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Article

Prospective Observational Study of Oral Health in Hospitalized Diabetic Patients in the Internal Medicine Service of the Morales Meseguer Hospital

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Abstract: Background: Oral health is a critical aspect of overall health, particularly in diabetic patients. This study explores the oral health status of diabetic patients and its potential relationship with various health parameters. Methods: Conducted at Morales Meseguer Hospital, this prospective observational study involved diabetic patients, primarily with type 2 diabetes. Data collection occurred from November 27, 2020, to July 21, 2021, using tools like Vatech® PaX-400C orthopantomograph and Microsoft Office 365. The study was approved by relevant ethical committees and adhered to the Helsinki Declaration. Results: The study included 35 patients, predominantly male (71.43%), with an average age of 69.31 years. A significant portion (88.6%) exhibited poor oral health, with common issues being periodontitis (60%), cavities (71.4%), and periapical lesions (57.1%). Relationships between oral health and factors like smoking, C-reactive protein levels, and vitamin D levels were explored, with some reaching statistical significance. The study also noted a potential link between oral health and systemic diseases like cardiovascular disease and diabetes. Discussion: The findings highlight the intricate relationship between diabetes mellitus and oral health, emphasizing the need for integrated care approaches. Challenges encountered included limitations due to the COVID-19 pandemic and reliance on orthopantomography. The study suggests that improved oral health can lead to better glycemic control and overall health outcomes. Conclusion: This research emphasizes the importance of comprehensive care in diabetic patients, integrating oral health care and addressing issues like smoking and polypharmacy. Collaborative efforts between medical and dental professionals are crucial for holistic patient management and improved health outcomes.

Keywords: oral health; diabetes; periodontal disease; caries; periodontitis

1. Introduction

Oral health is an essential component of overall health and well-being. The World Health Organization (WHO) defines oral health as “a state of being free from chronic mouth and facial pain, oral and throat cancer, oral infection and sores, periodontal (gum) disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual’s capacity in biting, chewing, smiling, speaking, and psychosocial well-being” [1].

Despite the importance of oral health, many people neglect their oral hygiene, leading to a range of oral health problems that can have serious consequences for their overall health [2]. Poor oral health can have a significant impact on an individual’s quality of life. It can cause chronic pain,

difficulty eating and speaking, and social isolation. In addition, poor oral health has been linked to a range of systemic diseases, including diabetes, cardiovascular disease, and respiratory disease [3,4]. The links between oral health and these diseases are complex and multifactorial, but research suggests that poor oral health can contribute to the development and progression of these conditions. One of the most significant links between oral health and overall health is the relationship between periodontal disease and diabetes [5–8].

Periodontal disease is a chronic inflammatory condition that affects the tissues that support the teeth. It is caused by the accumulation of bacteria and other microorganisms in the mouth, which can lead to the formation of plaque and tartar. If left untreated, periodontal disease can cause the gums to recede, the teeth to become loose, and eventually, tooth loss [9]. Research has shown that individuals with diabetes are at an increased risk of developing periodontal disease, and that poor oral health can contribute to poor glycemic control in individuals with diabetes [10,11]. The links between oral health and cardiovascular disease are also well-established. Research has shown that individuals with periodontal disease are at an increased risk of developing cardiovascular disease, and that the presence of periodontal disease can contribute to the progression of existing cardiovascular disease and produce more comorbidity. The mechanisms that underlie this relationship are complex, but research suggests that inflammation and endothelial dysfunction may play a role [12,13]. In addition to the links between oral health and systemic diseases, poor oral health can also have a significant impact on an individual's mental health and well-being. Chronic pain, difficulty eating and speaking, and social isolation can all contribute to depression, anxiety, and other mental health [14–16]

The aim of this research was to assess the oral health status of diabetic patients who have been hospitalized in Morales Meseguer University Hospital in the Internal Medicine service. The study evaluated the possible relationship between oral health and blood biomarkers alterations that they have presented.

2. Material and Methods

2.1. Study Design

This prospective observational study was conducted at Morales Meseguer University Hospital, within the Internal Medicine and Cardiology sections. We focused on a cohort of diabetic patients, predominantly suffering from type 2 diabetes due to its prevalence. The recruitment and data collection phases spanned from November 27th, 2020, to July 21st, 2021.

2.2. Participant Selection

Patients were eligible for inclusion if they had a diagnosis of diabetes mellitus and were receiving care under the Internal Medicine or Cardiology services. Informed consent was a prerequisite for participation, with all procedures adhering to the ethical standards of the Helsinki Declaration. The University of Murcia's Biosecurity and Ethics Committee and Data Protection Department approved the study (ID: 2895/2020).

2.3. Data Collection

Upon securing informed consent, we gathered comprehensive clinical histories and conducted oral examinations at the University Dental Clinic. A Vatech® PaX-400C orthopantomograph was used for imaging, capturing orthopantomographies in JPG format. For data acquisition and entry, we utilized Microsoft Office 365 and Excel, ensuring a structured and secure data management process.

2.4. Human Resources

The research team was multidisciplinary, including specialist medical personnel and nursing staff from the Internal Medicine and Cardiology departments, administrative and radiology staff from the University Dental Clinic, and two trained dentists responsible for the orthopantomography analysis.

2.4.1. Radiographic Analysis

Two experienced dentists, previously calibrated for this study, performed the orthopantomographic analyses. They assessed each patient's oral health, examining the number and severity of dental caries, periodontitis, and periapical lesions. All evaluations were conducted using standardized protocols to ensure consistency.

2.5. Statistical Analysis

The collected data underwent rigorous statistical analysis, conducted by the Department of Statistics at the Faculty of Medicine, University of Murcia, and by Professor Virgilio Gómez Rubio at the University of Castilla La Mancha. We utilized SPSS software (Version 22.0, SPSS Inc., Chicago, IL, USA) for the analysis. Frequency and percentage of oral health outcomes were reported, and comparisons between variables were made using Pearson chi-square and Fisher's exact tests. Continuous variables were compared using t-tests, with a significance level set at $p < 0.05$.

3. Results

The sample have 35 patients, predominantly male (71.43%), with an average age of 69.31 years. The glycemic control showed that 60% of the patients had plasma glucose levels above target, indicating room for improvement. All patients uses more than 5 drugs, polypharmacy.

In terms of oral health, 88.6% of the diabetic patients studied showed signs of poor oral health. Specifically, 60% had periodontitis, 71.4% had cavities, and 57.1% had one or more periapical lesions. A potential relationship between oral health and length of hospital stay was observed, as well as with other factors such as smoking, C-reactive protein (CRP) elevated levels, vitamin D low levels, diabetes mellitus (DM), alcoholism, and hypertension. However, statistical significance was not reached with the rest of the variables studied.

Statistically significant results were found for the relationship between length of hospital stay and smoking (p value = 0.0007) (Table 1), readmission and smoking (p value = 0.0104) (Table 2), and cavities and potassium levels (p value = 0.030) (Table 3). Additionally, a slight relationship was observed between periodontitis and an increase in CRP, reaching statistical significance, and with HbA1c, although it did not reach statistical significance (Table 4). Caries and periapical lesions had a negligible relationship with the length of hospital stay, and the periapical lesion had a slight relationship with hospital readmission.

Table 1. Diseases p value according to length of stay.

| | P- value |
|------------------------------------|----------|
| Smoking | 0.0007 * |
| Enolism | 0.7409 |
| Hypertension | 0.467 |
| Dyslipidemia | 0.8524 |
| Diabetes Mellitus type 2 | 0.663 |
| Diabetes Mellitus type 1 | 0.3912 |
| Control Glycemic | 0.5662 |
| Renal Insufficiency | 0.2825 |
| Cardiac Insufficiency | 0.8981 |
| Ischemic heart disease | 0.9445 |
| Chronic airflow obstruction | 0.4323 |
| Digestive disease | 0.906 |
| Infectious disease | 0.1706 |
| Cerebrovascular disease | 0.3912 |
| Cognitive impairment | 0.7262 |
| Chronic anemia | 0.3682 |

| | |
|-----------------|--------|
| Active neoplasm | 0.7723 |
|-----------------|--------|

Table 2. Diseases p value according to 3-month readmission.

| | P- value |
|-----------------------------|----------|
| Smoking | 0.0104 * |
| Enolism | 1 |
| Hypertension | 1 |
| Dyslipidemia | 0.5748 |
| Diabetes Mellitus type 2 | 0.5748 |
| Diabetes Mellitus type 1 | 0.2831 |
| Control Glycemic | 1 |
| Renal Insufficiency | 0.6889 |
| Cardiac Insufficiency | 1 |
| Ischemic heart disease | 1 |
| Chronic airflow obstruction | 1 |
| Digestive disease | 1 |
| Infectious disease | 0.1567 |
| Cerebrovascular disease | 1 |
| Cognitive impairment | 0.5361 |
| Chronic anemia | 0.6399 |
| Active neoplasm | 0.1715 |

Table 3. Data p value according to caries.

| | P- value |
|-----------------------------|----------|
| Glucose | 0.1391 |
| Urea | 0.1081 |
| Creatinine | 0.298 |
| Uric acid | 0.4104 |
| Albumin | 0.3314 |
| Calcium | 0.5595 |
| Phosphorus | 0.4712 |
| Magnesium | 0.2293 |
| Sodium | 0.912 |
| Potassium | 0.0030 * |
| Hierro | 0.8983 |
| Ferritin | 0.1514 |
| Transferrin | 0.3277 |
| Transferrin saturation | 0.5839 |
| Vitamin B12 | 0.2053 |
| C-reactive protein | 0.1868 |
| Procalcitonin | 0.2369 |
| Glomerular filtration | 0.1613 |
| Thyroid stimulating hormone | 0.2397 |
| HbA1c | 0.7981 |
| Vitamin D-0H25 | 0.0962 |
| Hemoglobin | 0.108 |
| Parathyroid hormone | 0.4036 |

Table 4. Data p value according to periodontitis.

| | P- value |
|--|----------|
|--|----------|

| | |
|-----------------------------|----------|
| Glucose | 0.9216 |
| Urea | 0.9597 |
| Creatinine | 0.3372 |
| Uric acid | 0.8491 |
| Albumin | 0.3704 |
| Calcium | 0.5193 |
| Phosphorus | 0.9575 |
| Magnesium | 0.3259 |
| Sodium | 0.5985 |
| Potassium | 0.6502 |
| Hierro | 0.3123 |
| Ferritin | 0.4742 |
| Transferrin | 0.418 |
| Transferrin saturation | 0.7618 |
| Vitamin B12 | 0.5874 |
| C-reactive protein | 0.3612 |
| Procalcitonin | 0.9674 |
| Glomerular filtration | 0.3975 |
| Thyroid stimulating hormone | 0.0077 * |
| HbA1c | 0.2448 |
| Vitamin D-0H25 | 0.8065 |
| Hemoglobin | 0.1475 |
| Parathyroid hormone | 0.374 |

73.53% of the patients presented lesions compatible with active caries, although no statistically significant relationship was found with other variables studied.

4. Discussion

4.1. Discussion of the Method

The relationship between diabetes mellitus and oral health is complex, with analytical alterations due to oral diseases potentially exacerbated in diabetic patients [5,17]. This is particularly true in cases of poor glycemic control over an extended period, characteristic of this chronic condition. Such complications can have systemic repercussions, worsening the overall health of patients and diminishing their quality of life [18].

Our study acknowledges the need for enhanced interprofessional collaboration between physicians and dentists, aiming to improve patient outcomes through better-informed treatment plans [19]. Previous research supports the notion that improved oral health can lead to better glycemic control, creating a positive feedback loop that ultimately benefits both oral and systemic health [10].

In terms of methodology, our study faced challenges due to the global pandemic, with a significant portion of potential participants opting out due to safety concerns. This limitation is acknowledged as a potential influence on our findings. Additionally, our reliance on orthopantomography (instead of conventional oral examination) for the analysis of periodontitis, caries, and periapical lesions, while necessary to minimize patient exposure during the pandemic, is recognized as a limitation. A comprehensive clinical examination would have provided a more nuanced understanding of each patient's oral health status.

Despite these challenges, our analytical approach, utilizing logistic regression and other statistical methods, allowed for the identification of relationships between oral health, length of stay, and several biomarkers. However, it is crucial to highlight that the relationships identified were of slight to medium effect, indicating the need for further research to fully understand the intricate connections between diabetes, oral health, and systemic health outcomes [20].

4.2. Discussion of the Results

Upon analyzing the demographic characteristics of our study, we highlight that we have 35 participants, of which 71% are males and 29% are females, with an average age of 69 years and a standard deviation of 14.53. All are residents from Murcia.

Older individuals have a higher probability of tooth loss and developing chronic oral diseases, as well as systemic diseases that require the use of polypharmacy daily (≥ 5 medications in 24 hours) [21]. In our sample, 100% of the patients took more than 5 medications daily, and 37% took some central nervous system depressant drug. According to the work of Tavares et al., this high use of medications can generate complications at the oral level, such as xerostomia, which, combined with age and changes that occur in the salivary glands, facilitates the appearance of caries and periodontitis, as well as other disorders in the oral cavity [22]. In our study, no statistically significant differences were found between oral health and polypharmacy. However, it is important to highlight the importance of deprescribing in older and pluripathological patients, removing drugs that are no longer necessary according to the evolutionary stages of the patients, and that can cause many side effects, which, along with interactions between their metabolism, facilitate iatrogenesis and are the cause of 20-80% of patient admissions due to incidents/reactions secondary to medications [23].

In the study by Chen et al., results like our study were obtained, where they had an average age of 60 years, like our study, and where they concluded that there was a positive relationship between periodontal disease and the increase in PCR and Hb1Ac, being this relationship statistically significant [17]. According to our results and as previously mentioned, a slight relationship has been observed between periodontitis with an elevation of PCR ($s=0.26$), reaching statistical significance, and hb1Ac ($s=0.15$), but without reaching statistical significance (as seen in figure no. 139).

The increase in age in the world population is a fact to consider, since oral health in older patients is diminished, affecting their quality of life. If the patient feels that their oral health is deficient, we can predict poor overall health, leading to low self-esteem and life dissatisfaction. This is a notable fact in elderly patients, especially important in institutionalized patients, a highly vulnerable population, as can be seen in the study of Wong et al. [24], where the care they receive in terms of oral hygiene is deficient. Nutrition in these patients is fundamental, and the presence of caries and infections can hinder their feeding, worsening already present nutritional problems [20]. These problems aggravate their health status and cause psychosocial distress in this population, decreasing their self-esteem. Therefore, a change in policies, along with better and more information, is necessary in this population. In our sample, there were no institutionalized patients, but three of them had cognitive impairment. Those who needed more care had family support, so they did not require admission to socio-sanitary institutions [24].

These patients have a high rate of hospital admissions, especially diabetic patients with HbA1c outside the therapeutic target. According to the retrospective study by Wei et al., where they analyzed whether the readmission of diabetic patients with glycemic control out of range (with higher glycated hemoglobin than those corresponding to their objectives) readmitted less after reinforcing antidiabetic treatment and achieving a reduction in HbA1c [25]. They obtained data of 17% readmissions, data that contrast with the study carried out by Torres and Donlo with data from Spain, stating that the patient with type 2 diabetes mellitus had a readmission rate of 67% and an average hospital stay of 3.1 days longer than a patient without diabetes [26]. In the study by Cheng et al., a retrospective analysis was carried out, with a sample of 27473 patients in Taiwan, with an average age of 68 years, similar to the average age of our study. The most common cause of hospitalization in this study was non-fatal stroke (34.7%) followed by heart failure (14.4%). In addition, the majority of patients did not readmit (92.9%) [27].

These data contrast with our work where a readmission rate of 31% was obtained, being these data more similar to our environment, as we have described above in national studies. Regarding the main reason for admission in our study, it was dyspnea (25%), which is mostly caused by heart failure (so this result could be similar to that obtained

5. Conclusion

In conclusion, this research underscores the necessity of comprehensive care for diabetic patients, incorporating oral health care and support for smoking cessation as integral components of patient management. It also highlights the need to address polypharmacy in elderly patients and suggests that collaboration with dental professionals could be a valuable strategy in the holistic care of these individuals.

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Conflicts of Interest: The authors declare no conflicts of interest.

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