|---|---|---|---|
| DMFT | › 40% | 14.8 ± 10.1 | › 0.05 |
| | ‹ 40% | 14.3 ± 9.3 | |
| Decayed | › 40% | 2.9 ± 2.3 | › 0.05 |
| | ‹ 40% | 2.4 ± 2.7 | |
| Missed | › 40% | 12.7 ± 9.5 | › 0.05 |
| | ‹ 40% | 11.4 ± 8.7 | |
| Filled | › 40% | 0.5 ± 1.7 | › 0.05 |
| | ‹ 40% | 0.7 ± 1.4 | |

## DISCUSSIONS

Iraq is one of several underdeveloped countries where oral illness is widespread. Carelessness, insufficient education, inconvenient attitude, or a lack of resources could be to blame. Most epidemiologic research in oral health focuses on children, and figures on the prevalence of oral hygiene and dental caries in the elderly population are scarce. This study aimed to examine dental status as a non-traditional risk factor for ACS because few studies have examined the association between oral hygiene state as a risk factor for the severity of ACS. Also, to better understand the association between cardiovascular disease and oral health.

The DMFT is an excellent tool for evaluating oral hygiene in any community. In this study, the mean decayed, missing, and filled teeth were (2.4±2.5, 10.9±8.9, and 0.7±1.7), respectively. A prior study demonstrated that the mean values were (2.9±1.7, 1.15±1.9, and 3.33±1.7), respectively, with participants aged 15–19 having a mean of 6.9 and applicants aged 35–45 having a mean of 7.8, and mean total DMFT values were 7.33±3.0 [23]. These outcomes were somewhat consistent with our findings. A similar result from another study indicated a link between DMFT –specifically, the total dental missing– and the progression of atherosclerosis [24].

Notably, all the study outcomes of DMFT scores were not corrected by age. It's important to remember that the DMFT study results weren't adjusted for age in any way. Most of the ACS (60.7%) in the current study had bad DMFT scores (DMFT›9), which in most cases indicated many missing teeth (10.9–8.9). Additionally, compared to the results of the nearby countries, the overall index of dental status across all study subjects was relatively high (13.7±9.8) [14].

The findings of poor dental hygiene among hospitalized adults are consistent with a growing body of research—though still debatable—that shows a link between hospitalized COVID-19 patients and harmful oral health-related problems [4]. The lack of public awareness of oral health, low financial accessibility brought on by insurance plans' exclusion of such treatments, and a lack of government backing for activities aimed at promoting oral health in communities are likely to be the causes. Additionally, the COVID-19 pandemic profoundly impacted human life everywhere and presented health services, governments, and society with previously unheard-of difficulties, particularly during the lockdown conditions [4, 25].

The risk evaluations for hospitalized patients may differ from population-based risk estimates, affecting the assessment of the actual contribution of such comorbidities in the current study. Diabetes and hypertension may be more common overall in patients who develop poor dental health among hospitalized ACS adults, so this could affect risk estimates for hospitalized patients.

Poor dental hygiene has been linked to COVID-19, and patients with hypertension are at a higher risk of developing severe consequences from COVID-19 [4, 26], according to reports. The age of the patient and the high incidence of comorbid conditions like diabetes (42.2%) and hypertension (48%) both raise the risk for severe disease [25]. Another Iranian study found that among several risk factors, diabetes, and systolic (but not diastolic) hypertension were more prevalent in older people [27]. However, it must be noted that the study results were consistent with those of earlier studies, which found a favorable correlation between smoking and patients with ACS [15, 27-31].

Aside from the incidence of high blood pressure and smoking among the male patients (p-0.05), gender had no discernible effect on the study variables. Similarly, males had a much higher percentage of filled teeth (data not shown). This conclusion is consistent with a previous study that involved 203 patients in total [32]. However, a Saudi Arabian study published last year showed contrary findings [14].

Between ACS patients with low LV functions and those who had their LV functions preserved, the dental caries index showed non-significant differences. Beata W. reported the same findings but observed a strong correlation between LVEF% and oral indices other than DMFT [33]. However, data indicate that periodontitis may be a risk factor for MI and subsequent care [34].

The link between dental health and the onset and progression of atherosclerosis has several potential causes. First, it might result from established risk factors like smoking, being overweight, or having diabetes confounding the traditional risk factors, which are significant determinants of both oral and ACS [9, 12, 17, 35]. Second, periodontitis may exacerbate an inflammatory vascular disease, accelerating atherosclerosis [34-36]. Third, the infectious concept might be accurate if microorganisms are inoculated into atherosclerotic plaques via episodic bacteriemia from periodontal foci [30, 31]. It's still unclear whether a pathogen's immune response or the pathogen worsens atherosclerosis [37].

It is recommended that older patients must be careful about their dental hygiene to lower the chance of developing ACS. We advise considering "tooth care" in conjunction with traditional cardiovascular risk factors and recommend that deteriorating oral health may be a warning indication of ACS. The dentists and the cardiologists will need to work together more in the future.

## CONCLUSIONS

Although it cannot be used to predict the severity of the ACS, oral hygiene in terms of dental status correlates with the number of stenosed coronary arteries (but not LVEF%). The study's findings indicate that to lower the incidence of atherosclerotic incidents in cases with MI and various cardiovascular risk factors, oral health preventative services should be provided to them.

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