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Correlation of salivary characteristics with high risk of dental caries; A clinical investigation

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1. Introduction

Dental caries is one of the most prevalent and alarming oral health problems encountered in people regardless of age. It is a chronic, multifactorial disease resulting in the destruction of tooth structure and may lead to tooth loss if not treated promptly. Furthermore, it has a significant impact on individuals and on the community as a whole [1] (in the form of discomfort, pain, functional impairment, aesthetic concerns and financial burden for treatment [2]). This makes it a prime public health concern that should be addressed immediately.

Patients considered to have a high risk of dental caries exhibit active carious lesions that have cavitated smooth surfaces of two or more teeth at one time. Also at a high risk are those who show signs of recurrent caries or have a history of smooth surface caries in the past.

Several external and internal host factors contribute to the development and progression of dental caries. The development of carious lesions in teeth is highly dependent upon lifestyle and diet [3]. It is a complex process in which bacterial metabolism produces acid by fermentation of carbohydrates [4]. Demineralization of hard tissue occurs as a result of this pronounced acid attack.

Amongst the external host factors, dietary sugars play an imperative role. Sugars provide a substrate for bacteria to ferment and Streptococcus Mutans is majorly involved [5]. The amount, frequency, concentration, and form of sugars are strongly related to the prevalence of dental caries [6]. In addition, dietary routine of low fiber, sugared/carbonated beverages and refined food can result in reduced clearance and an overall acidic environment. Other factors include inadequate oral hygiene [7] and irregular dental recall. Poor oral hygiene leads to increased plaque accumulation on the surfaces of teeth. This leads to increased bacterial load, lower pH of the mouth and eventually demineralization [8].

Internal host factors contributing to dental caries are tooth surface and saliva. The surfaces not accessible to cleaning aids are more prone to bacterial attack and thus, caries. Saliva plays a fundamental role in the maintenance of oral homeostasis [9]. Saliva has been used as a diagnostic tool for more than two thousand years, utilized as a marker of health or disease states [10]. Various functions of saliva include buffering, lubrication, antibacterial properties, antiviral action, and digestion. Being a complex aggregate of proteins, enzymes, regulating hormones, essential vitamins, immunoglobulins, a reservoir of electrolytes and metabolites makes saliva an important defense mechanism of the body [11]. This natural defense mechanism counteracts the acidic effect of bacteria by washing away debris, neutralizing pH and establishing equilibrium in the remineralization and demineralization cycle. Remineralization of hard tissue relies on saliva being a reservoir of calcium, phosphate and fluoride ions [4]. Therefore, saliva plays an extremely vital role in safeguarding and maintaining the integrity of oral soft and hard tissues in the mouth.

Salivary characteristics such as pH, flow rate, consistency and buffering capacity have been associated with dental caries. The flow rate is the quantitative measure of salivary secretion in milliliters per minute. A greater flow rate leads to increase in clearance of debris and bacteria. Xerostomia caused by decreased salivary production or secretion results in increased caries incidence, compromised periodontal health and functional impairment.

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Altered salivary production or secretion can be caused by medical conditions, medications or salivary gland disorders. Resting salivary flow rate (unstimulated) ranges from 0.25 to 0.35 ml/min, whereas stimulated salivary flow rate ranges from 1 to 3 ml/min [12]. Flow rate can be considered abnormal if in the resting state, it is < 0.1 ml/min and when stimulated, is < 0.5 ml/min.

The normal range of salivary pH is 6.2–7.6. Cariogenic bacteria ferment carbohydrates, releasing hydrogen ions. Increased H+ ion concentrations account for the acidic pH. Saliva maintains the pH of the mouth by clearing away food debris and microorganisms, as well as by its buffering capacity. A lower pH (<6.2), corresponding to an acidic environment means increased bacterial activity and lower mineral reservoir. Inversely, an elevated pH (>7.6) may lead to increased plaque accumulation and provides an environment for anaerobes to thrive. Therefore, a neutral salivary pH is essential for the health of oral soft and hard tissues. Bicarbonate ions in saliva have a buffering effect on the lower pH. They help in neutralizing the acidic effects caused by an increase in the hydrogen ion concentration [13].

Lastly, depending upon the protein and mucin content in saliva, it can be watery (clear) or thick (sticky or frothy). Parotid gland produces most of the saliva when stimulated, being more watery and serous in nature. On the other hand, submandibular gland produces 60% of the saliva at rest (both mucous and serous secretion in nature). Minor salivary glands do not affect the flow rate, as the major salivary glands do. The mucous content of saliva produced by minor salivary glands provides lubrication and protection. More mucins and proteins in saliva mean more lubrication and less plaque accumulation.

The aim of this study is 1) to evaluate the association of certain salivary characteristics (Flow rate, pH, consistency) in high-risk caries patients and 2) their efficacy as clinical tests to determine the risk of developing dental caries.

2. Materials and methods

This research was carried out in the Department of Restorative Dentistry at Islamic International Dental College and Hospital, Islamabad, Pakistan. After taking consent, a sample of saliva was taken from 303 patients and evaluated for flow rate (normal resting 0.25–0.35 ml/min, normal stimulated 1–3 ml/min), pH and consistency.

The inclusion criterions were set as healthy patients with more than 2 active carious lesions in the mouth and were above 9 years of age. Patients taking medications that cause hypo-salivation were excluded. In addition, patients with a history of metabolic disease, previous radiation therapy, salivary gland inflammation or disorder were also excluded from being sampled.

The unstimulated salivary flow rate was measured passively by asking the patient to spit in a plastic cup provided after 60 seconds (Fig. 1a). Patients were instructed to lower their heads facing forward, not to talk nor swallow the collecting saliva. The stimulated salivary flow rate was measured by requesting the patients to chew on paraffin wax pellets (Fig. 1b) for 60 seconds and spitting the saliva collected in a separate cup provided. The flow rate was measured by aspirating from a graduated syringe [14] (Fig. 1c and d). Universal indicator pH paper strips were placed in both cups and dipped in the salivary sample for 10 seconds (Fig. 2a). The color change on the pH strip was noted corresponding to the pH of the saliva, for samples with a very limited quantity of the salivary sample [15] (Fig. 2b). Where salivary content was sufficient, an electronic pH meter was used (Fig. 2c). Salivary consistency was observed subjectively as watery and clear or thick, frothy and stringy (Fig. 1a). The above-mentioned parameters were recorded along with patient's name, age and DMFT scores. The collected data was analyzed using SPSS software estimating the rate ratio using linear regression to relate the above mentioned salivary characteristics with dental caries in different age groups.

3. Results

The data was collected at random and totalled out to 303 patients. The data was analyzed and the mean calculated for the salivary characteristics individually. The mean decayed count was 4.34 with a standard deviation of 3.55. Salivary consistency was denoted as 1 or 2, being watery or thick respectively. The mean flow rate (standard deviation) was recorded to be 0.32 (0.34) ml/min unstimulated and 0.98 (0.77) ml/min stimulated. The mean pH (standard deviation) was documented to be 6.55 (0.92) for unstimulated and 7.21 (0.89) for stimulated salivary samples as shown in Table 1. Table 2 shows the linear regression model summary.

Age is the only factor which is significantly affecting dental

Fig. 1. a) pH strip in thick consistency frothy salivary sample. b) Paraffin wax pellets. c) Saliva sample in a graduated syringe (0.3 ml/min). d) saliva sample in a graduated syringe (0.7 ml/min).

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