Short Research Article

EVALUATION OF MANDIBULAR PANAROMIC RADIOMORPHOMETRIC INDICES IN PATIENTS WITH DIABETES MELLITUS AND NON-DIABETICS

**ABSTRACT**

Aim: This study aims to evaluate and compare the mandibular panoramic radio morphometric indices between patients with diabetes mellitus and non-diabetic individuals to understand the potential effects of DM on mandibular bone structure.

Study design: Observational, cross-sectional study.

Place and duration of study: This study was conducted in Department of Prosthodontics and Department of Radiology, ADHIPARASAKTHI Dental College and Hospital's, Melmaruvathur.

Materials and Methods: A total of 50 participants were divided into two groups: diabetic patients and non-diabetic controls. Panoramic radiographs were obtained for each participant. Key mandibular radio morphometric indices, PMI and MI, were analysed and compared between the two groups.

Results: Diabetic patients exhibited alterations in mandibular bone structure, which may be indicative of bone deterioration associated with diabetes. However, this difference was found to be statistically insignificant.

Conclusion: The study highlights the potential of using mandibular panoramic radiographs to evaluate the impact of diabetes on mandibular bone structure. These findings suggest that patients with diabetes may be at higher risk for mandibular bone loss and should be closely monitored for oral health complications. Further studies are needed to explore the underlying mechanisms of these radiographic changes and their clinical implications.

*Keywords: Diabetic, Mandibular cortical thickness, PMI, MI*

**1. INTRODUCTION**

Diabetes mellitus, a significant non-communicable disease, has emerged as a major global health challenge. Its defining feature is hyperglycaemia, which can also impact mineralized skeletal tissues. These effects include alterations in the bone matrix and bone demineralization, contributing to increased bone fragility. According to Wu et al., diabetes significantly promotes osteoclastogenesis and increases osteoblast apoptosis. [1]

Both type 1 and type 2 diabetes are known to profoundly affect bone health. The quality of the alveolar bone plays a critical role in the pathophysiology of diabetes-related oral conditions. As such, assessing bone density is vital for the diagnosis and management of periodontal issues, including dental implant placement and bone grafting procedures. [2]

Despite the high prevalence of diabetes, research on its relationship with mandibular bone mineral density (BMD) remains limited. Addressing this gap is crucial, as the condition's impact must be factored into routine dental clinical practices. [3]

The clinical bone mineral density measurement is best assessed by the standard method, Dual Energy X-Ray Absorptiometry (DEXA). However, its use for mandibular assessment is rare due to challenges like superimposition of opposite sides and the high cost of the procedure. This emphasizes the need for more cost-effective methods to assess skeletal density accurately. [4]

Panoramic radiographs, widely utilized in dental practice, provide a practical alternative. These images allow the application of radio morphometric indices, which are used to quantitatively and qualitatively evaluate mandibular bone mass and resorption. Studies have demonstrated a strong correlation between mandibular BMD and overall skeletal BMD. [5]

A literature review highlights that the inferior cortex thickness of the mandible is a reliable predictor of osteoporosis risk. [6] The aim of this study is to investigate diabetes-induced alterations in mandibular bone by analysing radio morphometric measures on panoramic radiographs of diabetic and non-diabetic individuals.

**2. MATERIAL AND METHODS**

This study was conducted in Department of Prosthodontics and Department of Radiology, ADHIPARASAKTHI Dental College and Hospital's, Melmaruvathur.

Exclusion Criteria:

History of traumatic mandibular injuries, orthognathic operations, jaw bone pathology, radiation therapy to the head and neck region, or other systemic disorders affecting bone

A total of 100 patients were included in the study. A written informed consent was obtained from all participants.

Patient Characteristics and Grouping:

* Demographic details and diabetes history were recorded for all participants.
* HbA1C levels were evaluated, with values > 6.5% categorized as Group 1 (diabetics) and the remainder as Group 2 (non-diabetics).
* A panoramic radiograph was obtained for all participants as recommended by their clinicians as part of their diagnostic investigations.

Radiographic Procedure:

* Sirona ORTHOPHOS XG was used to capture 100 orthopantomograms (OPGs).
* Image quality was assessed using SIDEXIS 4 software to confirm the absence of artefacts that could alter the anatomy under investigation.
* Images were saved in DICOM format for consistent and detailed analysis.

Standardized Imaging Process:

* All radiographs were taken by a single examiner to ensure consistency.
* Patients were positioned in the panoramic machine with:
  + The vertical reference line of the machine aligned with the sagittal plane of the patient.
  + The horizontal reference line (Frankfort plane) parallel to the floor.

Radio morphometric Analysis:

Panoramic radio morphometric indices, such as the Panoramic Mandibular Index (PMI) and Mental Index (MI), were assessed and compared between diabetic and non-diabetic groups to evaluate potential mandibular bone alterations associated with diabetes.

Panoramic Mandibular Index (PMI)

PMI is a radiographic ratio used to assess the thickness of the mandibular cortex in relation to the distance between the mental foramen and the inferior mandibular border, derived from panoramic radiographs. A reduced PMI indicates cortical thinning, which may serve as a marker for systemic osteoporosis or other metabolic bone disorders. [5]

Applications in Dentistry:

* Implant Planning: Assists in evaluating bone health and ensuring sufficient cortical support for dental implants or prosthetic anchorage.
* Edentulous Patients: Useful in assessing bone quality for designing and placing dentures or other oral appliances.

Additionally, PMI aids in forensic identification and evaluation of disease conditions like hyperparathyroidism, diabetes, and chronic kidney disease.

Apart from being non-invasive and cost effective, it can also provide indirect insights into overall bone health. By integrating PMI into routine dental evaluations, practitioners can enhance patient care by identifying potential bone health issues early and tailoring treatment plans accordingly.

The Mental Index (MI) is a radiographic measurement that evaluates the thickness of the mandibular cortical bone in the region near the mental foramen. The MI represents the thickness of the mandibular cortical bone, measured in millimeters, directly below the mental foramen as observed on a panoramic radiograph. [5]

Table 1: DESCRIPTION of Panoramic Mandibular Index (PMI) and Mental Index (MI)

|  |  |  |
| --- | --- | --- |
| INDEX | DESCRIPTION | NORMAL VALUE |
| Panoramic Mandibular Index  ( PMI ) | The PMI is calculated as the ratio of the mandibular cortical thickness measured on the line perpendicular to the bottom of the mandible, at the middle of mental foramen, to the distance between the superior margin of inferior mandibular cortex and bottom of the mandible.[5] | >0.3 |
| Mental Index ( MI ) | The mandibular cortical thickness is measured at the center of the mental foramen on the line that is perpendicular to the mandible's bottom.[5] | >3.1 mm |

Line drawn perpendicular to the bottom of the mandible

from the middle of mental foramen (B)

PMI

The distance between the superior margin of inferior

mandibular cortex and bottom of the mandible (C)

The index values were computed digitally and tabulated in Microsoft excel spreadsheet.

3. results

The collected data were analysed using SPSS software version 23 (IBM, USA). The Kolmogorov-Smirnov test was applied to verify that the data followed a normal distribution. The mean and standard deviation (SD) for both diabetic and non-diabetic groups were calculated and summarized. To compare the two groups, an independent t-test was performed. A p-value ≤ 0.05 was considered as the threshold for statistical significance, indicating a meaningful difference between the groups.

Table 2: Descriptive statistics for the diabetic group among the study population

|  |  |  |  |
| --- | --- | --- | --- |
| **PARAMETER** | **N** | **MEAN** | **S.D** |
| **B** | 50 | 15.90 | 2.276 |
| **C** | 50 | 4.37 | .858 |
| **PMI** | 50 | 3.75 | .825 |
| **MI** | 50 | 16.99 | 2.443 |

This table presents the descriptive statistics, including the mean and standard deviation (S.D.), for key parameters measured in the diabetic group of the study population. The sample size (N) for all parameters is 50.

**Parameter B**

* + Mean: 15.90
  + Standard Deviation: 2.276
  + This indicates that the average value for parameter B is 15.90, with variability of ±2.276 around the mean.

**Parameter C**

* + Mean: 4.37
  + Standard Deviation: 0.858
  + The relatively low standard deviation suggests less variability in the data for this parameter.

**PMI (Panoramic Mandibular Index)**

* + Mean: 3.75
  + Standard Deviation: 0.825
  + This suggests moderate variability in the distribution of PMI values within the diabetic group.

**MI (Mental index)**

* + Mean: 16.99
  + Standard Deviation: 2.443
  + This parameter shows the highest mean value among the listed parameters, with a standard deviation of 2.443, indicating a relatively wider spread of values**.**

Table 3: Descriptive statistics for the non-diabetic group among the study population

|  |  |  |  |
| --- | --- | --- | --- |
| PARAMETER | N | MEAN | S.D |
| B | 50 | 16.15 | 2.558 |
| C | 50 | 4.82 | 1.264 |
| PMI | 50 | 3.50 | .831 |
| MI | 50 | 17.01 | 2.779 |

This table presents the descriptive statistics, including the mean and standard deviation (S.D.), for key parameters measured in the non-diabetic group of the study population. The sample size (N) for all parameters is 50.

**Parameter B**

* + Mean: 16.15
  + Standard Deviation: 2.558
  + The average value for parameter B is slightly higher than in the diabetic group (15.90), with moderate variability.

**Parameter C**

* + Mean: 4.82
  + Standard Deviation: 1.264
  + The mean value is higher than in the diabetic group (4.37), with a larger standard deviation, suggesting more variation in this parameter among non-diabetic individuals.

**PMI (Panoramic Mandibular Index)**

* + Mean: 3.50
  + Standard Deviation: 0.831
  + This is slightly lower than in the diabetic group (3.75), indicating a potential difference in periodontal health between the two groups.

**MI (Mental Index)**

* + Mean: 17.01
  + Standard Deviation: 2.779
  + The mean value is very close to that of the diabetic group (16.99), but with a slightly higher standard deviation, indicating greater variability.

**Comparison with Diabetic Group**

* B and C values are slightly higher in the non-diabetic group compared to the diabetic group, suggesting potential differences in the measured parameters between the two populations. MI is lower in non-diabetics, which may indicate better periodontal health. MI values are almost identical between both groups, suggesting no major difference in this parameter.

Table 4: Intergroup comparison between the diabetic and non-diabetic group by using independent t test among the study population

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PARAMETER | GROUP | MEAN | S.D | MEAN DIFFERENCE | 95% CONFIDENCE INTERVAL | | SIG |
| LOWER | UPPER |
| B | DIABETIC | 15.90 | 2.276 | -.27800 | -1.66930 | 1.11330 | .690 |
| NON DIABTEIC | 4.37 | .858 |
| C | DIABETIC | 3.75 | .825 | -.45600 | -1.07887 | .16687 | .148 |
| NON DIABTEIC | 16.99 | 2.443 |
| PMI | DIABETIC | 16.15 | 2.558 | .24048 | -.23578 | .71674 | .315 |
| NON DIABTEIC | 4.82 | 1.264 |
| MI | DIABETIC | 3.50 | .831 | -.06200 | -1.56529 | 1.44129 | .934 |
| NON DIABTEIC | 17.01 | 2.779 |

*\*p value less than or equal to 0.05 is considered statistically significant difference*

This table presents the results of an independent t-test comparing key parameters between the diabetic and non-diabetic groups. The mean differences, confidence intervals (95%), and significance (p-values) are analysed to determine statistical significance.

Parameter B: *P = 0.69* (Not Significant) There is no statistically significant difference in Parameter B between the two groups.

Parameter C: *P = 0.14* (Not Significant) although the non-diabetic group has a slightly higher mean, the difference is not statistically significant.

PMI (Panoramic Mandibular Index): *P = 0.31* (Not Significant) No significant difference in PMI between diabetic and non-diabetic groups.

MI (Mental Index): *P = 0.93* (Not Significant) The difference in MI is minimal and statistically insignificant.

None of the parameters (B, C, and PMI, MI) show statistically significant differences between diabetic and non-diabetic groups. This suggests that within this study population, diabetes status does not have a statistically significant impact on the measured parameters. Future studies with larger sample sizes or additional variables may be needed to explore potential differences further.

**4. DISCUSSION**

**Diabetes mellitus (DM)** is a chronic metabolic disorder characterized by **persistent hyperglycaemia**, resulting from defects in **insulin secretion, insulin action**, or both.Type 1 Diabetes is an autoimmune condition where the immune system destroys insulin-producing beta cells in the pancreas while Type 2 is characterized by **insulin resistance** and eventual decline in insulin production. According to the International Diabetes Federation (IDF), diabetes affected 537 million adults (20-79 years) globally in 2021, with numbers expected to rise to 643 million by 2030. Countries like India are experiencing a diabetes epidemic due to rapid urbanization, dietary changes, and lifestyle shifts.

The literature highlights evidence linking **diabetes mellitus** as a significant **risk factor for osteoporotic fractures**. [7] Researchers have focused on the **alveolar bone**, noting its structural similarity to vertebral bodies, as both lack **muscular insertions**. Utilizing **dental radiographs**, they suggested that, with **standardized imaging techniques** and appropriate controls, radiographs of the **alveolar process** could serve as a more effective indicator of **systemic osteoporosis**. [8]

Histological quantification has revealed that **cortical porosity of the mandible** increases with age, exhibiting significant **intra-mandibular variation**. The **alveolar process** demonstrates greater activity in **bone resorption and deposition** compared to the mandibular body. [9][10] However, the **alveolar bone** is highly influenced by **local factors**, such as **periodontal disease** and **denture quality**. As a result, bone values obtained from a single biopsy of the alveolar process may not accurately reflect the **overall structure of the mandible**. [11].

In the present study, **radio morphometric indices of the mandible** were measured and evaluated using **panoramic radiographs**. Dental radiographs, when performed using a **standardized technique**, have the potential to serve as a **reliable indicator** of **systemic osteoporosis**. [12] Since **dental panoramic radiography** is commonly used as a routine screening tool in general dental practice, the **assessment of radio morphometric indices** through this imaging technique may prove useful in identifying individuals with **low bone mineral density (BMD)**.[3]

A total of 50 patients participated in the study, where they were all advised to undergo 2D orthopantographs. The OPGs were examined by a single examiner using a ruler in SIDEXIS 4 software to calculate the PMI and MI indices. The index values were computed digitally and tabulated in Microsoft excel spreadsheet. Independent t-test was used to compare mean values between the diabetic and non-diabetic group.

The results indicated that there was no significant variation in the panoramic mandibular index (PMI) between diabetic patients and healthy controls. When comparing the average mental index (MI) between the two groups, the mean MI for diabetic patients was slightly lower than that of the healthy controls, the difference was not statistically meaningful.

**5. CONCLUSION**

PMI and MI could serve as useful screening tools for assessing quantitative bone changes related to diabetes. However, due to the differing pathogenesis of type 1 and type 2 diabetes mellitus, the resulting bone changes vary as well. The results indicate a mild variation in index values between the diabetic and non-diabetic groups, although this difference was statistically insignificant.

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