Association of Hormonal Fingerprints and Dental Caries: A Pilot Study

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Abstract

Context: Dental caries remains the most widespread oral disease among all age groups. Hormonal fingerprints (second digit: fourth digit ratio or 2D:4D ratio) are biomarkers displaying sexual dimorphism and diverse human phenotypic traits. A person’s genetic makeup may influence the occurrence of dental caries.

Aim: The present study aimed to evaluate the influence of digit ratio on the incidence of dental caries.

Settings and Design: Two hundred patients between 18 and 55 years, reporting for restorations or endodontic therapy, participated in the study.

Subjects and Methods: Hormonal fingerprints (2D:4D ratio) were measured with the help of a digital vernier caliper. Caries incidence was recorded using the DMFT index.

Statistical Analysis used: Data obtained were tabulated and statistically analyzed using Independent t-test and Chi-square test.

Results: Males had a less mean 2D:4D ratio than females, which was statistically significant (p-value = 0.003). Chi-square test was applied, and there was a statistically significant correlation between high digit ratio and caries experience (p-value = 0.002). Females with a high digit ratio and males with a low digit ratio were in the moderate and low caries risk groups with a p-value of 0.029 and 0.001 in the respective risk groups.

Conclusion: The present study displayed a correlation between hormonal fingerprints (2D:4D ratio) and dental caries. An indicator of caries risk will help prevent caries by implementing oral hygiene measures, which will reduce its incidence as the most occurring oral disease.

Keywords: Caries incidence; dental caries; hormonal fingerprints

INTRODUCTION

Biological markers are a measurable indicator of physiological state or condition. They are used to measure, evaluate, and examine the normal or pathologic processes.[1] They are the tools that help in diagnosis, prevention, or retrogression of disease.[2] Biomarkers can be pulse, blood pressure, or anything that gives a correlation between biological process and a potential hazard, as given by the World Health Organization (WHO).[3]

One such biological marker is the hormonal fingerprint or digit ratio. Hormonal fingerprint or the digit ratio is the ratio of the second digit (2D) to the fourth digit (4D). The digits are measured from the midpoint of the fingers bottom crease (where the finger joins the hand) to its tip.[4] 2D:4D ratio is the 2D divided by the 4D of the same hand. It is considered a substitute marker for prenatal androgen exposure, which is known to show sexual dimorphism. This ratio (2D:4D) is lower in males and higher in females.[5] Individuals with a shorter index

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finger are testosterone derived and those having a longer index finger, estrogen derived.[6] The length of fingers on the human hand has been an area of research associated with various physiological and psychological traits and diseases. 2D:4D ratio is discussed more in medical science and has not been explored in dentistry.[7]

The most commonly occurring oral disease, which affects all age groups and is prevalent worldwide, is dental caries. It is the destruction of dental hard tissues by acidic by-products from bacterial fermentation of dietary carbohydrates, mainly sucrose.[8] There is a need to determine a biomarker that could prognosticate caries early. Hence, the study aimed to determine if an association exists between hormonal fingerprints (digit ratio) and caries incidence in the Indian population. The null hypothesis was that there exists no association between digit ratio (hormonal fingerprints) and caries experience.

SUBJECTS AND METHODS

The study was conducted in the Department of Conservative Dentistry and Endodontics. The study was initiated after approval from the Institutional Ethical Committee with reference no. ACDS/IES/35/October 2018. All the patients signed written informed consent before participation. A total of 200 patients reporting to the department for restorative or endodontic therapy were a part of this study. For standardization, the digit ratio of the right hand was measured for all the participants. Caries experience was assessed using the DMFT index.[9] Inclusion criteria were individuals 18–55 years of age and those who fall under the American Society of Anesthesiologists (ASA) Group 1 category. Patients falling under the ASA Group 2–5 categories, those with hormonal imbalance, and those with deformed digits were not a part of the study.[10]

Measurement of 2D:4D Ratio

The 2D (index finger) and 4D (ring finger) are measured from the midpoint of the basal crease till the tip of the digit, towards the palm side of the hand, using a digital vernier caliper [Figure 1]. 2D:4D ratio is obtained by dividing these values, and the obtained values were divided into two categories, i.e., low digit ratio (<0.95) and high digit ratio (> or = 0.95).[11] Since the digital vernier caliper is sensitive to every reading, the mean of three readings for every patient was recorded [Figure 1].

Evaluation of caries experience

Caries experience (decayed missing filled teeth [DMFT] index) was recorded under light, using a mouth mirror and Community Periodontal Index probe. Caries risk assessment classification was done according to the WHO Oral Health Survey [Table 1].[7,9] Two measurements were carried out in all the patients. Results obtained were tabulated and statistically analyzed using the t-test and Chi-square test.

RESULTS

The association between caries incidence and digit ratio was assessed based on gender, and it was noted that 15 female patients with a high digit ratio and 13 male patients with a low digit ratio were more in the low caries risk group with the p-value of 0.029 [Table 1]. Twenty female patients with a high digit ratio and 20 male patients with a low digit ratio were in the moderate caries risk group showing statistically significant results with the p-value of 0.001 [Table 1]. Furthermore, caries incidence was high in females. Individually participants with high digit ratios were falling more in the low and moderate caries risk groups. The relation of hormonal fingerprints and caries experience was inversely related in females and directly related in males.

When the digit ratio of males and females was compared, males had a lower 2D:4D ratio than females. The results were statistically significant (p-value = 0.003) using an Independent t-test [Table 2].

DISCUSSION

One of the most widespread chronic diseases worldwide is dental caries. It is an infectious disease with multifactorial etiology and slow evolution leading to the destruction of dental hard tissues.[8] One-fifth of the world accounts for about more than half of the total caries experience.[12] The population affected by caries has increased as the refined carbohydrate has become available.[13] Dental caries depends on the host-tooth surface, microorganisms, diet, and the equilibrium between the cariogenic and noncariogenic bacteria.[12] One of the factors affecting clinical judgment in

Figure 1: Measurement of 2D:4D ratio using digital vernier caliper
In this study, dental caries incidence was examined using the decayed-missing-filled teeth index (DMFT), as it is the tool recommended by the WHO for measuring and comparing dental caries experience in populations. It is used globally, is simple to apply, valid, and reliable. The analysis of results by DMFT remains uncomplicated.\cite{16,17}

Manning et al. and Brown et al. found that digit ratio remains unchanged lifelong.\cite{5,18,19} The length of the digits may vary during the growth and development phase, but the ratio will remain the same due to prenatal androgen exposure. Issrani et al. stressed that hormonal fingerprints could be potential biomarkers in early diagnosis, prognosis, and intervention for various dental diseases.\cite{20} The results of the present study are in accordance with the study done by Verma et al. and Lakshmi et al., who found that children with low digit ratio had more caries incidence than those with high digit ratio.\cite{10,21} However, a cross-sectional survey by Pallepati et al. in 350 school children, that compared the association between 2D:4D ratio and caries experience ($p$-value = 0.84), along with the relation between 2D:4D ratio and taste sensitivity ($p$-value = 0.98), reported no significant results statistically.\cite{22}

The ratio of 2D:4D (index finger: ring finger) is known to be more sensitive as compared to other digit ratios (3D:5D) as it shows sexual dimorphism and is related to diverse human phenotypic traits.\cite{23} Digit ratio is affected by prenatal androgen exposure in a fetus. Inspection of amniocentesis samples showed a negative correlation to prenatal testosterone, but a positive correlation to estrogen exposure.\cite{24} A fetus more exposed to testosterone is likely to present with a low (masculine) digit ratio. As the male fetuses have a high testosterone exposure, they have low digit ratios compared to females.

Similarly, the females have minor exposure to testosterone, therefore, likely to possess a high (feminine) digit ratio. Furthermore, molecular level studies have observed that prenatal testosterone is related to HOX A and HOD A gene expression. HOX A genes are highly conserved in mammals, which affect the differentiation of digits and toes. These genes are also involved in sex determination, morphogenesis of the urinogenital system, fertility, and hematopoiesis.\cite{25} Genetics may be responsible for caries directly or indirectly; factors that may come into play can be saliva or tooth composition, and dietary habits, among others.

Manning et al. found a positive association between 2D:4D ratios and luteinizing hormones (both hands) and estrogen (right hand only).\cite{5} Some reports state that the hormonal fingerprints of the right hand are more sensitive and differentiated to prenatal testosterone exposure, while others found average ratios across both.\cite{19,26} Studies on South Indian individuals also showed sexual dimorphism in 2D:4D ratios.\cite{27} This is in line with our study, with a female mean digit ratio (0.971) higher than a male mean digit ratio (0.957). This study determines to find if there is a relationship between hormonal fingerprints and caries incidence, and the results showed that the low digit ratio group was ruled by males and high digit ratio by females. Digit ratio was associated with moderate and low risks of caries experience ($p$-value < 0.05). There is an inverse relationship between hormonal fingerprints and caries incidence in females and a direct relationship between the two in males. The direct relationship between hormonal

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**Table 1: Association of caries incidence and digit ratio a/c to sex ($n$)**

| Caries risk category | DMFT (WHO basic method) | Digit ratio | Total ($n$) | Male ($n$) | Female ($n$) | $\chi^2$ | $p$-value |
|----------------------|-------------------------|-------------|-------------|-----------|-------------|---------|-----------|
| Very low (63)        | <1.2                    | High        | 54          | 24        | 30          | 3.429   | 0.082 (NS) |
|                      |                         | Low         | 9           | 7         | 2           |         |           |
| Low (42)             | 1.2-2.6                 | High        | 25          | 10        | 15          | 5.433   | 0.029 (S) |
|                      |                         | Low         | 17          | 13        | 4           |         |           |
| Moderate (56)        | 2.6-4.4                 | High        | 31          | 11        | 20          | 11.097  | 0.001 (S) |
|                      |                         | Low         | 25          | 20        | 5           |         |           |
| High (25)            | 4.5-6.5                 | High        | 17          | 5         | 12          | 0.053   | 1.000 (NS) |
|                      |                         | Low         | 8           | 2         | 6           |         |           |
| Very high (14)       | > 6.6                   | High        | 12          | 6         | 6           | 1.750   | 0.473 (NS) |
|                      |                         | Low         | 2           | 0         | 2           |         |           |

Chi-square test. Significant at $p$≤0.05. NS=Nonsignificant, S=Significant

**Table 2: Comparison of 2D:4D ratio among males and females**

| Gender | $n$ | Mean 2D:4D ratio | SD    | Difference | $t$     | $p$-value |
|--------|----|------------------|-------|------------|--------|-----------|
| Male   | 98 | 0.9577           | 0.03649 | -0.01411  | 2.997 | 0.003 (S) |
| Female | 102| 0.9718           | 0.02690 |            |        |           |

Independent $t$-test; Significant at $p$≤0.05. SD=Standard deviation, S=Significant
fingerprints and dental caries in permanent dentition suggested that caries had a definite and positive interaction with digit ratio. Thus, the null hypothesis was rejected.

Implementation of preventive measures, need for education for the correct maintenance of oral health, and preventive and continuous dental care are vital to the decline of caries prevalence. Further research to inspect the impact of 2D:4D on caries with larger sample size is required to ascertain the relationship with hormonal fingerprints and practical application in dentistry.

**CONCLUSION**

Hormonal fingerprint can thus act as a positive predictor for caries risk. Practitioners must recognize patients with caries and those at increased risk for carious lesions and then implement suitable preventive measures and treatment plans.

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**Conflicts of interest**

There are no conflicts of interest.

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