Having healthy teeth is more important than we would normally think and good diet is a key contributor in this. As per a study, people with 25 or more teeth tend to eat more nutritiously. Diet is commonly associated to increase in weight, cholesterol or sugar levels in the body. However, what we eat also affects the teeth and gums. Too many and/or frequent intake of cold drinks, sweetened fruit drinks, snacks etc. put our teeth at the risk of decay. A poor diet can lead to gum disease and tooth decay. Foods high in carbohydrates, sugars and starches greatly contribute to the production of plaque acids that attack the tooth enamel. Eventually these acids can cause tooth enamel to break down, forming a cavity. But this can be prevented. Some of the foods that help in protecting the health of teeth and gums are:

- **Tea:** Compounds called polyphenols, found in black and green teas, slow the growth of bacteria associated with cavities and gum disease. In a 2010 study published in the Journal of Dental Research, Wu and her colleagues wrote that tea, especially black tea, fights halitosis, or bad breath. "Polyphenols suppress the genes of bacteria that control the production of smelly compounds in the mouth," Wu said.
- **Cheese:** Research published in the journal General Dentistry earlier this year reported that 12- to 15-year-olds who ate cheddar cheese had lower acid levels in their mouths than those who ate sugar-free yogurt or drank a glass of milk.
- **Raisins:** Naturally sweet, raisins don't contain sucrose are also a source of phytochemicals, which may kill cavity-causing plaque bacteria. Some compounds in raisins also affect the growth of bacteria associated with gum disease.
- **Crunchy Foods:** munching foods like carrots, apples and cucumbers may disturb the plaque and act as a cleansing agent.
- **Vitamin Rich Food:** According to American Dental Association foods that contain calcium (e.g. cheese, leafy greens and almonds) and phosphorous (e.g. meat, eggs and fish) can help keep tooth enamel strong and healthy.
- **Sugarless Gum:** Chewing increases saliva secretion clearing away some bacteria.
- **Milk:** According to a study published in the American Dental Association, drinking a glass of milk after downing dry, sugar-sweetened Fruit Loops lowered levels of acid in the mouth more than drinking water or apple juice did.

To help control the amount of sugar you consume, read food labels and choose foods and beverages that are low in added sugars. Regular brushing and flossing help keep teeth healthy by getting rid of sugars and food particles that team up with bacteria to form plaque. Researchers at the University of Illinois at Chicago found that people who rinsed their mouths with black tea for one minute, 10 times a day, had less plaque buildup on their teeth than people who rinsed their mouths with water. What's more, the size and stickiness of their plaque was reduced.

I also take this opportunity to wish all of you a very happy, prosperous and healthy year ahead.

**Dr. Shveta Sood**
Editor In Chief
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Abstract

A survey study has been done to understand and analyze the dietary pattern of the individuals in a population of women subjects. Nutrition is the science that interprets the interaction of nutrients and other substances in food in relation to maintenance, growth, reproduction, health and disease of an organism. Malnutrition is a condition that results from eating a diet in which nutrients are either not enough or are too much such that the diet causes health problems. A nutritional assessment is an in-depth evaluation of both objective and subjective data related to an individual's food and nutrient intake and lifestyle. Questionnaires were developed to find out the socio-economic profile, dietary intake, nutritional status, general awareness and general practices about health and hygiene in adult females. During a nutrition interview the practitioner may ask what the individual ate during the previous twenty-four hours, beginning with the last item eaten prior to the interview. In this particular survey, we have used food frequency list along with the 24-hours recall method for taking data of the foods consumed within past 24 hours by the individual subjects. The nutrient consumption (ADA) had been observed to be higher than that of RDA, which may be associated with the risk of health related problems in the studied population. This increase in the dietary consumption is clearly visible, and there is a need to educate and create awareness regarding healthy food habits.

Keywords: Nutritional assessment, dietary intake, food groups, malnutrition, nutrient adequacy ratio

Introduction

Nutrition is the science that interprets the interaction of nutrients and other substances in food in relation to maintenance, growth, reproduction, health and disease of an organism. Malnutrition or malnourishment is a condition that results from eating a diet in which nutrients are either not enough or are too much such that the diet causes health problems. Freedom from hunger and malnutrition is a basic human right and their alleviation is fundamental prerequisite for human and national development. Various forms of malnutrition including both macro and micronutrient deficiencies affect a large segment of population in India. Various surveys carried out in different developing countries including India, have shown that aetiology of malnutrition is complex and often lacks clear cut elucidation. Systemic investigations revealed that the main causes of malnutrition are poverty, ignorance, and infection which are interlinked with one another to form a web of socioeconomic complex. Frye Kristin et al (2013) said that, malnutrition is a quiet pandemic affecting millions of people throughout the world. It has high public health significance because of the large number of people affected by malnutrition, the fact that vulnerable populations disproportionately suffer the effects of malnutrition, and because these effects are severe, long lasting, and cumulative. Inadequate intake of micronutrients can adversely influence growth and development, cognitive performance and increase susceptibility to infections.

While malnutrition is prevalent among all segments of the population, poor nutrition among women begins during infancy and continues throughout their lifetime. The nutrition transition in low income countries is being recognized as an emerging crisis due to changing health profiles. A classical example of changing health profile is evident from the nationwide surveys mapping the nutritional profile of women (NFHS, 2007). Research on women's status in society has found that the contributions Indian women make to families are often overlooked. Poor health has repercussions not only for women, but also their families.

Dietary studies are relevant for improving our understanding of the role of nutrition in preventing certain diseases, for identifying causes of public health problems and cost-effective interventions aimed at reducing potential health risks. Diet and nutrition are important factors in the promotion and maintenance of good health throughout the life. Income, individual
preferences and beliefs, cultural traditions, as well as geographical, environmental, social and economic factors all interact in a complex manner to shape dietary consumption patterns. A normal balanced diet must include foods from various food groups in sufficient amounts to meet the needs of an individual and to increase the immunity. As responsible health professionals, we intend to make an effort to investigate the nutritional status, dietary intake of women in professional courses. We aim to find the nutritional status of a sample urban female population and compare with recommended dietary allowance (RDA). As health education should give more emphasis to prevent health problems rather than providing cure\textsuperscript{[11]} Females have been singled out giving regard to their importance and role in the development and welfare of a family, society and a country as a whole. The data from our study may also provide an insight to programmers to design/develop interventions for health and lifestyle.

**Material & Methods**

**Participants**

20 asymptomatic female participants (Amity University Students) were randomly selected, mean age ($\pm$ SD); 22.75 $\pm$ 1.11) years. Exclusion criteria for the study were any history of acute and chronic diseases. A written consent was taken from all participants before commencement of the study. All the participants were assessed using questionnaire method.

**Study Protocol**

Questionnaires were developed to find out the socio-economic profile, dietary intake, nutritional status, general awareness and general practices about health and hygiene in adult females.

1. **Background questionnaire:**- It consisted of personal profile, their activity patterns and family history.

   - **Personal profile:** It included the basic information about the sample i.e. name, age, food habits (vegetarian, non-vegetarian or ome to eat), addiction (smoking, alcoholism), etc. The data was analysed by calculating the frequencies of variables.
   - **Activity pattern:** It includes the daily exercise, sleeping pattern, meal Pattern, Medications etc.
   - **Family History:** It included information about the diseases that are associated with the family members.

2. **Food frequency questionnaires:**- It included information about the consumption of various food groups, their amounts and their frequencies of consumption. The questionnaire consisted of all the common food products that were consumed in the study area. The frequency of consumption and also the amounts of food products were collected on the basis of which nutrient consumption in a day was calculated for each sample. The data was analyzed to find out:

   - The frequency of consumption of all the food products,
   - The minimum, maximum and mean intake of all the food products and,
   - The minimum, maximum and mean intake of the various macronutrients including energy, protein, carbohydrate and fat.
   - Nutrient adequacy ratio (NAR) for energy, protein, carbohydrates and fat.

**Statistical Analysis**

The data was analyzed using MS Excel windows software, statistical analysis including mean, frequency, cumulative percent, standard deviation and student’s t-test was carried out. The average daily intake of foods and their nutrients was calculated for acquired dietary allowance (ADA) and compared with ICMR recommended RDA. These test were applied to find out:

   - The minimum, maximum and mean intake of the various macronutrients including energy, protein, carbohydrate and fat.
   - Nutrient adequacy ratio (NAR) for energy, protein, carbohydrates and fat.

   \[
   \text{NAR} = \frac{\text{Nutrient Intake}}{\text{RDA}} \times 100
   \]

**Results & Observations**

**Dietary Pattern**

The dietary habits of the individuals were analysed to be 60% non-vegetarian and 40% vegetarian in the total sample population (Figure 1).
Nutritional Analysis

Food Consumption Frequency

Table 1. Percentage of Consumption Frequency of Each Food Group

<table>
<thead>
<tr>
<th>CONSUMPTION FREQUENCY</th>
<th>DAILY (%)</th>
<th>4-7 TIMES IN A WEEK (%)</th>
<th>2-3 TIMES IN A WEEK (%)</th>
<th>ONCE IN A WEEK (%)</th>
<th>LESS THAN ONCE A WEEK (%)</th>
<th>NEVER (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk &amp; Milk Products</td>
<td>75</td>
<td>5</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Meat &amp; Meat Products</td>
<td>90</td>
<td>5</td>
<td>15</td>
<td>25</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Pulses &amp; Legumes</td>
<td>65</td>
<td>15</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Veg. A</td>
<td>20</td>
<td>10</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Veg. B</td>
<td>35</td>
<td>5</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Fruits</td>
<td>65</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cereals</td>
<td>65</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Fat</td>
<td>65</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

Fig 1. Overall percentage of dietary pattern among the sample population

Fig 2. Observed consumption frequency of milk products

Fig 3. Observed consumption frequency of meat and meat product

Fig 4. Observed consumption frequency of pulses and legumes

Fig 5. Observed consumption frequency of cereals and cereal products

Fig 6. Observed consumption frequency of green leafy vegetables (Veg. A)

Fig 7. Observed consumption frequency of roots and tubers (Veg. B)
A throughout analysis of the food consumption frequency is well depicted in Table 1, showing percentage of total no. of subjects in corresponding food groups and consumption frequency. Figure 1-10 shows most of the individuals consume cereals and cereal product as their staple food, making it up to 65%. Milk and milk products show a high consumption within the sample population as 75% of the total individuals consume milk on a daily basis. Fats and sugar are equally consumed as cereals, making 65% of the total sample size consuming it daily. Even though 60% of the individuals were non-vegetarian, meat and meat products are still less consumed as compared to pulses and legumes, and vegetables.

**Acquired Dietary Allowance (ADA) and Recommended Dietary Allowance (RDA)**

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>NUTRIENT</th>
<th>ADA</th>
<th>RDA</th>
<th>DIFFERENCE</th>
<th>NAR(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ENERGY (kcal/d)*</td>
<td>2525.34</td>
<td>1875</td>
<td>650.34</td>
<td>135</td>
</tr>
<tr>
<td>2</td>
<td>PROTEIN (g/d)**</td>
<td>87.91</td>
<td>50</td>
<td>37.91</td>
<td>176</td>
</tr>
<tr>
<td>3</td>
<td>CARBOHYDRATE (g/d)**</td>
<td>417.4</td>
<td>130</td>
<td>287.4</td>
<td>68</td>
</tr>
<tr>
<td>4</td>
<td>FAT (g/d)**</td>
<td>52.6</td>
<td>20</td>
<td>32.6</td>
<td>263</td>
</tr>
</tbody>
</table>

*#kcal/d- Kilocalorie/day, **g/d - Gram/day

The nutrient consumption (ADA) had been observed to be higher than that of RDA, which may be associated with the risk of health related problems in the studied population. Although on application of student's t-test between ADA and RDA it was not significant (P<0.05). The net difference is represented in the Table 2. above. Also, a closer comparative analysis of the differences in consumption unit of each nutrient with respect to ADA and RDA is represented in figure 11.

**Discussion**

More than half of the total number of individuals in the studied population of women subjects is seen to be non-vegetarian, whereas 40% amongst them are vegetarian. This suggests that the nutritional status and food consumption frequency in the non-vegetarian group have a different pattern of distribution between the various food groups and dietary pattern in comparison to vegetarians’. But unlike this assumption, even though 60% of the population are non-vegetarian, the food habits are almost similar in both the groups, and meat and meat products becomes the least consumed food group amongst all the different categories and their sub-categories.
The food frequency list gives an overall idea of the frequently consumed food in the sample population. A major fraction of individuals prefer cereals and cereal products as their staple food. The study shows a high consumption of milk and milk products, which most of the subjects consume on a daily basis, cereals and sugar show equal consumption, followed by pulses and legumes, vegetables and fruits. High sugar intake may be due to regular intake of sugar and sweets, which forms an inevitable part of Indian delicacies. The least consumed food, as mentioned above, is meat and meat products.

Analysis of ADA and RDA suggests that the total amount of nutrients (ADA) is found to be exceeding in the data. The result was not significant as the sample size was small. The amount of calorie intake (energy) and carbohydrate are remarkably higher than that of their recommended dietary allowances. This may be due to negligence of the related aspects of nutrients in our survey such as protein quality, visible and invisible fat estimation etc., and also micronutrients are not considered in our survey. However, the increase in the dietary consumption of macronutrients is clearly visible, and there is a need to educate and create awareness regarding healthy food habits.

On analysis of Nutrient Adequacy Ratio it was seen that amount of energy, protein and fat are 135, 176 and 263% respectively, which may cause metabolic disturbances. There are few studies regarding the effect of long-term moderate to high intake of protein and the development of chronic diseases. Although few studies show that the body will absorb and use a greater amount of protein after different types of exercises than under more sedentary circumstances. Studies on weight training show clinically significant gains in muscle mass with a very high protein diet when compared to moderate protein intake, in some studies, however, increased protein intake fails to translate into functional differences in strength or muscle size. However, consistently consuming less protein than an individual’s daily requirement (approximately 0.7g/kg/day for a sedentary individual) causes loss of existing lean body mass, even with an excessively caloric diet.

**Conclusion**

It may be concluded that a fraction of individuals do not lie in the range of normal healthy individuals, as most of the women are taking fat in much higher amounts as analysed by this survey. However, acquired dietary consumption of nutrients is higher on an average than that of the RDA, which attributes to the increased risk of obesity and obesity-related health issues among a good number the individuals. Hence, the food plan of the individuals must be revised to improve the quality of their health. Increasing the awareness regarding healthy food habits would eventually lead to good health among the women.

**References:**


Abstract
Maxillary transverse discrepancy usually requires expansion of the palate by a combination of orthopedic and orthodontic tooth movements. Three expansion treatment modalities are used today: rapid maxillary expansion, slow maxillary expansion and surgically assisted maxillary expansion. This article aims to review the maxillary expansion by surgical approach and a brief on commonly used appliances.

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Key Words - Maxillary Transverse Deficiency, Maxillary Expansion, SARPE

Introduction
Transverse maxillomandibular discrepancies are a major component of several malocclusions. Orthopedic and orthodontic forces are used routinely to correct a maxillary transverse deficiency (MTD) in a young patient. The treatment is a combination of orthodontics and surgical procedures and provides dental arch space for alignment of teeth. The procedure also causes a substantial enlargement of the maxillary apical base and of the palatal vault, providing space for the tongue for correct swallowing and thus preventing relapse.

History
Orthopedic maxillary expansion (OME) was first described over 145 years ago by Angell in a case report. Emerson C. Angell placed a screw appliance between the maxillary appliance of a girl aged 14.5 years and widened her arch one quarter inch in two weeks. The essential passage reads: "this apparatus was placed in the mouth, when the shaft was made to revolve until the fixture was made uniformly firm, when the patient was provided with the key and instructed to keep the shaft as uniformly tight as possible". It was for the first time that double jackscrew with opposing thread has been described and used in orthodontics.

After initially falling to disrepute, it was reintroduced in the middle of the last century by Andrew Haas. Presently, OME has become a routine procedure in treating maxillary transverse deficiency (MTD) in a variety of malocclusions in young orthodontic patients.

As early as 1920, Mesnard demonstrated radiographically that the mid-palatal suture could be separated using fixed appliance and that space would be filled with bone within 4-6 weeks. The incidence of maxillary transverse deficiency in the deciduous and mixed dentitions is estimated at 8% to 18% of patients having orthodontic consultations. This entity may occur in the primary dentition and manifest itself as a constriction of the lateral dimension of the upper arch. Because of more complications after attempts to orthopedically alter the transverse dimension of the maxilla with advancing age, surgical procedures have been recommended to facilitate correction of transverse discrepancies. These procedures have conventionally been grouped into 2 categories: segmenting the maxilla during a LeFort osteotomy to reposition the individual segments in a widened transverse dimension, and surgically assisted rapid palatal expansion (SARPE).

Aim of this article is to present a comprehensive review of the literature, including indications, diagnosis, guidelines for case selection, a brief overview of the surgical techniques, orthodontic considerations to better aid the clinician in the management of MTD in skeletally mature patient.
Indications for Sarpe

The following have been reported in the literature as indications for SARPE, all applying to a skeletally mature patient with a constricted maxillary arch.  

1. To increase maxillary arch perimeter, to correct posterior crossbite, and when no additional surgical jaw movements are planned.
2. To widen the maxillary arch as a preliminary procedure, even if further orthognathic surgery is planned. This is to avoid increased risks, inaccuracy, and instability associated with segmental maxillary osteotomy.
3. To provide space for a crowded maxillary dentition when extractions are not indicated.
4. To widen maxillary hypoplasia associated with clefts of the palate.
5. To reduce wide black buccal corridors when smiling.
6. To overcome the resistance of the sutures when OME has failed.

Patient Selection

A thorough review of the literature shows significant disparities among clinicians regarding the criteria for case selection and the indications for SARPE. In this section, we will address the diagnostic procedures that are critical to proper case selection.

Amount of Expansion

Betts et al and others have recommended that the amount of desired expansion is an important factor in case selection for maxillary expansion in adults. In general, an orthodontist can camouflage transverse maxillomandibular discrepancies less than 5 mm with orthopedic or orthodontic forces alone. When the MTD is greater than 5 mm, surgical assistance is essential. Although both SARPE and segmental osteotomy are used for surgically assisted maxillary expansion, segmental osteotomy is reported to be unstable, especially when more than 8 mm expansion is desired. It is also essential to evaluate the buccolingual inclination of the teeth because that may either mask or aggravate the discrepancy at the apical bases.

Appliances

A number of appliances have been used to correct MTD. Fixed appliances have been the mainstay in SARPE patients. Removable appliances are not recommended because they are effective only in the deciduous or early mixed dentition. Removable appliances also do not have sufficient retention and stability for intraoperative and postoperative use. Fixed appliances like the Haas, the hyrax, and the bonded palatal expander are recommended for use with SARPE. The Howe acrylic-lined bondable expander with a midpalatal jackscrew and the Minne expander consisting of a heavy caliber coil spring with 2 metal flanges soldered to the bands, are less frequently used. The force is generated by a jackscrew in all these appliances. Coffin springs, quad helices, and magnets have been suggested as means to apply expansion force in OME or slow expansion but are not used in patients undergoing SARPE.

The Haas appliance consists of acrylic palatal shelves that have been suggested to use the tissue support for producing more evenly distributed forces on the teeth and the alveolar processes. The hyrax has a metal framework that is less irritating to the palatal mucosa and is more hygienic. The hyrax appliance is constructed either as a 2- or a 4-banded appliance. In the 2-banded appliance, only 1 tooth on either side of the maxilla is banded (most frequently the first molars), and, in a 4-banded appliance, 2 premolars are included with the molars. For most appliances, the pitch of the jackscrew is 0.25 mm, which is equal to a quarter turn. Both the Haas and the hyrax palatal expanders can be constructed with a flat-plane occlusal-coverage splint. This type of appliance is bonded to the maxillary teeth, and its use has been recommended in patients with periodontally compromised dentition because it incorporates more anchor teeth. It can also be used for patients with symptoms of temporomandibular disorders.

Mommaerts suggested the use of a bone-borne titanium device with interchangeable expansion modules rather than a conventional tooth-borne appliance. According to him, conventional tooth-borne appliances produce greater loss of anchorage and more skeletal relapse both during and after expansion. Higher incidences of cortical fenestration and buccal root resorption are also observed with tooth-borne appliances compared with absolute bone-borne appliances. Orthodontic treatment can be initiated earlier in the postsurgical period with the bone-borne appliances than tooth-borne appliances. The application of the bone-borne distractor does not depend on a complete dentition. A number of bone-borne distractors are now available commercially. These include the transpalatal distractor, the Magdenburg palatal distractor, MDO-R device (Orthognathics, Ltd, Zurich, Switzerland), and...
the Rotterdam palatal distractor. They have been reported to have greater control of orthopedic movement than tooth-borne appliances. The pitch of the screw in most bone-borne distractors differs in its construction. The Rotterdam palatal distractor, for example, has a progressively reducing distraction for every activation. Thus, for the bone-borne distractors, the manufacturer’s guidelines must be followed. The bone-borne appliances are contraindicated in patients with extremely low palates, because the nails of the abutment plates loosen more easily and the distractor is not stable. These are also contraindicated in patients with immunodeficiency conditions and prior radiation therapy.

Orthodontic considerations and preparation

Before sending a patient for a SARPE, the orthodontist must ensure that there is enough space between the roots of the central incisors for a midline split. A periapical or occlusal radiograph should be taken, and the interradicular bone evaluated. If space is inadequate, preoperative root divergence must be created. To ensure the postoperative and posttreatment health of the teeth, the patient should be seen regularly by a periodontist. The gingiva should be healthy between the central incisors. After expansion, a large midline diastema is present, and the central incisors should be moved reciprocally at a controlled and slow rate. A similar yet smaller diastema is obtained in patients who undergo OME when the teeth drift to close the space after expansion. No clear protocol is evident from the literature regarding the rate of midline space closure in SARPE patients. Occasionally, clinicians place a pontic tooth in the midline and slowly grind it down on the proximal surfaces to allow for the central incisors to move toward each other.

Surgical Technique

The surgical technique for SARPE involving a midpalatal split was described in 1938. In the first half of the 20th century, there was no significant evolution of surgical techniques for orthognathic surgery or SARPE. The improved management of infections allowed for increased surgical correction of skeletal deformities in the second half of the century. In 1959, Kole advocated the use of selective dentoalveolar osteotomies to section the cortical bone and reduce the resistance to orthodontic movement. Converse and Horowitz advocated the use of both labial and palatal cortical osteotomies for expansion in 1969. A LeFort I type of osteotomy with a segmental split of the maxilla and the placement of a triangular unicortical iliac graft for correction of maxillary constriction was presented by Steinhauser in 1972.

Many surgical procedures have been designed to resect the areas of resistance to lateral expansion in the midface. The areas of resistance have been classified as anterior support (piriform aperture pillars), lateral support (zygomatic buttresses), posterior support (pterygoid junctions), and median support (midpalatal synostosed suture). Initial reports described the midpalatal suture as the area of greatest resistance to maxillary expansion. However, later reports highlighted the zygomatic buttress and the pterygomaxillary junction as critical areas of resistance.

Kennedy et al studied the effects of selected maxillary osteotomies as an adjunct to OME in mature rhesus monkeys. They evaluated the influence of lateral maxillary and pterygomaxillary osteotomies with and without palatal osteotomy vs unoperated controls or palatal osteotomy alone and found significant differences. They concluded that reducing or eliminating the resistance to lateral movement by osteotomy allows for movement of the basal bone of the maxilla.

Timms and Vero and Timms suggested that there are 3 stages of surgical assistance for maxillary expansion based on the patient’s age. Stage 1 (median osteotomy) is performed for patients aged 25 years or older, or younger if rapid maxillary expansion was tried and failed. Stage 2 (median and lateral osteotomies) is reserved for those aged 30 years and older, and stage 3 (median, lateral maxillary and anterior maxillary osteotomies) is for patients aged 40 years and older.

Bett and Ziccardi recommended a total bilateral maxillary osteotomy from the pyriform aperture to the pterygomaxillary fissure along with a midpalatal split from the anterior to the posterior nasal spines. They recommended sectioning all articulations and areas of resistance—anterior, lateral, posterior—and median support of the maxillary arch. According to them, the osteotomy should be created parallel to the occlusal plane with a step at the maxillary buttress. An osteotomy in this region prevents interferences from the buttress to expansion. The osteotomy should be placed approximately 4 to 5 mm above the apices of the maxillary teeth. They also recommended releases from the nasal septum and the pterygoid plates. Lehman et al however, did not recommend a palatal split. According to them, the removal of the resistance from the zygomatic buttress is sufficient to remove resistance to expansion. This conservative technique was also suggested by other authors.
Northway and Meade\textsuperscript{36} recommended that no attempt should be made to separate the maxilla from the pterygoid plates to avoid invasion into the pterygomaxillary junction. According to them, such a separation requires extreme force and usually causes the plates to fracture. Pogrel et al\textsuperscript{17} recommended only a midpalatal cut in addition to the transection of the lateral support. Most surgeons recommend a soft-tissue incision that exposes the bone for a direct cut with a bur, an osteotome, or a reciprocating saw. Occasionally, the midline split can be made by an osteotome between the central incisors without a soft-tissue incision.\textsuperscript{35} Instead of the single midline split of the maxilla, some authors described 2 paramedian palatal osteotomies from the posterior nasal spine to a point just posterior to the incisive canal.

Variations in surgical technique have also been recommended based on the patient's age, presence of palatal torus, missing teeth,\textsuperscript{40} presence of or tendency toward an anterior open bite, need for a secondary LeFort osteotomy, extremely tapered arch form, and the requirement for only unilateral maxillary expansion.\textsuperscript{41,31,42} Recently, endoscopically assisted SARPE and LeFort I osteotomy techniques have also been presented to reduce morbidity, especially in growing patients.\textsuperscript{43}

From the review of the literature, it is apparent that there is no consensus about either the extent or the procedure for SARPE. There are also no conclusive means to determine the areas of resistance to lateral maxillary expansion or ascertain an individualization of the surgical cuts. The extent of surgery ideally should depend on the areas of resistance with some individualization. The mandibular dentition should be decompensated before surgery to allow assessment of the amount of transverse expansion necessary, to establish arch coordination, and to assist in preventing postexpansion relapse with dental interdigitation.\textsuperscript{44} The tooth-borne appliance should be placed preoperatively, and the appliance key must be in the operating suite to allow intraoperative activation.\textsuperscript{44} If a bone-borne palatal distractor is to be used, the distractor is placed at the surgery after the maxillary articulations are transected.\textsuperscript{10}

### Retention, Stability, and Relapse

The issue of long-term stability and relapse with SARPE has not been studied in detail in the literature. In general, most reports state that surgical expansion is more stable than OME.\textsuperscript{44,31,35,43} Some authors recommended that retention is not necessary for SARPE, and the orthodontist can begin orthodontic treatment without a holding phase.\textsuperscript{35} Other authors recommended a period of retention after expansion varying from 2 to 12 months.\textsuperscript{44,17,46} The relapse rates for SARPE vary from 5% to about 25%.\textsuperscript{7,84,93,94} These rates are significantly lower than the relapse rate of OME, which can be as high as 63%.\textsuperscript{68,95,96} The high rate of relapse associated with OME is due to its use in skeletally advanced patients. OME is neither predictable nor stable in older patients. In a study by Berger et al,\textsuperscript{93} both OME and SARPE were compared in an age-appropriate sample. The OME sample comprised subjects aged 6 to 12 years, and the SARPE group's ages ranged from 13 to 35 years. These authors found no difference in the stability of SARPE and OME. They, however, did not quantify the relapse amount in either group. Most studies on SARPE discussed relapse as an issue that the clinician should be aware of but reported that the incidence of relapse is low. Few studies cite the need to overexpand with SARPE.\textsuperscript{45} This is especially true for bone-borne appliances; the relapse was subjectively reported to be extremely low.\textsuperscript{10,47}

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Abstract
Cone beam computerized technology (CBCT) offers 3-dimensional visualization and more complex and more accurate imaging compared to analog and digital radiographs. The introduction of cone beam computed tomography (CBCT) has shifted maxillofacial imaging from a two-dimensional to a volumetric approach in terms of technical data acquisition, reconstruction, image display, and image interpretation. Technologic developments have facilitated the development of affordable CBCT units small enough to use in the dental office. This cost-effective diagnostic technology has expanding applications in the treatment planning and image guidance of operative and surgical procedures. The fundamental principles of operation of maxillofacial CBCT technology, operational parameters, the task-specific equipment, image selection, and image display modes used, and the method of sequencing the interpretation of CBCT images were reviewed. Image production and image display are the two main components of CBCT imaging. Image production is accomplished in three consecutive phases: acquisition configuration, image detection, and image reconstruction. Among the parameters to be considered are exposure settings, image resolution, frame rate, trajectory arc, and FOV. Units are designed to permit scanning of the patient in a standing, seated, or supine position. A head stabilizing mechanism is used to minimize motion artifact. Scan volumes are generated from a single scan or multiple adjacent limited field volumes through digital stitching. Images should be viewed digitally and dynamic, facilitated by the use of appropriate software and task-specific protocol formatting.
Keywords: Cone beam computed tomography, field of view, data acquisition, reconstruction, image display, trajectory arc.

Key Words - Maxillary Transverse Deficiency, Maxillary Expansion, SARPE

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Introduction
This technology is based on the principle of tomosynthesis and the shape of the X-ray beam used for imaging is cone shaped hence it is named cone beam computed tomography.

In a single scan the X-ray source and a reciprocating X-ray sensor rotate around the head of the patient and acquire multiple images of the region of interest. The assimilated images are the raw data that subsequently undergo a primary reconstruction to mathematically replicate the patient’s anatomy into a single three-dimensional volume that consists of volume elements (voxels). Each voxel is small in size (0.1-0.4mm for each face) and hence the image has a reasonably high resolution. The field of view (FOV) can be customized to include a portion of or the entire maxillofacial region. The CBCT software permits reformatting and viewing the image data from multiple approaches; that is in straight or curved planes and in three-dimensions. CBCT is an accurate and useful tool for many clinical oral-maxillofacial indications, including the identification of anatomical structures and locations prior to implant placement and other oral surgery procedures, prior to and during endodontic procedures and when planning treatment for orthodontics. Recently, CBCT scans have also been studied for their ability to noninvasively measure the thickness of palatal mucosa in different locations, and have been found to be accurate. CBCT also plays a role in the identification,
Reasons for referrals were mainly related to wisdom tooth anatomy, cystic lesions, and the positioning of mesiodens and impacted canines and premolars. The majority of CBCT users in dentistry are clinicians placing dental implants.

**History**

“I have discovered something interesting, but I do not know whether my observations are correct,” stated Wilhelm Conrad Roentgen in 1895 after he saw the bones of his hand clearly displayed in an outline of flesh when he held it between a cathode ray tube and a barium-coated screen. In December 1895 he reported this to the Wurzburg Physical Medical Society with a radiograph of his wife’s hand, and within weeks of Roentgen’s report, newspapers and professional journals exploded with descriptions of his finding. By February 1896, in most cities and small towns it was demonstrated as the “new light.” The importance of X-rays was also recognized in dentistry—only 14 days after Roentgen published his discovery, Dr. Walkhoff, a dentist in Braunschweig, Germany, produced images of teeth.

These intraoral X-rays were produced with small glass photographic plates wrapped in sheets of black paper and rubber. By 1900, after a period of skepticism and debate over the benefits of radiography compared to transillumination, dentists began to routinely use X-rays in routine dental examinations. Dental clinicians came to rely greatly on radiograph and scanning technology for the diagnosis of disease and for the identification of anatomical structures for treatment planning. This development was furthered by the introduction of digital radiography. In 1988, cone beam computerized tomography (CBCT) was introduced to dentistry. This technology offered 3-dimensional visualization and more complex and more accurate imaging compared to analog and digital radiographs. CBCT was originally devised as a cost-effective and efficient method for obtaining cross-sectional 3-dimensional images for radiotherapy, and later for angiography. Conventional medical computerized tomography (CT) devices image of patients in a series of axial plane slices that are captured as individual stacked slices or from a continuous spiral motion over the axial plane. Conversely, CBCT presently uses one or two rotation sweeps of the patient similar to that for panoramic radiography. Image data can be collected for a complete dental/maxillofacial volume or limited regional area of interest. The X-ray energy of CBCT is similar to that of panoramic radiography with a typical operating range of 1-15 mA at 90-120 kVp, while that of medical CT is significantly higher at 120-150 mA, at 220 kVp.

**Working of CBCT**

Cone beam machines scan patients in three positions:

Sitting, standing, supine.

The four basic constituents of CBCT image production are:

- Acquisition configuration
- Image detection
- Image reconstruction
- Image display

**Acquisition Configuration**

A single, partial, or complete rotational scan from an X-ray source occurs when a corresponding reciprocating area detector moves synchronously around a fixed fulcrum within the patients head.

**VOXEL:** The term pixel is a contraction derived from the words picture and element. Pixel represents the smallest single component of an image on a two-dimensional grid. A voxel is a volume pixel. The voxel adds the third dimension (3D) to the digital image by adding the Z-axis to the X-axis and the Y-axis. The voxel becomes the smallest element in the 3D environment. When viewed as a digital image, the pixel size controls...
the resolution. The smaller pixel size yields a higher resolution image, and conversely, the larger the pixel size, the lower the resolution or quality of the image.

Field of View

The dimensions of the FOV or scan volume generated depend principally on:

- The detector size and shape
- The beam projection geometry
- Collimation of the beam.

The shape of the scan volume can be cylindrical or spherical. Collimation of the primary X-ray beam restricts the irradiation to the region of interest (ROI). Hence the field size limitation safeguards that an optimal FOV can be selected for each patient, depending upon the disease and the region selected to be imaged.

Scan Factors

As the scan progresses, single exposures are made at definite degree intervals, generating individual 2D projection images, known as basis, frame, or raw images which are comparable to lateral and posterior anterior cephalometric radiographic images, each slightly offset from one another. The complete series of images is known as the 'projection data'.

The number of images encompassing the projection data throughout the scan is determined by: the frame rate, the completeness of the trajectory arc, the speed of the rotation.

Higher frame rates provide images with fewer artifacts and better image quality. However, the greater number of projections proportionately increases the amount of radiation a patient receives.

Image Detection

CBCT units are categorized into two groups, based on detector type: An image intensifier tube/charge-coupled device combination. A flat-panel imager.

Image Reconstruction

Once the basic projection frames have been acquired, data must be processed to create the volumetric data set. This process is called reconstruction. Reconstruction times vary, based on the acquisition parameters (voxel size, FOV, number of projection), hardware (processing speed, data throughput from acquisition to workstation computer), and software (reconstruction algorithms) used.

The raw images from CBCT detectors often show spatial variations of dark image offset and pixel gain due to the spatially differing physical properties of the photodiodes and the switching elements in the flat panel and also because of variations in the X-ray sensitivity of the scintillator layer. To compensate for this shortcoming, raw images require systemic offset and gain calibration and a correction of defect pixels. The sequence of the required calibration steps is known as 'detector preprocessing'. The CBCT technology comes in multiple image display formats. The volumetric data set is a compilation of all available voxels and, for most CBCT devices, is displayed to the clinician on screen as secondary reconstructed images in three orthogonal planes (axial, sagittal, and coronal), usually at a thickness defaulted to the indigenous resolution. Optimum visualization of orthogonal reconstructed images is based upon the adjustment of window level and window width to favor bone and the application of specific filters.

Advantages of CBCT

- X-RAY BAEM LIMITATION: Reducing the size of the irradiated area by collimation of the primary x-ray beam to the area of interest minimizes the radiation dose. Most CBCT units can be adjusted to scan small regions for specific diagnostic tasks.

- IMAGE ACCURACY: The volumetric data set comprises a 3D block of smaller cuboid structures, known as voxels, each representing a specific degree of x-ray absorption. The size of these voxels determines the resolution of the image. In conventional CT, the voxels are anisotropic — rectangular cubes where the longest dimension of the voxel is the axial slice thickness and is determined by slice pitch, a function of gantry motion. Although CT voxel surfaces can be as small as 0.625 mm square, their depth is usually in the order of 1–2 mm. All CBCT units provide voxel resolutions that are isotropic — equal in all 3 dimensions.

- RAPID SCAN TIME: Because CBCT acquires all basis images in a single rotation, scan time is
rapid (10–70 seconds) and comparable with that of medical spiral MDCT systems. Although faster scanning time usually means fewer basis images from which to reconstruct the volumetric data set, motion artifacts due to subject movement are reduced.

- With digital radiography, radiation doses generally are lower than with conventional dental radiographs. They offer quicker image taking and accuracy, the ability to store the images indefinitely in computer archives without deterioration, and the ability to send them to other clinicians as a digital file when required.

Limitation of CBCT Imaging

Factors limiting the usage include:

- Cost for the equipment and imaging studies
- Higher radiation dose as compared to conventional radiographs
- Relative sophistication of operation requires skilled and experienced personnel for interpretation of the resultant data.
- Cone–beam technology centered on an image intensifier may create distortion of the periphery of the images.
- Prolonged time required for image manipulation and interpretation.
- Artifact is one of the foremost factors in corrupting the CBCT image quality and is thus a vital part in diagnostic precision.
- Comprehensive selection criteria for utilization of CBCT technology for several dental applications have not yet been established.
- Viewing of lamina dura configuration or bony detail, both lamina dura and bony detail are best visualized on periapical radiographs compared to CBCT.
- Cone–beam technology does not give much soft tissue detail and, newer algorithms have been developed to improve this aspect, it cannot be compared to medical CT.
- Poor soft tissue contrast: It is mainly due to three factors:
  1) Scattered radiation is a major feature in decreasing the contrast of the CBCT system.
  2) Heel effect, produced by the divergence of the X-ray beam over the area detector. This effect creates a large variation in the incident X-ray beam on the patient and subsequent inhomogeneity in absorption, with greater signal-to-noise ratio on the cathode side of the image compared to the anode side.
  3) Inherent flat–panel detector-based artifacts affect its linearity or response to X-radiation.

- Dental CBCT systems do not use a standardized system for scaling the gray levels that signify the reconstructed density values which are arbitrary and do not allow for evaluation of bone quality. CBCT systems do not appropriately display Hounsfield units. The kV and mA (dosage) used in CBCT is less and hence the penetration power and the ability to resolve between different tissue is less.

Clinical Application of CBCT

- Dental Implants

Information about bone height, regional width, bone ridge thickness and morphology, and inferior alveolar nerve canal location is essential for selection of the correct dental implant size and length. Implant planning using a surgical guide stent and CBCT will provide information that results in a safe clinical procedure that avoids inferior alveolar nerve trauma, maxillary sinus penetration, and other iatrogenic sequelae of dental implant placement. CBCT provides the clinician with more precise and accurate imaging, providing better preoperative information and thereby helping avoid problems associated with any surgery in sites close to these structures or where compromising factors are present. Researchers have found that CBCT accurately detects differences in the loop length and diameter of mandibular canals, and that large variations in these structures occur between individuals. In addition, CBCT scans can detect accessory mental foramina.

- Oral Surgery

CBCT imaging offers improved intra- and inter-observer reliability for the identification of some facial anatomical features. Safe and optimal removal or transplantation of impacted wisdom teeth and localization of impacted canines are enhanced with the use of CBCT. In oral surgery, CBCT is superior in generating images to locate root position and proximity of impacted third molars to the inferior alveolar nerve, compared to 2-dimensional cephalographs. Detects any
alterations in the cortical and trabecular bone patterns and assessment of bone grafts in analyzing and assessing paranasal sinuses.

- **Orthodontics**

For orthodontics, one single CBCT scan can effectively generate all the images needed for orthodontic diagnosis including the lateral cephalograph, the panoramic radiograph, the antero-posterior cephalogram, temporomandibular joint tomograms, and many other oblique/cross-sectional slices. 3-D imaging allows for accurate and reliable assessment of the positions of impacted canines and supernumeraries as well as of the adjacent teeth for resorption and surrounding soft and hard tissues. CBCT scans can also measure and quantify volumetric changes of craniofacial structures using superimposition techniques.

- **Endodontics**

CBCT scans offer increased accuracy for the identification of root canals, and their location, prior to endodontic therapy. When compared with 2-dimensional digital radiographs, CBCT enables clinicians to identify more canals in multi-canal teeth that can then be instrumented and obturated, thereby increasing the likelihood of a successful outcome. CBCT scans have also been found to increase accuracy in identifying horizontal and vertical root fractures, which can be difficult to definitively diagnose using traditional methods. Helps in the evaluation of maxillofacial growth, age, airway function and analysis.

- **Other Oral Pathological Conditions**

CBCT scans are useful in cases where orofacial pain exists, and for the detection and/or diagnosis of osteoarthritis, osteoarthrosis, hypoplasia, hyperplasia, aplasia, loose bodies, and neoplasia of the temporomandibular joints. CBCT scanning has also been used to assess the severity of TMJ osteoarthritis, as well as to detect various oral pathological conditions such as apical cysts, fibrous dysplasia, and cementomas. Other dental applications include visualization of cleft palate cases in craniofacial anomalies, assessment of pharyngeal airway patency or obstruction, and sinus evaluation.

**Conclusion**

One of the most important dental diagnostic innovations has been the advent of cone beam computed tomography, which has proven effective for many applications in oral health care. CBCT is a technology that is considered by some to be the standard of care where 3-D imaging is necessary in dentistry. This technological leap allows practitioners to gain immediate access to accurate 3-D images of anatomical structures, which often are critical to precise diagnoses, more effective treatment planning, and increased case acceptance. This should include improved outcomes, reduced need for exploratory procedures, improved treatment predictability, reduced morbidity, and potentially lowered cost and time savings.

The development and rapid commercialization of CBCT technology dedicated to imaging the maxillofacial region will undoubtedly increase dental practitioner access to 3D radiographic assessments in clinical dental practice. CBCT imaging provides clinicians with sub-millimetre spatial resolution images of high diagnostic quality with relatively short scanning times (10–70 seconds) and a reported radiation dose equivalent to that needed for 4 to 15 panoramic radiographs.
References

Abstract
Saliva is a clear, colorless, opalescent, slightly acidic, mucoserous exocrine oral biofluid. Historically blood, urine, sweat, sputum and stool have been extensively studied and routinely used as diagnostic mediums. Saliva despite being the most easily accessible is the least studied for disease diagnosis in the medical territory. This article reviews the diagnostic potential, new discoveries, technological advances and barriers to widespread implementation of saliva in diagnostics.

Keywords: Biomarkers, Saliva, Genomics, Nanotechnology, Proteomics

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Introduction
Saliva is a biofluid continuously secreted into the oral cavity by the major and numerous minor salivary glands. It keeps the mouth moist and clean, helps in preparing ingested food for easy digestion, protects teeth and oral mucosa and also excretes some heavy metals out of the body. Saliva contains proteins which are either produced in situ by salivary glands or are derived from plasma. Thus many biomolecules that circulate in blood are also present in human saliva. It contains components derived from serum, gingival crevicular fluid and mucosal transudate. The exchange between plasma and saliva takes place through processes of passive diffusion across cell membrane, active transport, ultrafiltration and transudation. Whole saliva is thus a mixture of the secretions of major and minor salivary glands, mucosal transudations, gingival crevicular fluid, serum and blood derivatives from oral wounds, desquamated epithelial cells, expectorated bronchial and nasal secretions, bacteria and bacterial products, viruses and fungi, other cellular components, and food debris.

The quantity of saliva produced by the individual, the rate at which it is produced by individual exocrine glands and its composition, both, at rest and in function, are all useful parameters to evaluate health status. Saliva was first used for assessing health in 1960 when salivary calcium levels were analyzed and found to be raised in cystic fibrosis patients. Its potential as a diagnostic tool for evaluating health and disease has received substantial interest in recent years. Cutting edge molecular approaches (e.g. genomics, proteomics, transcriptomics and pharmacogenomics) and metabolomic analysis have broadened the discovery of microbial pathogens associated with oral and systemic diseases. Entities within the body that can be objectively measured are referred to as biomarkers. Many biomarkers are non-specific and cannot be used alone to diagnose any particular disease. Efforts are underway for identification of multiple biomarkers that are correlative of a disease, and then can be screened concomitantly to create a comprehensive panel of tests that significantly increase diagnostic specificity. Salivary diagnostics shows promise in detection of various oral and systemic diseases. Recent research in this field has enabled development of lab-on-a-chip devices useful in detection of illicit drugs, alcohol, to measure hormone levels, diagnose HIV; and to detect pregnancy as well as cancer.

As a diagnostic fluid, saliva offers distinct advantages over serum:

- It can be collected noninvasively by individuals with modest training.
- Offers a cost effective approach for screening of large populations.
- Easy to collect, store, and transport.
- Unlike blood, saliva does not clot.
- Small samples required.
- Gland-specific saliva identifies gland-specific pathology.
- Minimal risk of contracting infections during collection.
- Fewer compliance problems.
Few limitations of saliva as a diagnostic fluid are:

- Certain biomolecules present in saliva show diurnal variations, so may not always reliably reflect their molecular concentrations as in serum.
- Salivary composition can be influenced by the collection method and the salivary flow rate.
- Saliva contains analytes in concentrations that are relatively less than in blood.
- Blood or food particles in saliva samples may compromise results.

**Saliva collection**

Under resting conditions, saliva comprises chiefly of submandibular gland secretion. On stimulation, there is greater increase in parotid gland secretion and these two glands are responsible for 90% of the total salivary secretion. The volume of saliva produced is highest before, during, and after meals, reaching its maximum peak at around 12 a.m., and falls considerably at night, while sleeping.

The unstimulated whole saliva can be collected using draining, spitting, suction or absorption methods. Stimulated whole saliva can be obtained with using oral movements such as gentle mastication, chewing a piece of paraffin wax of standardized size, chewing neutral gum base or rubber bands or keeping in mouth foodstuffs containing citric acid. A modified Lashley cup or Carlson-Crittenden collector often is used for collecting saliva from the parotid glands. Many custom-made collectors such as the Wolff collector are used for collection of submandibular and sublingual gland secretions. Collection of a single constituent of the whole saliva can be done by cannulation of a single salivary duct or using a filter paper or a commercial micropipette. Saliva specimens, after collection, may be kept at room temperature if it is to be analyzed immediately or in 30-90 minutes. It should preferably be kept at -4 °C if it is to be analyzed in 3-6 hours and -20 °C to -80 °C if analyzed after days or months to maintain the sample integrity.

**Salivary Biomarkers For Oral Diseases**

Saliva has long been used to diagnose caries using caries activity tests. Biomarker analysis of saliva can be used for analyzing an individual's susceptibility to caries. High numbers of S. mutans and Lactobacillus indicates a shift in oral microflora from healthy to more cariogenic. Lower secretion rate and buffering capacity and lower amounts of PRPs (PRP1, PRP2), histatin and statherin in saliva could increase the propensity to develop dental caries. Diagnostic kits for S. mutans and lactobacillus counting are widely used in dental practice and conducted without laboratory facilities. Commercial kits for determination of salivary buffering capacity are also available.

Progress from gingivitis to periodontal disease can be determined by the presence of pathogenic bacteria. Lactoferrin, an iron binding protein, sequesters iron from the environment and inhibits microbial growth. The anti-microbial properties of lactoferrin in saliva are seen to be diminished in periodontitis. Cystatin C, a physiologically active antimicrobial protein with an inhibitory potential against lysosomal enzymes, is a major contributor of periodontal disease. A remarkably low level of salivary cystatin C is a fairly significant marker of inflammation to assess periodontal disease severity, particularly in aggressive periodontitis patients. Mucin in saliva has an important role of interfering with the colonization and aggregation of Aggregatibacter
actinomy cet em com it ans. Decreased mucin MG2 output noted in periodontitis suggests a decline in mucin defense and consequently a higher susceptibility for oral infection. Periodontal infections, can occur when such defense mechanisms are impaired due to invasion of micro-organisms such as Porphyromonas gingivalis and Actinobacillus actinomy cet em com it ans. In response to this increased bacterial invasion, the major defense factors present in saliva, IgG, IgM and IgA concentrations show a rise in periodontitis and consequentially their levels are seen to decrease considerably following periodontal therapies.\(^{(5)}\)

Christodoulides et al (2007)\(^{(6)}\) found C-reactive protein (CRP) and significant IL-1 and MMP-8 elevations in whole saliva of periodontitis patients. Some monogenic syndromes are associated with severe periodontal disease (acatalasia, hypophosphatasia, Chediak-Higashi syndrome, chronic neutropenia, leukocyte adhesion deficiency, cyclic neutropenia, Ehlers-Danlos syndrome and Papillon Lefèvre syndrome). This has indicated that a genetic mutation at a single locus can impart susceptibility to periodontitis.\(^{(7)}\) Recently, interleukin 1A and 1B gene have been identified that can be correlated with the degree of tissue destruction that occurs in advanced periodontal disease. Many chair side Salivary diagnostics are also useful for oral diseases such as mucositis, oral herpes and burning mouth syndrome. Increased salivary albumin level can assist in monitoring of chemotherapy induced stomatitis. The most likely cause of the increased salivary albumin, IgG, and sodium concentrations is an increased transudation of serum products due to the ulcerations and apparent mucosal thinning observed visually.\(^{(8)}\) Specific antibodies against oral cavity herpes simplex virus can be detected in the gingival fluids which can aid in its diagnosis.\(^{(9)}\) Loeb et al (2008) found a significantly decreased concentration of CS and an increased activity of glandular kallikrein in patients with glossodynia.\(^{(10)}\)

**Salivary Diagnostics for Systemic Diseases**

### Saliva in hereditary diseases

**Cystic fibrosis (CF),** a genetically determined condition is caused due to a mutation in the CFTR gene. A defective electrolyte transport in epithelial cells and viscous mucus secretions from glands and epithelia characterize this disorder. Elevations in electrolytes (sodium, chloride, calcium, and phosphorus), urea and uric acid, cathepsin-D, lactase dehydrogenase, total protein and lipids are observed in the submandibular saliva of CF patients\(^{(11)}\).

**21-Hydroxylase deficiency,** an inherited disorder of steroidogenesis is characterized by congenital adrenal hyperplasia. Early morning salivary levels of 17-hydroxyprogesterone (17-OHP) determined by ELISA is a useful screening test for non-classic 21-hydroxylase deficiency, since the salivary levels have been found to accurately reflect its level in serum.

### Saliva in Autoimmune Diseases

**Sjogren's syndrome (SS),** an autoimmune endocrinopathy is characterized by xerophthalmia, xerostomia, and keratoconjunctivitis. A low salivary flow rate in these patients causes oral dryness. Serum chemistry can demonstrate polygonal hypergammaglobulinemia and elevated levels of rheumatoid factor, anti-nuclear antibody, anti-SS-A and anti-SS-B antibody, ESR and IGs.\(^{(12)}\) Increased salivary concentrations of sodium chloride, IgA, IgG, lactoferrin, β2-microglobulin, lysozyme C, and cystatin C and a decreased concentration of amylase, carbonic anhydrase and phosphate are also present.\(^{(13)}\) Sfriso et al (2003)\(^{(14)}\) found that higher concentrations of salivary neopterin reflected glandular damage in primary SS. Castro et al (2003)\(^{(15)}\) found that the combined determination of h2-microglobulin and Gamma-glutamyl-transferase in saliva and serum was useful for differentiating SS patients from normal subjects. Researchers have also measured specific concentrations of cytokines in the saliva of patients with SS for their eventual use in diagnosis. Interleukins 2 and 6 are found in levels significantly high in individuals that suffer from this disease.\(^{(16)}\) Whole saliva of these patients was found to contain more informative peptides and mRNA than did gland-specific (parotid or submandibular/sublingual) saliva. **Multiple Sclerosis (MS)** is a demyelinating disease of the central nervous system. IgA plays a major protective role in the CNS response to triggering agents of the disease. MS produces no significant change in the saliva of such patients except for a reduction in secretory IgA production. **Cushing’s syndrome** is characterized by high cortisol levels in body. Diagnostic trials recommended by the Endocrine Society are: 24-hour urinary free cortisol, dexamethasone suppression test – 1mg oral at night and late-night salivary cortisol. Two late-night salivary cortisol measurements are useful in filtering out patients with a suspected hypercortisolism.\(^{(17)}\)

### Role of Saliva in Diagnosis of Malignancy

Saliva holds potential in use for diagnosis and estimating prognosis of malignancies. Human oral fluid from Oral
Squamous Cell Carcinoma (OSCC) patients contain signature peptides and proteins potentially useful for OSCC detection. Li et al (2004) showed that 1,679 genes had different expression levels in saliva in cancer patients and seven cancer-related mRNA biomarkers exhibited at least a 3.5-fold elevation in OSCC saliva. These potential salivary RNA biomarkers were transcripts of IL8, IL1B, DUSP1, HA3, OAZ1, S100P, and SAT. The combinations of these biomarkers yielded 91% sensitivity and specificity in distinguishing OSCC from the controls. Hu et al (2008) identified five candidate biomarkers (M2BP, MRP14, CD59, catalase and profilin) for detection of OSCC. The combination of these candidate biomarkers yielded a sensitivity of 90% and specificity of 83% in detecting OSCC. Nagler et al (2006) found significant increases in salivary concentrations of Cyfra 21-1, tissue polypeptide antigen, and cancer antigen-125 (CA125) in OSCC (tongue) patients. Zhong et al (2005) found that telomerase activity detected positively in patients with OSCC. John et al (2004) found that significantly increased IL-8 in saliva holds promise as a biomarker for OSCC. Badawi et al (1998) found higher levels of salivary nitrate and nitrite, and increased activity of nitrate reductase in oral cancer. Warnakulasuriya et al (2000) found that p53 antibodies can be detected in saliva in a subset of tumors with p53 aberrations. Oral HPV is a mucosal viral infection that could potentially lead to oral cancer. ORA risk® HPV is an FDA approved salivary test that identifies various genotypes of this virus, including HPV8, HPV11, HPV16 and HPV18. Thus this non-invasive easy-to-use screening tool can enable the clinician to establish increased risk for oral cancer and determine appropriate referral and monitoring conditions. Application of saliva in diagnostics also includes the detection of ovarian cancers and breast carcinomas. Chen et al (1990) found that salivary CA-125, a protein found in greater concentration in tumor tissues showed better assay value than serum for ovarian cancers. Elevated salivary levels of tumor markers c-erbB-2, CA15-3 and CA125 have been found useful in detection of breast cancer and/or the post operative follow-up of such patients.

Saliva in Diagnosis of Infectious Diseases

Antibodies against viruses, bacteria, fungi and parasites can be detected in saliva and can aid in the diagnosis of infections.

Viral Infections:

The salivary antibodies of human immunodeficiency virus (HIV), hepatitis C virus (HCV), hepatitis A virus (HAV) and Dengue (IgM and IgG antibodies) by ELISA have a considerable correlation with those of the serum values. Salivary IgA levels to HIV decline as infected patients become symptomatic. Detection of IgA antibody to HIV in saliva may, therefore, be a prognostic indicator of the progression of HIV infection. Antibody to HIV in saliva has sensitivity and specificity between 99% and 100%. Several salivary and oral fluid tests have been developed for HIV diagnosis. Orasure is a FDA- approved commercially available testing system that detects antibodies against the p24 antigen of HIV. All of the existing oral-based diagnostic tests for HIV infection are screening tests, detecting antibodies to HIV-1 or both HIV-1 and HIV-2 (OraSure® HIV ½).

Salivary antibodies have also been found positive following immunization against poliovirus and rotavirus. Aiyar et al (1990) found that in young infants, saliva is a better indicator of rotavirus infection than is serum. Jin et al (2001) found that measles, mumps and rubella (MMR) virus genome detection by real-time PCR (RT-PCR) and antibody detection in oral fluid samples were useful for surveillance of MMR. PCR based identification of virus DNA of herpes simplex virus type I in saliva helps in the detection of its reactivation.

Bacterial Infections:

Saliva, like blood can be used in diagnosis of bacterial infections by identifying disease specific antigens or antibodies through ELISA, western blot assay and PCR. Higher titers of salivary anti-Shiga toxin antibody have been found to correlate significantly with serum in shigellosis. Pneumococcal capsular antigen and pneumococcal C polysaccharide antigen detection in saliva offers a valuable diagnostic method for diagnosing pneumococcal pneumonia as serum testing has low sensitivity. Schwartz et al (1991) found that anti-tick antibody in saliva can serve as a biomarker of tick exposure that is a risk factor for lyme disease seropositivity. Detection of E. histolytica DNA in saliva by PCR assay could be used for diagnosis of amebic liver abscess. For amebic colitis, the sensitivity of the RT-PCR assay for detection of E. histolytica DNA in blood and saliva was 36% and 64%
Fungal Infections:

Salivary fungal count analysis provides valuable information in cases of oral candidiasis.37

Saliva in Diabetes

Ghid et al (2007) found decreased ghrelin level and increased glucose and amylase in diabetic individuals. Diabetes has long been theorized to influence the course of periodontitis, and persons with diabetes have an increased prevalence and severity of periodontitis. Procalcitonin levels are generally known to rise in persons with systemic infection. Persons with periodontitis and type 2 diabetes have raised salivary pro-calcitonin levels that reflect their degree of periodontal activity. Salivary adiponectin, a protein that regulates glucose levels and fatty acid breakdown may also be used as a marker for increased risk of non-insulin dependent diabetes mellitus.

Role of Saliva in Cardiovascular Disease

Cardiovascular disease markers in saliva, such as amylase are useful for post operative control of patients with history of cardiovascular surgery. Low level of salivary amylase in the pre-operative stage of aorta aneurism is seen to be associated with an increased mortality. Saliva in acute myocardial infarction patients shows higher levels of creatinine phosphokinase, myeloperoxidase, tumor necrosis factor alpha (TNF-α) and proinflammatory matrix metalloproteinases. Increased unstimulated whole saliva CRP, CD40 ligand and creatinine kinase myoglobin fraction showed 86% sensitivity and 81% specificity.37 Increased salivary concentrations of myoglobin, cardiac troponins and intercellular adhesion molecule-1 are other salivary markers for cardiovascular disease. Increased levels of salivary lysozyme are shown to be associated with hypertension, which is an early stage of CVS disorders. Cardiovascular disease biomarkers in unstimulated whole saliva correlated better with serum than sublingual and gingival swabs.

Saliva in Renal Diseases

Chronic kidney disease and its treatment affect a wide range of tissues and systems of the body. Renal disease patients, especially those on hemodialysis show a wide range of biochemical changes such as hypokalemia, hyperphosphatemia and hypocalcaemia and hormonal alterations like secondary hyperparathyroidism. It directly or indirectly affects salivary flow and composition. Salivary flow rate is found reduced and salivary calcium, phosphorous, urea, sodium and potassium levels are found significantly higher in such patients. Walt et al (2007) and Arregger et al (2008) reported a series of salivary markers that were associated with end stage renal disease. The list of markers included nitrite, uric acid, sodium, chloride, pH, α-amylase and lactoferrin with increased cortisol & creatinine. Disposable home-use calorimetric test strips have been shown to be useful for monitoring salivary analyte levels at home, thereby eliminating periodic visits to the clinic and/or invasive blood testing.

Summary of salivary biomarkers for oral and systemic disorders.3

Application of Salivary Diagnostics for Miscellaneous Conditions

Role of Saliva in Monitoring Hormone Levels

Saliva testing measures free hormone and is helpful in assessing unsupplemented hormonal status. Saliva collection can enable multiple collections over the day or month which is otherwise logistically cumbersome considering a serum test. Therefore it is best used for evaluating circadian cortisol pattern and cyclical output of estrogen and progesterone throughout the month in pre or peri-menopausal women. Due to lipid solubility, cortisol and other steroid hormones can be readily detected in saliva. Salivary cortisol is useful for identifying patients with Cushing’s syndrome, Addison’s disease and increased stress. Increased salivary aldosterone corresponds significantly to plasma aldosterone levels of patients with primary aldosteronism.42 Another novel use of hormone testing in saliva is in pregnancy by detection of human gonadotropin hormone. Pregnancy stik® is a FDA approved commercially available at-home pregnancy test kit that delivers results in just a few minutes. Salivary estriol spikes about 2
weeks before onset of labor and can be used to identify increased risk of pre-term birth. Insulin can also be detected in saliva and can be used to monitor serum insulin levels. Increased glucose and α-amylase and decreased ghrelin and adiponectin in saliva can be used for diagnosis of diabetes. However, saliva testing for peptide hormones such as growth hormone and thyroid are not yet available.

Role of Saliva in Monitoring of Drug Levels

Only the unbound fraction of the drug in serum enters into saliva through diffusion. This unbound drug is usually the pharmacologically active fraction whereas in serum both bound and unbound fractions of a drug can be detected. So this represents an advantage in drug monitoring in saliva. Correlation of drug concentrations in saliva and plasma suggests successful therapeutic monitoring of patients treated with drugs such as phenytoin, theophyllin, phenobarbital, ethosuximide, isoniazid, paracetamol and primidone. Methadone appears in saliva in concentration ten times higher than in blood.

Ethanol is unionized in serum, is not protein bound and has a low molecular weight and lipid solubility. Therefore, it diffuses rapidly into saliva. Salivary ethanol concentration may be used as an index for its concentration in serum in a salivary sample obtained within 20 minutes of its ingestion. Other drugs that can be detected in saliva are amphetamines, barbiturates, benzodiazepines, cocaine, phencyclidine and opioids. Oratect®III is a FDA cleared on-site drug screening test using saliva that is commercially available. Thioctanate identified using fourier transform infrared spectroscopy is helpful in detection of cigarette smoking. Detection of nicotine using ELISA helps to monitor exposure to tobacco smoke. The nicotine concentration is three times higher in parotid saliva than in submandibular or sublingual saliva.

Role of Saliva in Psychological Disorders

Saliva reflects the systemic condition by showing variations in the rate of flow, pH, and composition. Anxiety and depression lead to a decrease in salivary flow rate resulting in xerostomia. Acute stress conditions also lead to significant salivary changes with a prominent decrease in secretary IgA and increase in salivary amylase, molecular chaperone Hsp70 α-amylase, lysozyme, sIgA and testosterone. Other salivary markers include cortisol and substance-P. Increased salivary cortisol, chromogranin, α-amylase, lead and cadmium and decreased IgA and lysozyme are useful markers for assessment of occupational stress.

Salivary Diagnostics in Forensic Dentistry

Salivary tests have been used widely in forensic studies. Saliva samples can be obtained from bite marks, drinking glasses, cigarette butts, postage stamps, envelopes, and other sources and then used to detect blood-group antigens or salivary genetic proteins. Approximately 85% of individuals secrete blood-group substances in their saliva including A, B, H, and Lewis antigens useful for identification in criminal cases and paternity law suits. For DNA testing, samples of DNA are taken from the buccal surface with an oral swab. Saliva is often present at crime scenes, in sufficient amounts to allow typing of the DNA. PCR allows replication of thousands of copies of a specific DNA sequence in vitro, enabling study of the smallest amounts of DNA. Since DNA is relatively stable in dry state, these samples can be used to place an individual at the scene of a crime.

Conclusion

Human saliva is a mouth fluid possessing several functions involved in oral health and homeostasis, with an active protective role in maintaining good oral health. Saliva as a diagnostic specimen can, not only give the same information as serum testing but at times also additional or new information that cannot be obtained from serum. Considering its accuracy, ease of use and cost effectiveness, salivary diagnostics hold promising avenues for diagnoses, classification and/or predicting the prognosis of oral and systemic diseases. However, much research and work needs to be done before these can be brought to routine use and enable chair-side diagnosis of multiple oral and systemic diseases at the dental office.

References


Abstract
HYPER” means increased and “BARIC” means pressure. Hyperbaric Oxygen Therapy (HBOT) is increasingly being accepted as a beneficial adjunct to diverse clinical conditions. Non-healing ulcers, chronic wounds and refractory osteomyelitis are a few conditions for which HBOT has been extensively tried out. The dental surgeon has also found a good ally in HBOT in managing dental conditions. This mode of treatment still remains under-utilized in the field of dental surgery. This article comprises a short review on Hyperbaric Oxygen Therapy and its use in dentistry.

Key Words: hyperbaric, oxygen therapy, periodontal disease

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Introduction
A mode of treatment in which the patient is entirely enclosed in a pressure chamber and breathes 100% oxygen at a pressure greater than 1 atmosphere absolute (ATA).

Hydrobaric Oxygen Therapy is the fascinating use of barometric pressure for delivering increased oxygen dissolved in plasma to body tissues. Hyperbaric oxygen therapy (HOT) or hyperbaric oxygen (HBO) involves intermittent inhalation of 100% oxygen under a pressure exceeding that of the atmosphere, that is greater than 1 atmosphere absolute (ATA). Therapy is given in special therapeutic chambers which were earlier used primarily to treat illnesses of deep sea divers. Hyperbaric oxygen therapy (HBO) has been recommended and used in a wide variety of medical conditions, often without adequate scientific validation of efficacy or safety. Over the last two decades, animal studies, clinical trials have produced reasonable scientific evidence or well validated clinical experience. Experiences with HBO therapy in India have been published in select journals with limited circulation but there has been no interdisciplinary recognition of hyperbaric medicine at a national level. Hyperbaric Oxygen Therapy (HBOT) is increasingly being accepted as a beneficial adjunct to diverse clinical conditions. Non-healing ulcers, chronic wounds and refractory osteomyelitis are a few conditions for which HBOT has been extensively tried out. The dental surgeon has also found a good ally in HBOT in managing dental conditions.

Historical Background
- In 1900's: Hyperbaric spas flourished in the North American continent and Europe. Lack of a firm physiological basis and poor choice of indications caused scientific stasis in this field for many subsequent years.
- In 1930's: HBO was first used in decompression sickness suffered by deep sea divers to recompress by Behnke.
- In 1950's: The modern clinical application of HBO began, in parallel with an increased understanding of blood gas analysis and gas exchange physiology.
- In 1960's two institutions preeminently pursued the clinical aspects of high pressure oxygenation. Dr. Bakers from the University of Amsterdam developed the use of intermittent HBO, for the treatment of gas-gangrene. Second major focus of interest in this area was Royal Infirmary of Glasgow, where various anesthetic and surgical aspects of HBO were applied and discussed.
- In 1965: It was first used to assist wound healing when it was noted that burns of the victims of coalmine explosions treated with HBO healed faster.
In 1968: Duke University in North Carolina expanded a long-standing program of environmental physiology with the construction of inter-connected multiplace hyperbaric chambers.

Since 1970: Most of the instructional courses, research work and guidance have been provided by Under seas and Hyperbaric Medical Society (Headquarters in Kensington, Maryland). This medical organization publishes guidelines for hyperbaric oxygenation every 2-3 years.

Physiological Basis

When we normally breathe air (with 21% O₂) at sea level pressure, most tissues need of oxygen are met from the oxygen combined to hemoglobin, which is 95% saturated. 100 ml blood carries 19 ml O₂ combined with hemoglobin and 0.32 ml dissolved in plasma. At the same pressure if 100% O₂ (oxygen) is inspired, O₂ combined with hemoglobin increases to a maximum of 20 ml and that dissolved in plasma to 2.09 ml. The higher pressure during HBO treatment pushes more oxygen into solution. The amount of O₂ dissolved in plasma increases to 4.4 ml/dL at a pressure of 2 ATA and to 6.8 ml/dL at 3 ATA. This additional O₂ in solution is almost sufficient to meet tissue needs without contribution from O₂ bound to hemoglobin and is responsible for most of the beneficial effects of this therapy. The principal rationale of HBO therapy is to decrease tissue O₂ tension. Hence, it is reasonable that primary indications are conditions that include either regional or global hypoxia. Another group of indications take advantage of the fact that specific micro-organisms are oxygen intolerant. The increase in hydrostatic pressure inherent in HBO therapy provides an important part of the rationale for use in gas lesion diseases such as gas embolism, etc.

Hypoxia

Hypoxia or hypoxiation is a pathological condition in which the body as a whole (generalized hypoxia) or a region of body (tissue hypoxia) is deprived of adequate oxygen supply. Variations in arterial oxygen concentrations can be part of the normal physiology, for example, during strenuous physical exercise. A mismatch between oxygen supply and its demand at the cellular level may result in a hypoxic condition. Hypoxia in which there is complete deprivation of oxygen supply is referred to as anoxia.

Mechanism

Hypoxia extends beyond the local wound environment. Reactive oxygen species are produced, including oxygen free radicals. Initially, these cause vasoconstriction followed by vasodilatation. Endothelial cell damage and release of prostaglandins, pro-inflammatory cytokines (tumor necrosis factor-α and interleukin-6) and nitric oxide from vascular endothelium occurs. Subsequent membrane peroxidation further increases the cellular damage. As capillaries become leaky, interstitial edema occurs. Circulation is further compromised with compounded injury. The surgical or medical reestablishment of interrupted circulation sends blood to the ischemic area, providing new oxygen substrate for the formation of more free radicals. In massive injury the release of inflammatory cytokines and free radicals escape the normal regulatory mechanisms and can lead to multiple organ failure. Hence, a long and catastrophic chain of events can be initiated by O₂ deprivation.

Procedures and Equipment

HBO therapy is administered in a hyperbaric chamber. They are of two basic types:

Monoplace chambers: It is transparent, made up of acrylic, can accommodate a single patient and the patient does not require a mask. Primary advantage: Cost and space requirements.

Multiplace chambers: Usually of steel (some may be made up of aluminum), can accommodate more than two people and is pressurized with air, while the patients breathe O₂ from a tight fitting mask/circuit.

Advantage: Is suitable for critically ill patients requiring ventilation, monitoring and constant attendance. Pressure and duration: It depends upon the indication. It ranges from 2 to 6 ATA for 2-6 h. Decompression sickness/gas embolism may require prolonged, continuous saturation protocols. PIO₂ (partial pressure of inspired) very rarely exceeds 2.8 ATA.

Practical Aspects of care in a Chamber

Fire safety: Maintaining electrical components outside the chamber. Passing cables through insulated pass throughs.

Electrical defibrillation: In a hyperbaric chamber defibrillation is controversial, because of the possibility of poor skin contact, arcing and risk of fire. Large metal environment may predispose attendants to shock. Chambers needs to be
decompressed prior to use of a defibrillator. Moreover, the latency of bubble formation and onset of decompression sickness symptoms is sufficient to allow a brief excursion to 1 ATA for defibrillation, with subsequent return to previous pressures.³

**Cellular and Biochemical Benefits of Hyperbaric Oxygen**

- Promotes angiogenesis and wound healing
- Kills certain anaerobes
- Prevents growth of species such as Pseudomonas
- Prevents production of clostridial alpha-toxin
- Restores neutrophil mediated bacterial killing in previously hypoxic tissues
- Reduces leucocyte adhesion in reperfusion injury preventing the release of proteases and free radicals which cause vasoconstriction and cellular damage.⁴

**Medical Uses of Hyperbaric Oxygen**

Regional hypoxia (compromised graft flap, osteoradionecrosis (ORN), wounds and ulcers), crush injuries, thermal burns, global hypoxia (CO, CN intoxication, and severe anemia), infections (clostridialmyonecrosis, necrotizing fascitis, refractory osteomyelitis, and rhinocerebral mucormycosis), gas lesion conditions (gas embolism and decompression sickness).⁴

**Therapeutic Effects of Hyperbaric Oxygen**

Hyperoxygenation causes (i) immune stimulation by restoring white blood cell (WBC) function and enhancing their phagocytic capabilities and (ii) neovascularization in hypoxic areas by augmenting fibroblastic activity and capillary growth. This is useful in radiation tissue damage and other problem wounds.⁵ Vasoconstriction reduces edema and tissue swelling, while ensuring adequate oxygen delivery and is thus useful in acute trauma wounds and burns. Bactericidal for anaerobic organisms and inhibits the growth of aerobic bacteria at pressures >1.3 ATA. It inhibits the production of alpha-toxin by Clostridium welchii and is synergistic with aminoglycosides and quinolones. Thus, it is lifesaving in gas-gangrene and severe necrotizing infections. Reduces half-life of carboxy hemoglobin from 4 to 5 h to 20 min or less and is the treatment of choice for carbon monoxide poisoning in fire victims.⁵

**Universally accepted indications for hyperbaric oxygen therapy**⁶

**Acute conditions** (where HBO therapy should be given earliest when combined to conventional treatment)

1. Non-healing ulcers, problem wounds, compromised skin grafts and flaps
2. Crush injury, compartment syndrome, and acute traumatic ischaeemias
3. Gas gangrene / clostridial infections
4. Necrotizing soft tissue infections (subcutaneous tissue, muscle, fascia)
5. Thermal burns
6. Exceptional blood loss (anaemia)
7. Intracranial
8. Post-anoxic encephalopathy
9. Burns
10. Sudden deafness
11. Ocular ischemic pathology
12. Air or gas embolism
13. Decompression sickness
14. Carbon monoxide poisoning and smoke inhalation

**Chronic conditions**

1. Non-healing wounds / problem wounds (diabetic / venous etc.)
2. Radiation tissue damage
3. Skin grafts and flaps (compromised)
4. Chronic osteomyelitis (refractory)

Non-healing ulcers, problem wounds, compromised skin grafts and flaps: These wounds have the underlying problem of tissue hypoxia, with oxygen tension usually below 20 mmHg, and therefore more prone to infection. The elevation of oxygen tension by hyperbaric oxygen therapy has powerful effects on wound dynamics, by both enhancing leukocyte bactericidal activity and promoting the fibroblast-collagen support needed for neovascularization. In the United States problem wounds are the commonest indication for adjunctive hyperbaric oxygen therapy and include diabetic and other small vessel ischaemic foot ulcers, dehiscent amputation sites, nonhealing traumatic wounds and vascular insufficiency ulcers and post radiation ulcers. Several studies have shown improved healing and a lower incidence of amputation with 4-30 sessions.⁷,⁸,¹⁰ HBO improves both graft and flap survival compared with routine postoperative surgical care alone. The beneficial role of HBO therapy in plastic surgery and the role in occlusive arterial diseases in the extremities is well known.⁹,¹⁰
Acute traumatic ischaemias ATI (Crush injury, compartment syndromes and others): ATI occurs when an injury compromises circulation. This may place portions of the extremity or the entire extremity at risk of necrosis or amputation. Secondary complications such as infections, nonhealing wounds and ununited fractures frequently develop. The immediate effect of HBO in ATI is enhanced oxygen at the tissue level, increased oxygen delivery per unit of blood flow and reduction of edema. Finally, HBO may mediate the effects of the reperfusion injury in ATIs especially in those where tissue ischaemia is severe and or prolonged (revascularisation, reimplantations, etc.). Surgery and antibiotics remains the corner stone of therapy. Addition of adjunctive HBO has shown to reduce significantly the morbidity and mortality associated with these injuries. Overall cost of management of these injuries is also reduced substantially.1,10

Clostridial myonecrosis (Gas gangrene): Clostridium welchii cannot produce alpha-toxin when the patient undergoes HBO therapy. The organism is not killed by hyperbaric oxygen and alpha-toxin is not detoxified by HBO; however, with production shut-off, alpha-toxin is fixed in the tissues within 30 minutes. It also has antibiotic synergyism with aminoglycosides, quinolones, sulpha and amphotericin B. A three-pronged approach consisting of HBO, surgery, and antibiotics is essential in treating gas gangrene.1,9,11

Necrotizing soft tissue infections: Hyperbaric oxygen therapy may be used as an adjunct treatment of soft tissue infections with tissue necrosis, due to mixed aerobic and anaerobic organisms. Increasing tissue oxygen tension enhances white cell killing of bacteria, promotes inhibition of anaerobic organism growth, and increases the oxidation/reduction potential. These conditions include necrotizing cellulitis, progressive dermal gangrene, anaerobic streptococcal myositis, crepitant anaerobic cellulitis, and necrotizing fasciitis. Primary management remains adequate surgical debridement and antibiotic coverage. The high mortality and morbidity with these conditions warrant the addition of adjunctive hyperbaric oxygen therapy.1,12,13,14,15

Treatment of late radiation tissue damage (osteoradionecrosis, radiation cystitis, enteritis, etc): In a patient who has had between 2,000 and 5,000 rads, there is a possibility that there may be difficulties with subsequent healing. Above 5,000 rads, healing of any subsequent surgical wound will be a definite problem. HBO therapy remains the keystone of treatment of radiation-induced illnesses. Recently, a clearer understanding of its pathophysiology has evolved. The basic physiology of this process is a progressive oblitative endarteritis with resultant hypoxia and tissue ischemia. Hyperbaric oxygen induces neovascularization of tissue and the tissue PO2 rises to 81% of normal plus or minus 5% between 18 and 30 hyperbaric treatments. Successful surgery and grafting is possible with a PO2 of 75% of normal. Controlled clinical experience has demonstrated a perioperative staging of hyperbaric oxygenation, termed the “Marx Protocol”, has significantly reduced the incidence of post-operative infection, dehiscence, and healing delays. Two reports have specifically addressed the issue of hyperbaric oxygen’s cost effectiveness in this disorder: Marx and colleagues and Dempsey et al.16,17 The authors concluded that in carefully selected patients, managed along algorithmic lines, the addition of hyperbaric oxygen therapy resulted in improved clinical outcomes while greatly reducing the overall cost. The effect of hyperbaric oxygen in radiation-induced bone necrosis, severe laryngeal necrosis, hemorrhagic radiation cystitis, colitis, scleral necrosis is also now well recognized. The cure rate for radio necrosis of the mandible now approaches 94% in those patients treated with hyperbaric oxygen.

Thermal Burns: The burn wound is a complex and dynamic pathophysiologic process characterized by a zone of coagulation, surrounded by a region of stasis, bounded by an area of hyperemia. A significant body of data clearly supports the efficacy of hyperbaric oxygen in the treatment of thermal injury. Reduction in fluids, less conversion to full thickness injury, preservation of marginally viable tissue, improved microcirculation, reduction in edema, faster epithelialization, less inflammatory response, enhancement of PMN killing, preservation of tissue creatine phosphate, adenosine triphosphate and decreased wound lactate have all been reported with HBO. A significant reduction in hospital stay and cost of treatment with adjunctive hyperbaric oxygen therapy has been reported.17

Carbon monoxide (CO) poisoning and smoke inhalation: It is recommended that patients with severe CO poisoning, those with neuropsychological changes and those in high risk group be treated with HBO irrespective of their COHb levels. HBO at 2.5 ATA reduces the half-life of carboxyhemoglobin from 4 to 5 hours in subjects breathing room air to 20 minutes or less. Timely administration of HBO prevents neuronal injury, prevents delayed neuropsychological sequel and terminates the biochemical deterioration.1,4,11
Osteomyelitis (Refractory): Hyperbaric oxygen provides periodic elevation of bone and tissue oxygen tensions from hypoxic to normal or hyperoxic levels. This promotes angiogenesis, increased leukocyte killing, aminoglycoside transport across bacterial cell walls and osteoclast activity in removing necrotic bone.\textsuperscript{18,19}

Air or gas embolism (AGE)/Decompression sickness (DCS): Air embolism can occur as a result of surgical procedures in a hospital setting. It can also occur in nonsurgical patients due to over-expansion in a patient on respirator. Traumatic injuries such as penetrating injuries of the chest, blast injuries etc. can all lead to AGE. HBO is the primary treatment for AGE from any cause. DCS is caused by nitrogen bubble formation in the vascular system and in tissues sufficient to interfere with the function of an organ. The cause is rapid decompression during ascent from diving, flying or a hyperbaric/hypobaric chamber. HBO therapy should be begun during the acute episode and continued till symptoms clear.\textsuperscript{20,21}

Exceptional blood loss (Anemia): The patient has lost sufficient red cell mass to compromise respiratory requirements and will not receive transfusions because of medical or religious reasons. The intermittent use of hyperbaric oxygen therapy will supply enough oxygen to support the basic metabolic needs of the respective tissues of the body until red blood cells are restored.\textsuperscript{21}

Intracranial abscesses: HBO is recommended as an adjunctive therapy in abscesses in deep locations or multiple abscesses, in compromised hosts, in situations where surgery is contraindicated and in patients showing no response to conventional treatment. HBO therapy will be beneficial because of the anaerobic bacterial flora, reduction of edema, enhancement of host defence mechanism and the well-known beneficial effect of HBO in concomitant skull osteomyelitis.\textsuperscript{11}

Sudden deafness: It is well known that cochlear activity is very sensitive to constant supply of oxygen. Many studies have shown that the performance of the auditory system can be improved by an intense application of oxygen during HBO therapy along with haemodilution and vasoactive drugs. Literature survey of 50 studies: 4109 patients treated within three months when conventional treatment failed concluded that HBO therapy is warranted within three months of above indications.\textsuperscript{21}

Post-anoxic encephalopathy: HBO increases oxygen supply to the ischemic neurons, reduces edemas and reverses the reduced flexibility of erythrocytes. HBO should be administered as soon as possible and must be part of an intensive reanamtion program.\textsuperscript{24}

Visual vascular pathology: HBO has been used in retinal arterial thrombosis (along with other measures) and has been shown to be effective if performed at the earliest in patients who can still tell the difference between light and dark. In retinal venous thrombosis it is beneficial in reducing vasogenic edema. It must be given as soon as possible and combined with other pharmacological measures.\textsuperscript{33}

**HBO, Therapy Application in the Field of Dentistry:**\textsuperscript{26}

**Osteomyelitis:** Chronic bone infections that resist treatment carry high medical costs over the years. In combination with a comprehensive regiment of cleansing, isolation of infection, bone and muscle grafting and antibiotics, HBO can speed the healing process and may also reduce the likelihood of re-infection.

**Radio Necrosis:** HBO therapy represents a new approach to the treatment of wounds caused by radiation therapy. Radiation burns differ considerably from normal wounds. When the body is wounded, the blood flowing from all directions is cut off abruptly, therefore creating a sudden drop in oxygen pressure and sending a message to the brain to send all the infection fighters and healing agents.

In the case of radiation therapy, the pinpoint center of the area being treated receives the greatest amount of damage, while the perimeter receives the least. Since the radiation damage is gradual, the oxygen pressure does not drop abruptly and the brain does not receive the message to send infection fighting and healing agents. When the oxygen pressure is increased by over 10 times during HBO therapy, the brain can then recognize a sudden decline in pressure at the wound site, triggering the healing process. This provides new hope for patients suffering from radiation wounds that are incapable of healing.

**Soft-Tissue Infections:** HBO has also been proven to fight infection from bacteria that need oxygen to survive. Although it may seem that raising oxygen levels would promote the growth of these bacteria, the reverse is true. Simply stated, white blood cells kill bacteria with an “explosion” of oxygen. When oxygen levels are lower than normal due to poor circulation, white blood cells are not strong enough to produce this explosion. HBO not only restores oxygen to the normal level, but “super charges” these cells by delivering oxygen under greater than normal pressure.
**Tissue Flaps and Grafts:** Most tissue flaps and grafts heal readily without HBO. However, when a flap has lost oxygen and is in danger of becoming unsalvageable, HBO can often sustain the flap until the blood flow can be restored. HBO therapy can also significantly increase new capillary growth following surgery.

**Traumatic Crush Injury:** A number of factors contribute to tissue death due to traumatic crush injury. Although a surgeon can repair large blood vessels, crushed micro-vessels (capillaries) cannot be mended. In addition, the affected area may swell, limiting circulation even further. As the oxygen level drops in the tissue, the cells lose their consistency and their ability to regenerate. HBO sends oxygen to greater volumes of tissue, promoting new cell growth. It is vital that crush injury patients receive HBO therapy early, perhaps even before surgery is scheduled.

**Effects of Hyperbaric Oxygen Therapy on Periodontal Disease**

Periodontitis is an inflammatory disease caused by bacterial biofilms, which adhere on the teeth. The inflammatory and immune responses in periodontitis are a continuum of the normal host response to infection that eventually becomes the pathology when homeostasis is lost. Though there is ample of data to support the beneficial effects of HBO therapy for various medical conditions, very few studies have documented for its use in periodontal diseases. An increase in tissue oxygen tension generally speeds up the healing process in problem wounds in all parts of the body. An oxygen-rich milieu always inhibits the growth of anaerobic microorganisms, effectively supporting antibiotic and surgical therapy. In addition, an oxygen-rich milieu enhances the function of leukocytes, activating or supporting the body’s local defense mechanisms in areas that are already frequently poorly perfused, which in turn speeds up the healing process. Subsequent regenerative processes are also influenced by the increase in oxygen tension. Tissue capillarity clearly increases, and fibroblast replication is enhanced.

In addition, the healing process in damaged bone can be accelerated by oxygen therapy or even made possible in the first place. Frequently, oxygen is applied centrally by increasing the oxygen tension in the air breathed in during HBO therapy. This leads to an increase in the amount of oxygen physically dissolved in the blood and, thus, to higher oxygen levels in peripheral tissue. The increased concentration of oxygen brings about the change in bacterial milieu described above and improves the healing process in the wound. As serious infections are frequently deep seated, and intact skin constitutes too great of a barrier to diffusion, applying oxygen centrally is generally the only possibility to increase oxygen tension in the affected region. In cases of poorly healing superficial wounds and impaired skin integrity, local external applications can be used instead of central oxygen therapy. The principle behind this type of therapy is occlusion relative to the surrounding area with localized oxygenation.

Shannon et al. tested oxygen effects on healing gingival wedge excisions using Sprague-Dawley rats operated controls were maintained at normal pressure in room air experimental groups of rats each were exposed for 90 min daily to one of the following: (1) 20.8% oxygen at 2.4 atmospheres pressure, (2) 100% oxygen at 1 atmosphere pressure, and (3) 100% oxygen at 2.4 atmosphere pressure. Histometric analysis was performed using light microscopy. The controls failed to show healing comparable to experimental animals until the end of 2 weeks. Enhanced connective tissue healing was most significant in the 2.4 atmospheres pressure groups at 3 and 6 weeks when compared with controls. However, by 12 weeks, no significant differences could be detected. Early connective tissue adaptation does not imply eventual attachment as epithelial down growth progressively displaced the connective adjacent to the root in both experimental and control groups.

Oxygen can also be applied locally when the oral mucous membrane is diseased, such that the resorption barrier is reduced, and there is only a short distance of diffusion. In addition, gingival and periodontal infections can also be caused or even dominated by anaerobic microorganisms, making it desirable to impair the milieu to reduce the growth of anaerobic microorganisms.

**Discussion**

Several studies have described the beneficial role of HBO in the treatment of various human pathologies either alone or in combination with other therapies. Very few studies have been conducted to analyze the effects of HBO therapy on periodontal disease. Chen et al. showed that HBO increases local oxygen distribution, especially at the base of the periodontal pocket. This could inhibit the growth of anaerobe bacteria, and also on the other hand, would allow the ischemic tissues to receive an adequate intake of oxygen sufficient for a rapid recovery of cell metabolism. A combination of both HBO and SRP substantially reduces (by up to 99.9%) the Gram-
negative anaerobe loads of the subgingival microflora. HBO or SRP alone produces a temporarily more limited effect on the periodontal anaerobe load, which later reverts to the pretreatment values. HBO exerts its killing action specifically against those micro-organisms which, via the production of sophisticated virulence determinants, are responsible for direct tissue damage.

Chen et al in 2003 have reported the effects of HBO in a controlled study of periodontitis in 24 patients. The study teeth were divided into four groups based on treatment: (1) HBO therapy, (2) HBO therapy + scaling, (3) scaling, and (4) control. Highly significant differences in gingival indices (GI), sulcus bleeding indices (SBI), probing depth (PD), attachment loss (AL), plaque index (PLI), and gingival blood flow (GBF) were seen in the HBO, the HBO + scaling and the scaling groups compared to the control group. The numbers of subgingival anaerobes as well as the numbers of rods, fusii and spiro were reduced markedly in these three treatment groups.

Chen et al in 2003 studied the therapeutic effects and holding time of HBO on severe periodontitis patients. 30 cases with periodontitis were selected and randomly divided into two groups, that is, the HBO group was exposed to a pressure of 0.25 MPa and control group were rinsed. GI, SBI, PLI, PD, AL, and gingival crevicular fluid (GCF) were measured during the first and last clinical visits and 1-year after HBO therapy. HBO can decrease GI of patients with periodontitis by 1.1, SBI by 1.2, PD and AL by 0.7 mm, volume of GCF by 2.0, and significant differences could be seen in the above indices between pre- and post-HBO therapy. The GBF had a 1.8-fold increase after HBO exposure. GI and SBI 1-year after HBO therapy were larger than that of time after HBO therapy. There were no significant differences in the PLI, PD, AL, GCF, and GBF between post HBO therapy and 1-year after HBO therapy. It was concluded that HBO had good therapeutic effect on severe periodontitis, and this effect lasted for >1-year.

Microorganisms can secrete different enzymes that can destroy collagen and growth factors. When the oxygen concentration in gingival tissue is low, amount of bacteria in the periodontal pockets increases. HBO seems to effectively decrease the amount of bacteria and simultaneously inhibit collagenase secretion. A study by Rabkin and Hunt showed that oxygen at 2.0 ATA could inhibit the growth of certain pathogens related to periodontitis. HBO has also shown bactericidal/ bacteriostatic effects on Actinomyces, Bacteroides, and Streptococcus.

Conclusion

Hyperbaric Oxygen Therapy is poised at an exciting era of revival. The role of hyperbaric oxygen therapy is scientifically established in certain well defined conditions and the hyperbaric chamber is now an integral part of hospital services. Dentists must familiarize themselves with recent evidence on this mode of therapy, so that their patients are not denied the gains of this modern treatment. Cost analysis has shown that the addition of hyperbaric oxygen to conventional treatment results in significant cost savings due to lesser stay in hospital and shorter course of illness.

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Abstract

Mass disaster may be caused by natural or man-made circumstances such as severe flooding, earthquakes, volcanic eruption, wars & boundary disputes. Forensic identification is a multi-disciplinary effort that typically involves the coordination and cooperation of law enforcement officials, forensic odontologists, forensic pathologist, forensic anthropologists and other specialists as deemed necessary. The identification of large number of casualties in mass disasters is complex and fraught with hazards, both physically and emotionally. Forensic odontologist plays an important role in the identification of deceased as the resistant nature of dental tissues to environmental assaults, incineration, immersion, trauma, mutilation make teeth an excellent source of identification. Various forensic dental modalities of identification include matching techniques, post-mortem profiling, genetic fingerprinting, dental fossil assessment and dental biometrics with digital subtraction. This review emphasizes on the role of forensic odontologist in disaster victim identification.

Key words: Mass disaster, forensic odontologist, forensic identification, disaster victim identification.

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Introduction

The United Nations Disaster Relief Organization (UNDRO) defines a disaster as: “a serious disruption of the functioning of a society, causing widespread human, material, or environmental losses which exceed the ability of the affected society to cope using its own resources”. The term disaster can also be defined as “a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area”.

Disasters are events that are often unexpected with damages of unexpected magnitudes. Its response and management has always been one of the biggest challenges to a community. Mass disaster may be caused by natural events such as severe flooding, earthquake or volcanic eruption. It may also be caused by human activities such as mishaps involving mass transport by land, sea or air; other causes include war, boundary disputes, ethnic or religious conflicts. In all such incidents the identity of the deceased, assailant or the cause of death becomes important as the core of various investigations are based on these processes. Dental identification assumes a primary role in the identification of remains when post-mortem changes, traumatic tissue injury or lack of a fingerprint record invalidate the use of visual or fingerprint methods. The identification of dental remains is of primary importance when the deceased person is skeletonized, decomposed, burned or dismembered. The principal advantage of dental evidence is that, like other hard tissues, it is often preserved after death. Even the status of a person’s teeth changes throughout life and the combination of decayed, missing and filled teeth is measurable and comparable at any fixed point in time.

Role of Forensic Odontologist During Mass Disaster Identification

Forensic odontologists in a disaster zone are involved in recognizing dental evidence, collecting, recording and analysing them. A report is then prepared based on the findings analysed by examining the dental and the surrounding anatomical structures. In most countries, forensic odontologists are included in the disaster victim identification team. This team is usually
constituted of members from multi-disciplinary backgrounds such as law enforcement officials, forensic pathologists, forensic odontologists, forensic anthropologists, Serologists, Criminalists and other specialists all are dedicated to ascertain thorough management during a disaster. All care is taken to ensure proper handling of evidence or information collected from a disaster site. To maintain the integrity of a disaster site, it is essential to collect and process evidence in a manner that accurate results can be achieved and in turn provide closure for families of those involved in the disaster. The principal duty of forensic odontologists is to conduct dental investigations on victims, dental radiography, dental charting and entering findings onto the Post-Mortem sheets. However, in a disaster zone, Forensic Odontologists may be apportioned several tasks that aid in the establishment of positive identity using dental evidence. The post mortem work may either be carried out at the recovery site set up at or near the disaster zone or at the autopsy room but either way the investigation is carried on in a laboratory setting majorly governed by the nature of the disaster.

Forensic odontologists may start-off with basic procedures like collecting, identifying and describing dentition at the recovery site. For example, details such as intact or fragmented jaw, condition of teeth in those jaws and dentures if any may be recorded. Information on damages such as fractures and damages either caused from burns may be identified and recorded. In cases of extreme damage such as when the jaws are severely damaged due to fire or when teeth are mobile, forensic odontologists take photographs and dental radiographs on site. Loss of teeth during transportation and handling may usually be seen in children with mixed dentition, victims with severe periodontal diseases or even badly decomposed bodies. Therefore, care must be taken by forensic odontologists to make sure that all evidence collected must be secured with the head.

The expected outcome of a successful victim identification process after a mass disaster is the correct identifications of victims. This can be achieved by following systematic process and maintaining quality management along the process. In odontological investigations after disasters, dental charts and radiographs made available from the families of victims or their dentists are compared with the dental status of the victim to reach a positive identification. Radiographs have been recommended and used in comparing ante mortem and post mortem information for a long time now. Dental information gathered is then recorded in Ante-Mortem and Post Mortem data charts.

Figure 1: Key tasks for forensic odontologist

The American Board of Forensic Odontologists Body (ABFO) Identification guidelines recommend four conclusions when reporting dental identification (Table 1):

Table 1: ABFO Body Identification Guidelines

| Positive Identification | Anti-mortem and post-mortem records match in details with no unexplainable discrepancies |
| Possible Identification | Anti-mortem and post-mortem data have consistent features but due to poor quality, identity cannot be positively established |
| Insufficient Evidence | Available information is insufficient to form basis for a conclusion |
| Exclusion | Anti-mortem and post-mortem data are clearly inconsistent |

Challenges in Indian Context

Disaster Victim Identification (DVI) is very challenging and demanding process. Unfortunately, like other developing countries, there is a great scarcity of any organized plans for identification of mass disaster fatalities in India.

India is far behind both in the theoretical and practical aspects of Disaster Victim Identification based on dental data. The Standard Operating Procedures are not available to guide and handle the Disaster Victim Identification Process. The consistent guidelines regarding ante mortem dental data collection are not available. The ante mortem records require the patient's oral and medical history and the treatment done but there is no uniform recording format followed throughout the country. The standard of dental care and frequency with which people visit the dentist varies around the country and while some people in urban population may have up-to-date records; this will not be

the case for every area. Still there are many areas where population doesn't have access to basic medical facilities what to talk of dental treatments. Complete ante mortem dental records are most often lacking, so making comparative dental identification almost a mirage. If there is no ante-mortem dental information to which the post-mortem information can be compared, then the potential of this technique to identify the individual accurately can't be utilized.\(^2\)

**Recommendations**

Malik P and Khajuria H has recommended few suggestions for DVI:\(^3\)

i. Planning is crucial for successful identification of victims in mass disasters and a special identification team should be responsible for the work. The mass fatality response plan of India can be designed based on the international lines for Disaster Victim Identification.

ii. The development plan of Government of India/Ministry can incorporate the inclusion of Forensic Odontologist in the Disaster Victim Identification Teams.

iii. A uniform National Dental Record Database can be maintained and made available to the appropriate authorities alternatively the protocols for collection of ante mortem data can be established to remove the discrepancies originating from the inaccurate data entry or translations from local languages.

iv. Routine dental check up with appropriate radiography should come under primary care service in the National Health Schemes; this will afford reasonable generation of broad based national ante mortem Dental records for comparison at mass disaster instances.

v. The National Institutes like University Grants Commission/Dental Council of India can take appropriate role in designing a specified curriculum and modules for education and training courses for Forensic Odontology or as part of Continuing Dental Education Programmes.

**Conclusion**

Although every disaster is unique but they have one thing in common i.e. the large number of fatalities. The preservation of life is the top most priority at any major incident. So the disaster response teams mainly aim at rescue and care of the survivors and forensic odontologist plays a crucial role in the identification of those individuals who cannot be identified visually or by other means. The unique nature of our dental anatomy and the placement of custom restorations ensure accuracy when the techniques are correctly employed.

**References**


Abstract

Gingival biotype is the thickness of the gingiva in the facio-palatal dimension. Tissue biotypes have different gingival and osseous. In clinical practice, identification of the gingival biotype is important. Gingival biotype has a significant impact on the outcome of restorative, regenerative and implant therapy. Often neglected tissue biotype could make the difference between success and failure of treatment. This review article highlights the general aspects of gingival biotypes, methods to assess gingival thickness and its clinical significance.

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Key Word: Gingival biotype, Ultrasonography, implants, probe transparency

Introduction

Gingival biotype refers to the quality of the soft tissue profile surrounding the teeth. The gingival perspective of aesthetics is concerned with soft tissue covering around the teeth. The gingival morphology plays an important role in determining the final aesthetic outcome, therefore during treatment planning, it is important to recognize various forms of gingival tissue. Different gingival biotypes respond differently to inflammation, trauma and parafunctional habits.

The morphological characteristics of gingiva depends on gingival complex, tooth morphology, contact points, hard and soft tissue considerations and gingival biotype.

Identification of gingival biotype helps in better determination of the treatment outcome in various branches of dentistry and is also important in clinical practice since differences in gingival and osseous architecture have been shown to exhibit a significant impact on the outcome of restorative therapy.

Ochsenbein & Ross in 1969 divided gingival anatomy into “pronounced scalloped” and the “flat” biotype.

Later the term periodontal “biotype” was used by Seibert & Lindhe in 1989 who classified the gingiva as either thin or thick, where thin corresponds to scalloped type and thick to the flat.

Prevalence

The thicker biotype was observed to be more prevalent in male population with short, wider forms of maxillary central incisors while the females had thinner biotypes and narrow, long form of maxillary central incisors. Among the different age groups, young group had a thicker biotype compared to older group. The mean papillary height was less in subjects with thicker biotypes.

Vandana and Savitha studied the thickness of the gingiva in association with age and found the gingiva to be thicker in the younger age group than in the older. Kolte et al. (2014) reported the same finding with the younger age group having significantly thicker gingiva but less width than that of the older age group and the gingiva was found to be thinner and with less width in females compared to males. According to a survey conducted by Bhat et al., the thicker biotype is more prevalent in male population whereas the female population consists of thin and scalloped biotype.

Characteristics of thin and thick gingiva

<table>
<thead>
<tr>
<th>Characteristics of thin gingiva</th>
<th>Characteristics of thick gingiva</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow zone of keratinized tissue</td>
<td>Large amount of keratinized tissue</td>
</tr>
<tr>
<td>Gingival thickness is &lt;1.5 mm, width is 3.5-5 mm</td>
<td>Gingival thickness is ≥2.0 mm, width is 5-6 mm</td>
</tr>
<tr>
<td>Pronounced scalloped soft tissue and bony architecture</td>
<td>Flat soft tissue and bony architecture</td>
</tr>
<tr>
<td>Slight gingival recession</td>
<td>Gingival margins usually are coronal to the cementoenamel junction</td>
</tr>
<tr>
<td>Dehiscence and fenestrations are usual findings in thin underlying bone</td>
<td>Thick bony plates</td>
</tr>
<tr>
<td>Thin marginal bone</td>
<td>Thick marginal bone</td>
</tr>
<tr>
<td>Small proximal contact area located near the incisal edge</td>
<td>Bread, more apically located contact areas</td>
</tr>
<tr>
<td>Triangle anatomic crowns</td>
<td>Square anatomic crowns</td>
</tr>
<tr>
<td>Sinus tooth form</td>
<td>Quadratic tooth form</td>
</tr>
<tr>
<td>Subtle cervical convexities in the crown</td>
<td>Marked cervical convexities in the crown</td>
</tr>
<tr>
<td>Gingival recession following disease</td>
<td>Deep pocket and intrabony defect formation following disease</td>
</tr>
</tbody>
</table>
Gingival Biotype Assessment

Various methodologies, invasive and non-invasive, have been proposed for measurement of the gingival tissue form. This includes visual inspection, ultrasonic devices, transgingival probing, and Cone beam computerized tomography imaging.

Visual Evaluation

Simple visual evaluation is used in clinical practice to identify the gingival biotype; however, it may not be considered a reliable method, as it cannot be used to assess the degree of gingival thickness.

Probe Transparency

Kan et al. presented a simple method of periodontal type determination, which utilizes translucency of the free gingiva during the probing of gingival grooves in teeth. Visual inspection of the transparency of the periodontal probe through the sulcus has become the most frequently used method for discrimination of thin and thick biotypes. The gingival biotype is considered thin if the outline of the probe is shown through the gingival margin from the sulcus.

The gingival tissue's ability to cover any underlying material's colour is necessary for achieving aesthetic results, especially in cases of implant and restorative dentistry, where subgingival metal restorations are used widely. Using a metal periodontal probe in the sulcus to evaluate gingival tissue thickness is the simplest way to determine gingival biotype; with a thin biotype, the tip of the probe is visible through the gingiva. This method is minimally invasive and can be performed routinely during periodontal probing procedures.

Modified Caliper

A tension-free caliper can only be used at the time of surgery and cannot be used for pre-treatment evaluation. Kan et al (2010) did a comparison study using periodontal probe, visual examination and tensile free caliper to assess the facial gingival biotype in maxillary anterior teeth compared visual evaluations, the use of a periodontal probe, and direct measurements with a tension-free caliper. These authors reported a statistically significant difference between visual assessment, the periodontal probe and the tension-free caliper; however, there was no statistically significant difference when comparing the periodontal probe assessment and the tension-free caliper. Based on these results, a periodontal probe in the sulcus is an adequately reliable and objective way to evaluate tissue thickness, whereas visual evaluation of the gingival biotype by itself is not as reliable as the periodontal probe or the tension-free caliper.

Cone Beam Computed Tomography (CBCT)

CBCT scans have been used extensively for hard tissue imaging because of their superior diagnostic ability. Fu et al measured the thickness of labial gingiva and bone and reported no statistically significant difference between the clinical measurements made with a caliper and radiographic measurements utilizing CBCT scans; however, CBCT measurements may be a more objective method than direct measurement. A plastic lip, tongue retractors, and wooden spatulas can be used to better visualize soft tissue margins.

Ultrasonic Devices

Kydd et al (1971) was the first to measure the thickness of palatal mucosa using an ultrasonic device. Ultrasonic devices appear to be the least invasive method and offer excellent validity and reliability. However, such devices are no longer available commercially; in addition, they make it difficult to both determine the correct position for accurate measurement and successfully reproduce measurements.

A new M-mode “oscilloscopic” presentation is also being investigated. It allows to show parameters of thickness in one or many places during moving the probe from gingival margin to behind the mucogingival junction. Salmon et al. in 2010 presented an ultrasound brightness-mode (B-mode) prototype device with 25-MHz high frequency. This device showed that tooth, implants surface, alveolar bone and surrounding soft tissue of periodontium are clearly visible. In this way the periodontal biological width, gingival thickness, bone dehiscence can be identified and measured.

Radiographic Morphometric Study

In the study conducted by Stein et al, they used the radiographic technique described by Alpiste Illueca, to evaluate the correlation of different morphometric parameters with the thickness of the buccal gingiva and alveolar bone at different apicocoronal levels. The result showed that the gingival thickness at CEJ, middle third and directly above the bone crest level were strongly
correlated with the alveolar bone crest than between the thickness of other parts of the gingiva and more apical parts of the alveolar bone plate.

**Advantages and Disadvantages of various techniques**

<table>
<thead>
<tr>
<th>Technique</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection</td>
<td>Simple, straightforward, restorative, and inexpensive</td>
<td>Subjective and highly variable</td>
</tr>
<tr>
<td>Transillumination</td>
<td>Simple, straightforward, and inexpensive</td>
<td>Involved, requires local anesthetic and affected by probe diameter, engorgement, probing force, and denaturation of gingival tissues.</td>
</tr>
<tr>
<td>Probe transparency</td>
<td>Simple, straightforward, and inexpensive</td>
<td>Subjective and invasive</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>Noninvasive, can provide quantitative measurements, images can be manipulated for better visualization of the hard and soft tissues</td>
<td>Additional cost involved, large probe diameter may hinder the use in areas of limited access, accuracy might be affected by moisture.</td>
</tr>
<tr>
<td>CBCT imaging</td>
<td>Noninvasive, can provide quantitative measurements</td>
<td>Subjective and invasive</td>
</tr>
</tbody>
</table>

**Gingival Biotype and its Implications in Dentistry.**

I) Gingival Biotype And Position of Teeth:

The dimensions of the buccal gingiva may also be affected by the bucco-lingual position of the tooth within the alveolar process. A change of the tooth position in buccal direction results in reduced dimensions of the buccal gingiva, while an increase is observed following a lingual tooth movement. Müller and Könönen (2005) demonstrated that most of the variation in gingival thickness was due to the tooth position and that the contribution of subject variability was minimal.

II) Gingival Biotype And Periodontal Treatment Planning:

The gingival morphology plays an important role in determining the final aesthetic outcome. Therefore during treatment planning, it is important to recognize differences in gingival tissue. Different gingival biotypes respond differently to inflammation, restorative, trauma and parafunctional habits. A gingival thickness of >2 mm was considered as thick tissue biotype and a gingival thickness of <1.5 mm was referred as thin tissue biotype. The initial gingival thickness is significant as it may predict the outcome of root coverage procedures and restorative treatments.

III) Gingival biotype and labial plate thickness:

For patients with a thin gingival biotype, extreme care should be taken during extraction to prevent labial plate fracture. Cook et al evaluated the correlation between labial plate thickness and thin or thick gingival biotypes—using information obtained from cone beam computed tomography (CBCT), diagnostic impressions, and clinical examinations of maxillary anterior teeth—and concluded that a significant association existed between gingival biotype and labial plate thickness. According to Fu et al, the thickness of the labial gingival tissue has a moderate association with the underlying bone.

IV) Tissue biotype and root coverage:

According to McFall, tissue thickness in the recipient site and the donor site are key factors in how mucogingival defects are treated. In cases involving root coverage surgeries, a flap thickness of 0.8-1.2 mm produced more predictable outcomes. An initial gingival thickness was found to be the most predictable factor for predicting the success of complete root coverage procedures. There is a correlation between flap thickness and complete root coverage.

V) Gingival Biotype And Implant Therapy:

Evidence suggests that the percentage of the success rate of immediate implants in anteriors is more in individuals with thick biotypes. However in patients with thin biotypes the frequency of gingival recession is high following implant restoration. The thicknesses of the crestal bone on the buccal aspect significantly influence remodeling during the initial four month healing period after immediate implant placement. A delayed implant must be considered when there is not enough soft and hard tissue thickness. However immediate implants can be considered with predictable results in thick biotypes.

VI) Gingival Biotype and Ridge Preservation:

Thick biotypes show greater dimensional stability during remodelling compared to thin biotypes. A thin gingival biotype is associated with a thin alveolar plate. More ridge remodeling has been found in thin biotype when compared with thick periodontal biotype. Ridge preservation should be considered for most thin biotype cases. Preservation of alveolar dimensions such as atraumatic extraction, socket preservation or ridge preservation techniques after tooth extraction is critical for achieving optimal aesthetic results in thin biotypes.

VII) Gingival Biotype and Maxillary Sinus Lining:

Aimetti et al in 2008 took maxillary mucosal biopsies from the sinus floor during otorhinolaringologic surgical interventions, and measured gingival thickness in the area of the maxillary anterior teeth. The authors reported that the average thickness of the Schneiderian membrane was 0.97 ± 0.36 mm. Patients with thick
gingiva had a sinus mucosa that was 1.26 ± 0.14 mm thick, compared to 0.61 ± 0.15 mm thickness among patients with thin gingiva. The results showed that gingival thickness is a reliable factor for predicting sinus membrane thickness. However research on this is still in its infancy.

References

Abstract

Filling root canal systems represents the culmination and successful fulfillment of a series of procedural steps that comprise start-to-finish endodontics. Although the excitement associated with the so-called “thrill-of-the-fill” is understandable, scientific evidence should support this enthusiasm. Moving heat softened obturation materials into all aspects of the anatomy is dependent on eliminating pulpal tissue, the smear layer and related debris, and bacteria and their by-products, when present. To maximize obturation potential, clinicians would be wise to direct treatment efforts toward shaping canals and cleaning root canal systems.

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Introduction

The objective of root canal filling procedures, therefore, should be the total three dimensional filling of the root canals and all accessory canals.(1) Too often in the past, the adequacy of a root canal filling procedure was based primarily on its vertical appearance on the dental radiograph. Excessive emphasis was placed on whether the filling reached the radiographic apex of the tooth, whether it overextended beyond the apical foramen, or whether it was short—presumably placed at the cementodentinal junction. In everyday practice, too little emphasis was given to the paramount problem of eliminating the root canal system as an entity, by its total obturation, in spite of significant data which were produced demonstrating astonishing failure in the absence of threedimensional filling. What is required is a deeper appreciation of the importance of filling canals laterally and in depth as well as vertically, and then the adaptation of clinical technique to make the objective both simple and effective.

The Calamus Dual 3D Obturation System is one unit that conveniently combines both Calamus “Pack” and Calamus “Flow” handpieces . The Calamus Pack handpiece is the heat source that, in conjunction with an appropriately sized Electric Heat Plugger (EHP), is utilized to thermosoften, remove, and condense gutta percha during the downpacking phase of obturation. (2)

Key Words : Calamus, Obturation, Heated GP, 3D Obturation.

Case Report

A 26-year-old female with a non contributory medical history sought treatment at Department of Conservative dentistry and Endodontics in Manav Rachna Dental College. The chief complaint was “pain on chewing.” Clinical examination showed a large carious lesion with pulp exposure. The tooth was not sensitive to cold testing or electronic pulp testing (Vitality Scanner, Analytic Technology, Glendora, CA, USA). Investigations for swelling, sinus tract, and periodontal involvement were negative; the pulp was diagnosed as necrotic. Preoperative radiographs revealed minimal periapical changes and slight widening of periodontal ligament space. Anaesthesia was obtained and an access cavity was prepared.

Four canal orifices were located at the floor of the pulp chamber. Pulp extirpated and The canals were negotiated with Using K-file size number 10(Dentsply, Maillefer, Switzerland.) The working length was determined radiographically with K-file size number 15.(Figure 2)

The Calamus 3D system was used for obturation. The master cone, protaper F3 gutta-percha, was inserted to the full working length and apical tugback was checked (Figure 3). The master cone is typically cut back about 1.0 mm from the radiographic terminus (RT) so that its most apical end is just short of the “apical constriction.” Three manual pluggers of diameters 0.7 mm, 0.9 mm, and 1.3 mm (Dentsply Tulsa Dental Specialties) were selected to compact the gutta-percha in coronal, middle, and apical thirds, respectively. The Calamus Pack
handpiece was activated to sear off the nonuseful portion of the master cone. During this procedure there is transfer of heat in the coronal 3-4 mm of gutta-percha. A large prefit plugger generates the first WOC (wave of compaction) and automatically compacts warm gutta-percha vertically and laterally into the root canal system. The pack handpiece was activated again; the EHP (electrically heated plugger) was plunged to 3-4 mm of the previously compacted material, deactivated, and then removed, along with a “bite” of gutta-percha. The medium prefit plugger carries a second wave of condensation and compact middle third of root canal system. This procedure was repeated for apical third of root canal. The apical third obturation was now complete. The backfill phase was started by dispensing a longer 3 to 4 mm segment of warm gutta-percha into middle region of the canal. The working end of the medium size prefit plugger is stepped circumferentially around the preparation to clean the dentinal walls and flatten the dispensed material. Utilizing the plugger in this manner will promote successful hydraulics and generate “reverse” waves of condensation. The backfill phase was continued till the entire canal was filled. (Figure 4)

Fig: 1: Calamus Dual 3D Obturation system.

Fig: 2: Working length i.r.t 36.

Fig: 3: Master Cone i.r.t 36.

Fig: 4: Obturation i.r.t 36.
Discussion

After locating the canals, access was widened to facilitate root canal preparation. Root canal was prepared initially with hand files up to size number 20 and then continued with protaper files. The calamus 3D obturation system was used for the obturation. The major benefits of this system are that Calamus Dual brings the flow and the pack together in one convenient, space-saving system. The downpack phase creates an effective apical plug and the backfill phase effectively seals lateral canals and furcal canals. During the pack phase thermo-softened gutta-percha is moved into the narrowing cross-sectional diameters of the preparation and generates a piston effect on the entrapped sealer to fill canals laterally as well as create good apical corkage. During this heating and compaction cycle, the operator will tactilely feel the warm mass of gutta-percha beginning to stiffen as it cools. Importantly, using a plunger to press on warm gutta-percha during the cooling cycle has been shown to completely offset shrinkage. The backfilling of canal is started by activation of flow handpiece.(3) A short 2 to 3 mm segment of warm gutta-percha is dispensed into the most apical region of the empty canal. Small prefit pluggers are used to compact the warm gutta-percha in the middle third. This generates reverse wave of compaction. The backfill procedure is continued till the entire canal is filled.

Conclusion

Three-dimensional obturation not only seals the apical third but also seals multiple portals of exit, that is, the accessory canals and furcal canals.

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Abstract

Overdenture, since long has been the choice of treatment in patients with partially edentulous arches for the advantages associated with it in the form of improved proprioception, decreased ridge resorption, better retention, stability, and support. Significant advances in the treatment modality have popularized the usage of attachment in the abutment tooth for enhanced retention, stability, and support as compared to conventional overdenture fabricated on abutment tooth. This case report presents a case rehabilitated with tooth supported overdenture with copings for maxillary arch and a removable partial denture for the mandibular arch.

Key words: complete denture, overdenture, tooth-supported, abutments, copings

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Introduction

DeVan golden statement: "Perpetual preservation of what remains is more important than the meticulous replacement of what is missing" is the goal of preventive prosthodontics and Overdenture is one of the most practical measures used in preventive dentistry.

Overdenture is defined as a removable partial denture or a complete denture that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants.

In a 4 years study by Renner et al., it was found that 50% of the roots used as overdenture abutments remained immobile.

Retention of a tooth for an overdenture preserves a portion of one of the major sensory inputs i.e. input from the periodontal proprioceptors, which contain information about the magnitude and direction of the occlusal forces as well as about the size and consistency of the food bolus. This along with the input of other receptors in the mouth, muscles, TMJ contributes to the overall response. The periodontal receptors input are also protective against occlusal overloading.

Extraction of all teeth results in total loss of all input from periodontal ligament receptors; whereas use of an overdenture preserves the sensory input. The natural anterior teeth give more discreet sensory input, but posterior teeth should also be retained for overdentures whenever feasible even though their sensory input is less. It is also known that the retention of teeth for overdentures provide better sensory feedback regarding masticatory performance, and it has economical and psychological benefits also.

Case report

A 55-year-old male patient with complete upper edentulous and partially lower edentulous condition reported to the Department of Prosthodontics Manav Rachna Dental College, Faridabad with the chief complaint of difficulty in chewing food since 1 year. His major desire was to improve his masticatory function and to retain natural teeth.

Fig. 1 front and profile pictures of the patient.

History revealed that the patient was edentulous for the past 6 years and was wearing maxillary and mandibular removable partial denture since then. The general health status of the patient was quite satisfactory with
no history of systemic disorders.

Extraoral examination showed the patient to have a convex profile. (Fig. 1) Intraoral examination revealed partially edentulous maxilla and mandible. Teeth present in maxilla were 13, 25, 26 and in mandible were 32, 33, 36, 37, 42, 43 with sound periodontium. The ridge is seen with sufficient inter arch space of 18mm with an average mouth opening of 41mm. The old existing dentures were compromised in retention and stability due to under extended borders along with severe occlusal wear. The patient was explained about other treatment modalities like removable partial denture, fixed partial denture and implant.

As the patient was insistent on retaining his natural teeth and with consideration to his financial concerns we opted for removable prosthesis for the lower denture and for tooth supported overdenture for maxilla. The new removable prosthesis was planned with an overdenture with retained teeth using metal copings which again were a cost effective treatment option with respect to copings with attachments.

Treatment undertaken:

1. Intentional endodontic treatment was undertaken for 13, 25 and 26 as they were to be used as abutments for the over denture.

2. After completion of the endodontic treatment, the abutment were reduced to 3 mm height (medium coping) and axial preparation finished with a chamfer finish line. (Fig. 2) Impressions were made using putty wash technique.

3. The wax patterns were made on the poured casts after the impression making (Fig. 3), which were casted to obtain metal copings.

4. The metal copings obtained were polished and cemented (Fig. 4) on the abutment with glass ionomer cement (GC Corporation, Tokyo, Japan).

5. In the next appointment maxillary border moulding was done and final impression was made (Fig. 5) using light body addition silicone (Affinis, Coltene). Master casts were poured with type III dental stone (Kalabhai, Mumbai, India) [Fig. 6].
6. Rest of the procedure followed was the same as that of a conventional complete denture.

**Fig. 6.** Beading and boxing of impression and master cast.

7. Permanent record bases were fabricated and occlusion rims were fabricated with modelling wax. Wax rims were adjusted until tentative occlusal vertical dimensions were established, and jaw relations were recorded.

**Fig. 7.** Acrylized maxillary overdenture

8. Teeth were arranged in the usual manner and were tried in patient's mouth and the trial denture was checked for esthetics, phonetics, occlusal vertical dimension, and occlusion.

9. The dentures were then acrylized, (Fig. 7), after finishing and polishing they were delivered to the patient (Fig. 8).

**Fig. 8.** Denture in patient's mouth.

**Discussion**

In the elderly population it is common to observe poor dentition, affected by periodontal disease and dental caries. In certain situations, the patient is limited to being rehabilitated with conventional complete dentures due to the fact that no other options are available. However, the use of select teeth in strategic positions can greatly improve the final treatment result in terms of overdenture stability and retention. This improvement is accomplished by utilization of roots to support, stabilize, and retain the overdenture. This alternative offers the patient a more comfortable prosthesis. The canines and premolars are teeth most ideal for supporting the overdenture. This is because of their large root surface area.

Also progressive alveolar atrophy after tooth extraction can be prevented by retaining teeth or tooth root beneath an overdenture to keep a few teeth and use them or their roots for a tooth or root supported overdenture has been shown to substantially reduce the bone loss in the mandible. However, patient cooperation is mandatory for maintaining adequate oral hygiene to avoid cavities and periodontal disease of the retained teeth, therefore using metal copings to protect the abutment is a better alternative for a treatment option to conventional dentures or noncoping overdentures, but on the flip side fabrication and cementation of metal copings add to the technique sensitivity and cost of the overdenture fabrication. Overdentures are bulkier than most conventional dentures as abutments and sometimes attachments have to be accommodated beneath the dentures, hence depending on the amount of interridge space available the type of copings can be fabricated. There are four basic types of primary copings:

1. Long copings (6-8 mm).
2. Medium copings (4-6 mm).
3. Medium-short copings (2-4 mm).
4. Short copings (1-2 mm).

The copings may exhibit wear over a period of usage and there can also be cementation failures which can lead to dislodged copings. It is necessary to have awareness about all the merits and demerits of such treatments to be able to better apply them in clinical practice.
References


Abstract

Frenum is defined as a small fold of mucous membrane connecting the lip to the alveolar process providing stability to the lip and tongue. The abnormal frena often cause problems such as loss of papilla, recession, diastema, difficulty in brushing, alignment of teeth, and psychological disturbances and therefore needs to be removed. The present case report illustrates the treatment of abnormal thick papilla penetrating maxillary labial frenal attachment which is treated with Z-plasty procedure.

Key words: Frenum, Frenectomy, Z plasty, Midline diastema, abnormal frenum, esthetics

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Introduction

Aesthetic concerns have led to an increasing importance in seeking dental treatment, with the purpose of achieving perfect smile. Adult patients often seek treatment for diastema present between maxillary central incisors. The presence of an aberrant frenum being one of the etiological factors for the persistence of a midline diastema, the focus on the frenum become essential in some cases. Frenal attachments are usually thin folds of mucous membrane with enclosed muscle fibers that attach the lips to the alveolar mucosa and underlying periosteum. Aberrant frena often cause problems such as loss of papilla, recession, diastema, difficulty in brushing, alignment of teeth, and psychological disturbances. Thick labial frenum makes cleaning in that area difficult and causes accumulation of plaque. Often a thick maxillary labial frenum with papillary attachment/penetration results in 24.29-40% of midline diastema. In the present case report two cases with thick labial frenum attachment, frenectomy was done through Z-plasty which is a plastic surgery technique which is used to improve the functional and cosmetic appearance.

Case Report

A 20-year old male who reported to the Department of Periodontology with the chief complaint of a midline diastema between the maxillary central incisors. On oral examination the diastema was observed with an abnormal thick papilla penetrating frenal attachment.

So, the Z plasty procedure was decided after the examination was carried out. Patient was told about the procedure and informed consent was taken. Sub cutaneous injection was done to check for allergy to local anesthesia. He was then administered 2% xylocaine with Adrenaline. Infiltration was given on the labial aspect between the two central incisors and on the palatal aspect near the base of the papilla. The area was assessed and one central incision was given and two lateral incisions at an angle of 60 degrees, creating two triangular flaps of equal size and shape. The shape of the incision was in the form of Z. Adequate undermining of surrounding tissues was performed to achieve proper mobilization of the flaps and minimize the distortion of the underlying structures. The two flaps were then transposed to the opposite side of apex of each flap. They were then sutured to the defect at the opposite side of the other flap base and secured in position by using interrupted braided silk suture. After suturing also the shape was in the form Z. The vertical incision on the attached gingival was also closed by suturing. Antibiotics and analgesics were administered and routine wound care instructions were given to the patient. The wound was re-examined after a day, then after a week and sutures were removed in 1 week time.

IInd case

A 17-year old female patient reported to the department of Periodontology with the chief complaint of difficulty in brushing in the maxillary anterior region and on examination it was observed that an abnormal...
thick papilla penetrating frenual attachment was present. So, the Z-plasty surgical procedure was performed with the same procedure.

**Discussion**

Frenum is defined as a small fold of mucous membrane connecting the lip to the alveolar process providing stability to the lip and tongue. The labial frenual attachments have been classified as mucosal, gingival, papillary and papilla penetrating, by Placek et al (1974).

1. Mucosal – when the frenual fibres are attached up to the mucogingival junction.
2. Gingival – when the fibres are inserted within the attached gingiva.
3. Papillary – when the fibres are extending into the interdental papilla.
4. Papilla penetrating – when the frenual fibres cross the alveolar process and extend up to the palatine papilla.

The abnormal frena are detected visually by applying tension over the frenum to see the movement of the papillary tip or the blanch which is produced due to ischaemia in the region. The frenum is characterized as pathogenic when it is unusually wide or when there is no apparent zone of the attached gingiva along the midline or the interdental papilla shifts when the frenum is extended. The aberrant frenum can be treated by frenectomy or by frenotomy.

Frenectomy is a complete removal of frenum, including its attachment to the underlying bone, and may be required in the correction of an abnormal diastema between the maxillary central incisors. In the era of periodontal plastic surgery, more conservative and precise techniques are being adopted to create more functional and esthetic results. The management of aberrant frenum has traveled a long journey from Archer's and Kruger's "classical techniques" of total frenectomy to Edward's more conservative approach. Various other techniques which can be used for frenectomy are the simple excision technique, with electrocautery, with laser, V-Y plasty and Millers technique. In the present case, frenectomy was done through Z-plasty. The principle of Z-plasty was first described by Denonvilliers in 1856 for the release of an eyelid scar and is now utilized in every part of the body.
Sutures placed in Z shape

Basic Z-plasty flaps are created using an angle of 60° on each side. Classic 60° Z-plasty lengthens scars by 75%, while 45° and 30° designs lengthen scars by 50% and 25%, respectively. The Z pattern is effective as it promotes re-distribution of tension on the skin and the wound and helps in healing along the skin lines. It helps in minimizing scar formation and has a camouflaging effect. Angles used for Z plasty which are less than 60° are easier to transpose but results in less lengthening and realignment of the scar to <90°. Angles larger than 60° should be avoided because the force required to transpose the flaps increases markedly, making closure of the wound difficult. The length of each of the lateral limbs of the Z-plasty must be precisely equal to the central incision over the original scar, or puckering at the corners will occur, and additional undermining and trimming of the flaps will be necessary to obtain proper closure. Precisely, equal lengths and angles of the lateral arms are keys for obtaining proper flap closure after transposition in Zplasty.

Frenectomy using basic Z-plasty technique gives more esthetic and functional outcome due to its inherent properties of redirecting and lengthening effects on tissues which are not possible with other techniques. It also lengthens the scar in favorable way so that the labio-buccal sulcus depth and lip height are brought to the normal dimension from original shallow one.

Complications of Z-plasty may be flap necrosis, hematoma formation, wound infection, sloughing of the flap caused by high wound tension, and the trapdoor effect (elevation of central tissue resulting from a downward contraction of a surrounding scar). Most complications may be prevented by meticulous attention to technique. The trapdoor effect may be avoided by employing sufficient undermining of tissues surrounding the flap site.

Conclusion

In most of the other procedures frenectomy fail due to a high risk of re-occurrence and hypertrophic scarring while it is reduced by the use of Z-plasty. The main aim is to promote the use of this surgical technique it helps relieve soft-tissue tension and facilitates healing by primary intention. The frenectomy technique using Z-plasty for the removal of the abnormal labial frenum attachment is reliable, easy to perform, and provides excellent esthetic results as mild postoperative and discomfort was reported by the patients.

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