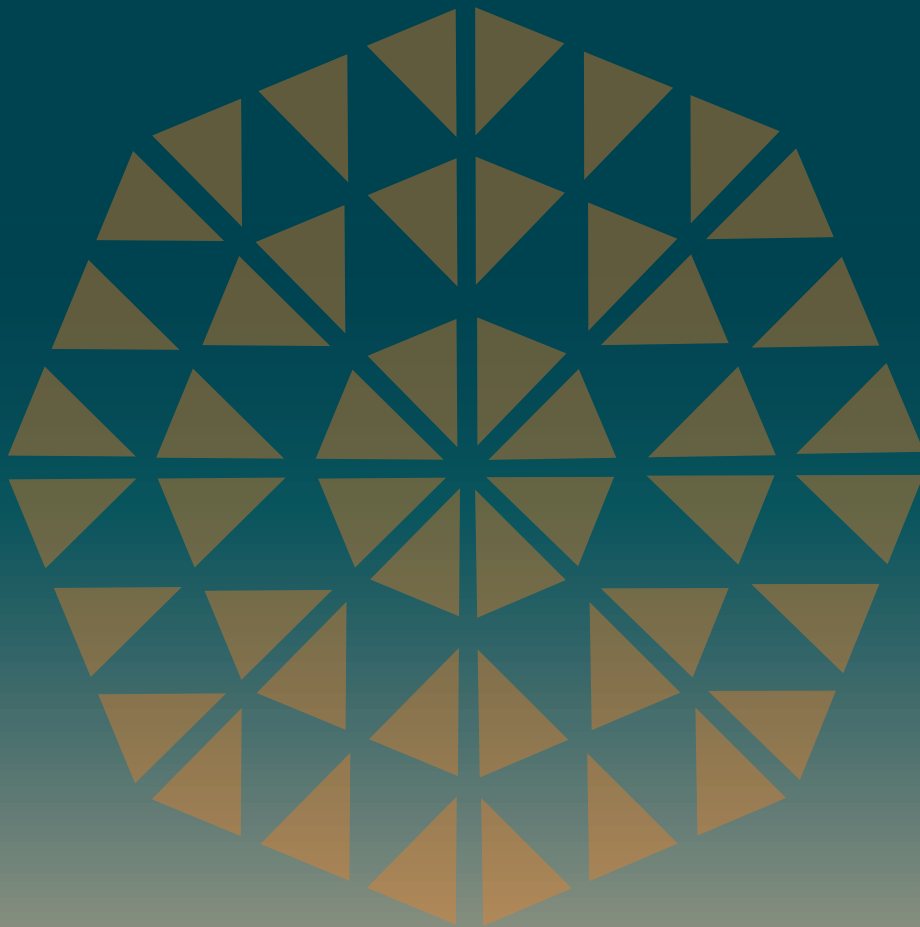


DENTAL BITES

Volume 10 Issue 2 | April - June 2023

Oral Surgery, Oral Medicine and Oral Pathology



a quarterly publication of



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Volume 10 Issue 2 | April - June 2023

**Oral Surgery,
Oral Medicine and Oral Pathology**

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Dear Readers,

I am delighted to share with you regarding two crucial aspects of our academic environment that significantly contribute to the holistic development of our students: the Mentor-Mentee System and the Happiness Program.

The Mentor-Mentee System plays a pivotal role in fostering a supportive and nurturing atmosphere within our institution. It is a platform where experienced faculty members guide and mentor our students, providing not only academic assistance but also helping them navigate the various challenges of professional and personal growth. This system enhances communication, encourages a sense of belonging, and ensures that our students receive personalized attention to help them thrive in their academic journey.

In tandem with the Mentor-Mentee System, our commitment to the well-being and happiness of our students is further exemplified through the Happiness Program. We understand that a positive and emotionally supportive environment is crucial for effective learning and personal development. The program is designed to promote mental health, resilience, and a sense of fulfilment among our students. Through workshops, activities, and counselling services, we aim to create an atmosphere where each student feels valued and supported, contributing to their overall happiness and success.

As we embark on another academic year, let us embrace these initiatives wholeheartedly. The Mentor-Mentee System and the Happiness Program are integral components of our vision to create well-rounded individuals who not only excel in their academic pursuits but also lead fulfilling and happy lives.

Wishing you all a successful and joyful academic year ahead.

With warm regards,

Dr Manoj Kumar K.P

Principal

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Review

VITAMIN D AND ORAL HEALTH

*Amith Adyanthaya, **Shemna.M.K, **Nileena Balan, **Laya Vijayaraj

Abstract

Vitamin D (VD) levels have been gaining growing attention in Oral Health. During growth and adulthood, VD deficiency (VDD) is associated with a wide variety of oral health disorders, and impaired VD synthesis may expedite some of these conditions. In children, severe VDD can induce defective tooth mineralization, resulting in dentin and enamel defects. As a consequence, these defects may increase the risk of the onset and progression of dental caries. Further, Vitamin D may also be linked with some oral pathology entities such as certain oral cancers and events of osteonecrosis of the jaw. This review aims to provide comprehensive evidence of how VD levels should be considered to promote good oral health, and to summarize how VDD may hamper oral development and its role in certain oral conditions.

Key words; Vitamins; Vitamin D deficiency, Oral health, Periodontal health, Periodontal disease, Periodontitis, Caries, Orthodontics Oral cancer

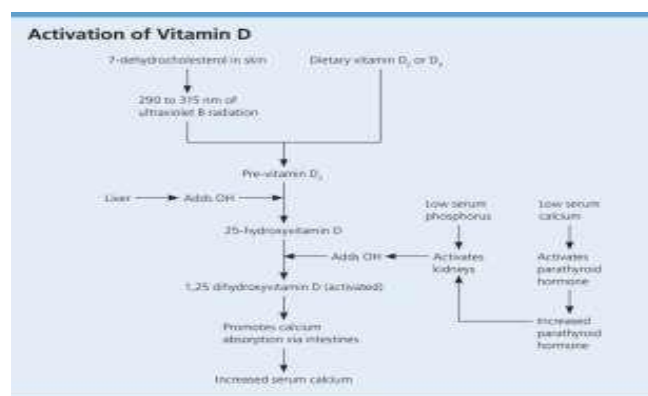
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Introduction

Vitamin D was originally classified as a nutrient when cod liver oil (a source of vitamin D) was found to have an antirachitic effect in infants. However, since the discovery of the vitamin D receptor in 1969 it has been increasingly recognized that the term “vitamin” D is inappropriate, and that this class of molecules is better defined as a complex endocrine system. In terms of its structure and mode of action, vitamin D is similar to the classic steroid hormones. Indeed, although vitamin D₃ can be found in the diet, the human body can produce it in the skin, by photoconversion of 7-dehydrocholesterol to vitamin D₃. Vitamin D₃ can be considered a pro-hormone, which is not known to have any intrinsic biological activity itself.¹

VITAMIN D METABOLISM AND ACTION



Vitamin D is a generic name comprising Vitamin D₂ and D₃. While Vitamin D₂ is manufactured through ultraviolet irradiation of ergosterol from yeast, Vitamin D₃ results from ultraviolet irradiation of 7-dehydrocholesterol from lanolin exhibiting the biological activity of cholecalciferol (vitamin D₃), and it is synthesized in the human skin².

Decreased vitamin D synthesis

Skin pigmentation, physical agents blocking UVR exposure, clothing, latitude, season, air pollution, cloud cover, altitude

Decreased nutritional intake of vitamin Strict vegan diet

Age and physiology related

Elderly, obese and institutionalised

Decreased maternal vitamin D stores

Exclusive breastfeeding

Malabsorption Celiac disease, pancreatic insufficiency (cystic fibrosis), biliary obstruction (biliary atresia)

Decreased synthesis

Chronic liver disease
 Increased degradation of 25 (OH) D
 Drugs such as rifampicin, isoniazid, anticonvulsants, glucocorticoids

The prevalence of vitamin D deficiency is increasing globally and has been reported to be common in the Middle East, Australia, India, Africa, and South America (Holick et al. 2011)³.

Vitamin D deficiency is generally regarded as being serum >50 nmol/L, and deficiency as <25 nmol/L. The systemic impacts of vitamin D deficiency are numerous, though the most common in children is the bone deformity rickets, and in adults, osteomalacia. It is important to note that hypophosphatemic rickets (vitamin D-resistant rickets) differs from vitamin D deficiency rickets. In hypophosphatemic rickets, production of vitamin D is inhibited secondary to phosphate wasting, which is caused by mutations in a range of genes (mainly PHEX) and is commonly inherited⁴.

Vitamin D has an essential role in phosphate and calcium metabolism and, therefore, in bone homeostasis. It can stimulate both formation and resorption of bone and can also influence host immune responses

Vitamin D Deficiency Impact on Oral Health

Vitamin D Deficiency in Tooth Mineralization and Caries Teeth are mineralized organs, surrounded by alveolar bone, and formed by three distinctive hard tissues: enamel, dentin, and cementum. The tooth mineralization process occurs parallel to skeletal mineralization, yet if mineral metabolism is disturbed then failures will occur similarly to those that occur in bone tissue. Vitamin D plays a key role in bone and tooth mineralization, and when levels are unregulated it can lead to the “rachitic tooth”, which is a defective and hypomineralized organ highly susceptible to fracture and decay⁵.

The mechanisms by which VDD affects tooth mineralization are well debated elsewhere. The main biological basis relies on the fact that severe VDD (<10 ng/mL) causes hypocalcemia and hypophosphatemia with secondary hyperparathyroidism (driven by hypocalcemia).

This hyperparathyroidism promotes intestinal absorption of calcium (Ca^{2+}), and renal production of $1,25\text{-}\alpha,25\text{-dihydroxyvitamin D}$ ($1,25[\text{OH}]_2\text{D}$),

increasing bone turnover leading to elevated serum levels of Ca^{2+} and low serum levels of inorganic phosphate (Pi). The initial hypophosphatemia is then severely worsened. Ultimately, the loss of vitamin D signaling pathways in tooth cells with low concentrations of Ca^{2+} and phosphate ions inhibit proper mineralization of teeth and mineralization defects occur.

Hypoplasia caused by vitamin D deficiency has the distinct characteristic presentation of ‘banding’, termed chronological hypoplasia⁵. The hypoplastic enamel appears as bands across the crowns of the teeth and corresponds to the section of enamel that was being produced during the time of the deficiency⁵. When the deficiency is corrected, enamel production returns to normal, and so a clear distinction exists between these two sections, as demonstrated.



The pattern of mineralization defect depends on the specific week of gestation when maternal VDD occurred. For example, approximately at the 13th week from conception, the human primary maxillary central incisor begins its calcification, and if there is a VDD status, there could be a hypoplasia/mineralization defect on the incisal third of the crown. Nowadays, it is known that maternal VDD at 12–16, 20–32 and 36–40 weeks results in defects at the incisal third, middle third and cervical third, respectively⁵.

Tooth development and eruption are complex processes that also involve alveolar bone resorption and an eruption pathway formation. Disturbances in dental development can lead to a persistent primary tooth (PPT) and delayed tooth eruption (DTE). PPT occurs when a primary tooth is retained beyond the regular exfoliation time. PPT can cause malocclusions, periodontitis, ankylosis and a severe impact on patient dissatisfaction. The molecular mechanism underlying PPT occurrence has not been fully explained, but it is known that PPT can lead to DTE of the permanent tooth. DTE is the emergence of a tooth into the oral cavity at a delayed time than expected according to sex and ethnic differences. The failure of dental emergence in the oral cavity influences the Pediatric and Orthodontic treatment plan, impacting a patient’s oral health.⁷

Vitamin D Deficiency and Periodontitis

Periodontitis is a complex polymicrobial disease induced by plaque and with persistent chronic inflammation. Although not fully understood, Vitamin D has apparent fine-tuning, anti-inflammatory and mineralization effects on the periodontium according to the latest in vitro evidence. A study showed that vitamin D may decrease the number of live porphyromonas gingivalis through active autophagy and might alleviate the inflammatory burden of periodontitis in rodent models: decreasing inflammatory levels (RANKL, TNF- α , IL-1, MMP-9); inhibiting IL-6 overexpression; and suppressing alveolar damage via inhibition of bone loss, apparently through systemic T-helper cells. In cultured human periodontal cells, Vitamin D induced a comparable mineralization effect to vitamin C⁵.

Vitamin D Deficiency and Orthodontics

With the increase in importance of aesthetic requirements, facial micro- and macro-aesthetics and smile have become a priority lesions. In a case-control study, VDD was associated with increased risk of squamous cell carcinoma of the esophagus, oral, and pharyngeal cancers, which were more prevalent in heavy smokers and severe alcoholism⁵.

for adolescents and adults

Albeit animal observational in nature, there is an increasing body of evidence showing that local application of vitamin D results in a faster tooth movement. Notwithstanding, VDD in animal models causes a slower rate of tooth movement, and consequent treatment delay or complications. In this sense, future studies in humans are needed to determine if VDD has a clinically significant effect on tooth movement and if vitamin D supplementation during orthodontic treatment, for instance in hypovitaminosis cases, improves the coupling of formation and resorption in alveolar bone remodeling during orthodontic tooth movement⁵.

Vitamin D Deficiency and Oral Pathology

Vitamin D might play an important function in the onset and progression of certain oral cancers, though there is still much to research. Remarkably, VDD is more common in patients with oral neoplastic

Measurement of Vitamin D Levels

25(OH)D is the major circulating form of vitamin D with a half-life of 2-3 weeks and its levels are the best available indicators of vitamin D status. Although 1, 25 (OH)2D

(calcitriol) is the active form, it has a half-life of only 4 hours and it is not a good indicator of vitamin D stores because (i) vitamin D deficiency can cause PTH elevation that induces increased 1- α hydroxylase activity, which results in normal or increased levels of 1,25 (OH) $_2$ D; and (ii) it circulates at the concentration that is 100-1000 fold less than 25(OH)D $_3$.

When to Treat? Vitamin D therapy is necessary for infants and children who manifest clinical features of hypocalcemia as a result of vitamin D deficiency or rickets and when vitamin D levels are in the deficient range even if asymptomatic. The three stages of etiology of vitamin D deficiency⁶.

Vitamin D toxicity

Should not be diagnosed solely on the basis of an elevated 25(OH)D level; it should rather be recognized as a clinical syndrome of both hypervitaminosis D and hypercalcemia, in which hyperphosphatemia and hypercalciuria also commonly occur. Patients with vitamin D toxicity can present with clinical symptoms (e.g., headache, metallic taste, nausea, and vomiting) and complications of hypercalcemia (e.g., dehydration, constipation, pancreatitis, and heart arrhythmias) and hypercalciuria (e.g., polyuria and kidney stones) (National Institute of Health 2016). While hypervitaminosis D in the absence of hypercalcemia may prompt further investigation to evaluate the etiology of increased vitamin D levels, it is not a medical emergency as is hypercalcemia³

Stages	Serum calcium	Serum phosphorus	ALP	PTH	25 (OH)D	1,25 (OH)D $_3$	Radiography
Early	N/↓	↓	↑	↑	↓	N	Osteopenia
Moderate	N/↓	↓	↑	↑↑	↓	↑	Rachitic changes 1+
Severe	↓↓	↑↓	↑↑	↑↑	↓↓	↑/N/↑	Rachitic changes 2+

ALP: Alkaline phosphatase; PTH: Parathrmone; 25(OH)D: 25-hydroxy vitamin D; 1,25 (OH) D $_3$: 1,25-dihydroxy vitamin D $_3$.

Table 5. Supplement dosage for different cutoff values of 25-hydroxyvitamin D levels.

Vitamin D status	Supplement dosage
Severe vitamin D deficiency < 10 ng/mL (< 25 nmol/L)	50,000 IU vitamin D ₂ or D ₃ /week for 6–8 weeks, then 800 IU vitamin D ₃ /day
Serum vitamin D of 10–20 ng/mL (25–50 nmol/L)	800–1,000 IU/day vitamin D ₃
Serum vitamin D of 20–30 ng/mL (50–75 nmol/L)	600–800 IU/day vitamin D ₃
Patients with malabsorption	10,000–50,000 IU/day vitamin D ₃

To convert from ng/mL to nmol/L, multiply by 2.496.

Group	Daily regimen (8–12 weeks)	Weekly regimen (8–12 weeks)	Stoss therapy (oral or IM)	Maintenance
< 1 mo old	1,000 IU	50,000 IU	–	400–1,000 IU
1–12 mo old	1,000–5000 IU	50,000 IU	1 lakh –6 lakhs units over 1–5 days (Preferably 3 lakh)	400– 1,000 IU
1–18 y old	5,000 IU	50,000 IU	3–6 lakh units over 1–5 days	600–1,000 IU
>18 y old	6,000 IU	50,000 IU	3–6 lakh units over 1–5 days	1,500–2,000 IU
Obese patients, patients with malabsorption syndrome, or on medications affecting vitamin D	6,000–10,000 IU/day			3,000–6,000 IU

* To convert (IU) to mcg of calciferol divide by 40.

Conclusions

VDD is highly implicated with oral diseases and has been linked with a higher risk of tooth defects, caries, periodontitis and oral treatments failure. The maintenance of appropriate 25(OH)D levels has shown to be associated with better oral development and health throughout life, though the impact of VDD correction through supplementation demands more evidence to allow definitive conclusions and potential clinical guidelines. Nevertheless, 25(OH)D levels should be considered to ensure a balanced oral health,

and these levels need to be verified before the treatment of any oral conditions to warrant fruitful treatment outcomes.

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Case Report

"RARE ENCOUNTER: A CASE REPORT ON SPINDLE CELL CARCINOMA OF THE ANTERIOR MANDIBLE"

*Manoj Kumar K P, **Atic Thomas, ***Sidharth Manoj, ***Muhammed Afsar

Abstract

Introduction: Spindle cell carcinoma is an aggressive carcinoma characterised by rapid growth and recurrence. SpCC of oral cavity is rarely reported in literature.

Case Report: Herein a case of 42-year-old man with a lesion on mandible anterior teeth region has been reported. It showed rapid growth in short span of three weeks.

Conclusion: Due to its aggressiveness and recurrence rate, differentiating spindle cell variant at an early stage is very important.

Key words: *Spindle cell, Pleomorphism, mandible, Pseudosarcoma, IHC markers, Vimentin.*

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Introduction

Spindle cell carcinoma (SpCC) is a rare, aggressive, biphasic cancer that frequently affects the oral mucosa as well as the upper aerodigestive tract. According to the WHO, this tumour is described as a "carcinoma that contains elements that resemble squamous cell carcinoma and are associated

with a spindle cell component."¹ It has tumour cells that are pleomorphic or spindled, like true sarcomas but being epithelial in origin.² Due to their unique microscopic characteristics, this cancer had been known by several other names, including sarcomatoid carcinoma, carcinosarcoma, pseudosarcoma, pleomorphic carcinoma, and polypoid

carcinoma.³ WHO classification has placed this tumour under a highly malignant variant of squamous cell carcinoma and labelled it spindle cell carcinoma.³ It is commonly seen in the sixth decade of life. Commonly affecting the male population.³ Like squamous cell carcinoma, the risk factors for SpCC include smoking, drinking alcohol, having poor oral hygiene, and having had radiation in the past. It has the potential to be aggressive and a predisposition for metastasis and recurrence.⁴ Due to this, a precise diagnosis is essential. The diagnosis must be made using both conventional histology and immunohistochemistry.⁴

Case Report

A 42-year-old man visited our department with chief complaint of swelling in lower anterior front tooth region in the last 3 weeks. Initially there was mobility of tooth in the lower anterior region followed by the swelling. Patient had occasional pain. Patient also gives history of occasional bleeding from the site. Lesion had no history of pus discharge. The progression of swelling was sudden.

He had no relevant medical history. Patient gives history of smoking and placing Hans

in the lower anterior buccal vestibule for the past ten years.

On inspection a swelling of size 3.5 X 5 cm extending Antero posteriorly from labial vestibule of lower anterior tooth region to the floor of the mouth and mesiodistally from distal aspect of 34 to mesial aspect 43. (Figure 1). Skin overlying the swelling is erythematous and intact. On palpation tenderness present in the lingual aspect. It had a firm consistency. It was non compressible, non-fluctuant and non-reducible. Grade 3 mobility was present in relation to 31, 32, 33, 34, 35, 41, 42. No lymph nodes were palpable.

Patient was sent for routine blood investigation. Blood reports were in normal range. CBCT revealed a lesion in relation to lower anterior teeth region which was well defined, non-corticated, irregular and permeative margin. The internal structure appeared homogeneously hypodense with mild ill-defined hyperdense area seen within lesion, suggestive of residual bone. Absence of alveolar crest, alveolar bone, labial and lingual cortical bone lead to floating teeth appearance for teeth 31,32, 33, 42, 42. Teeth 32 and 33 are noted to be displaced mesially and distally respectively.

The root apexes give “spike –root appearance.” (Figure 2) The impression was that of an Aggressive neoplasm in mandibular anterior region.

Chest X-ray did not show any abnormal findings. Incisional biopsy was performed with extraction of 31. (Figure 3) A single soft tissue bit of approximate size 1 x 0.5 x 0.7 cm was obtained and send for histopathologic examination along with extracted tooth (Figure 4) On H &E staining soft tissue section showed stratified squamous surface epithelium overlying a moderately collagenous stroma. Stroma showed highly cellular proliferating spindle cells in sheets, short fascicles, and whorled pattern. Few areas showed vacuolated cells resembling histiocytes. Cells showed abundant cytoplasm with hyperchromatic nucleus and prominent nucleoli and few areas had evident pleomorphism. Numerous dilated vascular channels with extravasated RBCs and mild to moderate chronic inflammatory cells were noted. Normal trabecular bone and calcifications are also noted. Histopathology report suggested spcc and advised immunohistochemistry for confirmation. IHC was then performed which confirmed the diagnosis of SpCC.

Patient was referred to higher centre for further management.



Figure-1: Preoperative Image showing the lesion in the anterior mandible.

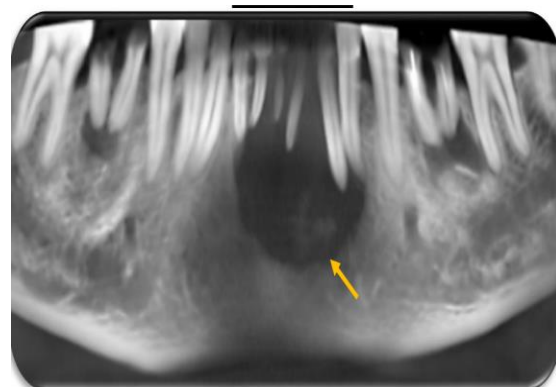


Figure-2: Preoperative CBCT



Figure-3: Shows operated site after incisional biopsy and extraction of 31



Figure-4: Specimen obtained after incisional biopsy

Discussion

With a reported incidence of fewer than 1% of all cancers in the oral areas and 3% of Squamous cell carcinoma, spindle cell carcinoma is extremely uncommon.^{2,3} There was a lot of uncertainty over the type of cancer, whether it is a benign or malignant sarcoma or carcinoma. Spindle cell carcinoma was first identified as a tumour with surface epithelial changes and an underlying spindle-shaped neoplastic proliferation only later, after studies of the morphologic, immune histochemical, ultra structural, and molecular features of this tumour were established.³

Due to the presence of spindled or pleomorphic tumour cells that mimic true sarcomas yet are epithelial in origin, it is classified as a biphasic malignant tumour. But one-third of them had monophasic spindled or pleomorphic histology, which makes the diagnosis more difficult.⁵

Most cases of this cancer are seen in the upper aerodigestive tract.³ The most frequent location is the larynx, especially the glottis, which accounts for 70% of cases.⁵ Within the oral cavity, the tongue, floor of the mouth, alveolar ridge, gingivae, or lower lip are the most typical locations.⁶

The skin of the head and neck, as well as the soft tissues of the scalp and orbit, may also be affected. Although the average age of diagnosis is in the sixth decade of life, it can also be diagnosed in people who are younger or older than this (range 29–93).⁶ A 12:1 ratio of male inclination has been recorded by several writers.^{3,5,7} The risk factors for SpCC are the same as those for squamous cell carcinoma, including use of alcohol, tobacco, poor oral hygiene, and prior radiation exposure.⁸ In this instance, the patient was a 41-year-old male who had a history of using tobacco for 10 years.

In 98.9% of instances, the growth of this tumour is exophytic polypoid or pedunculated. Additionally, it may be endophytic, sessile, or nodular.⁶ In this example, there was an exophytic mass. This cancer has a propensity to produce obstructive symptoms, particularly when it affects the larynx. Patients may exhibit coughing, a change in voice quality, hoarseness, dyspnoea, or stridor. Oral cavity and oropharynx tumours commonly appear with a single complaint of a lump, a painful, infected ulcer, or bleeding.

Both epithelial and sarcomatoid or spindle cell components can be seen histologically

in spindle cell carcinoma. The spindle cell component may demonstrate varied histological appearance ranging from benign reactive lesion to malignant lesions.³ Pleomorphic (similar to a malignant histiocytoma) and spindle cell sarcoma (similar to a fibrosarcoma) are the most prevalent types.² The squamous component is either focal dysplasia, carcinoma in situ, or invasive SCC, while the spindled component often predominates.⁷ Establishing the diagnosis requires the histological and immunological histochemistry proof of both the squamous cell component and the spindle cells with sarcomatous appearance.⁶ Differential diagnoses include benign to malignant lesions such malignant melanoma, reactive epithelial proliferations, fibrosarcoma, and reactive epithelial proliferations.

To understand the biology of SpCC and the histogenesis of the spindle cells inside these tumours, immunohistochemical investigations are helpful. There are numerous histogenetic hypothesis have been proposed over the years, with 3 principal theories, including: 1) it is a collision tumour or a carcinosarcoma; whereby a separate epithelial and mesenchymal cell have each become

malignant; 2) it is a spindle cell carcinoma or sarcomatoid carcinoma - an epithelial cell that differentiates into spindle cell component; or 3) it is pseudosarcoma - a squamous cell carcinoma that undergoes benign reactive stromal.³

Keratin (AE1/AE3, CK 1,8,9), epithelial membrane antigens, KI, and K18 are some epithelial markers. Keratin and epithelial membrane antigen are the most sensitive and dependable types. They aid in the differentiation of these lesions from other sarcomatous ones. In this study, cytokeratin was negative whereas EMA (epithelial membrane antigen) was positive. It shows that although the neoplastic cells are epithelial in origin, they have undergone changes that have caused them to lose their keratin. Vimentin, Desmin, S-100, Osteopontin and BMP (Bone morphogenic protein) are mesenchymal markers. Vimentin was shown to be present in the spindle-shaped cancer cells in this investigation. It implies that the strange fibroblast-like cells are carcinoma cells with true mesenchymal metaplasia, which have acquired mesenchymal properties both morphologically and functionally through metaplastic changes, leading to keratin loss and acquisition of vimentin as the

cytoskeletal protein.⁹ The versatility of the intermediate filament phenotype is demonstrated by the double tagging of keratin and vimentin in spindle cells.

Spindle cell carcinoma has been associated with another epithelial marker called P63.^{2,3} According to the TMN classification of the American Joint Committee on Cancer staging, spindle cell carcinomas are categorised based on their size and the presence or absence of metastases to nearby lymph nodes or other body regions.⁵ Spindle cell carcinoma therapeutic options have been discussed. Wide radical excision alone, according to some writers, is adequate, whereas surgery combined with radiation is preferred by others. Surgery followed by radiation provides the patient with the greatest long-term results.³ For patients who cannot be operated on and who have substantial nodal disease or a surgical margin that is positive, radiotherapy is seen as a viable option.⁶

Spindle cell carcinoma in the oropharynx and oral cavity can be aggressive and tends to recur and spread.³ There is significant debate over SpCC's prognosis and response to therapy.^{3,9} The prognosis is influenced by distant metastases, tumour invasion

depth, and polypoid shape. While patients with early-stage cancers often have favourable prognoses, individuals with highly invasive tumours typically have poor prognoses.²

Study on 15 patients with surgically removed spindle cell carcinoma of the oral cavity and oropharynx, a significant proportion of local recurrence (73.3%) and distant metastasis (33.3%) were seen.⁹ Another study on recurrence rate showed 71.4% recurrence and metastatic rate of 21.4%.¹⁰ According to several publications, the prognosis is worse than the conventional SCC at a comparable stage.^{3,9,10} A year later, death occurred in almost 30% of all oral cases.^{3,10} This result resembles the high grade SCC.¹⁰

Conclusion

Spindle cell carcinoma of head and neck is a rare and unique subtype of squamous cell carcinoma. Compared to the traditional Squamous Cell Carcinoma (SCC), it may be more aggressive. Additionally, it appears to spread and recur quickly. At the light microscopic level, it resembles other connective tissue sarcomas and spindle cell malignancies. To understand the

histogenesis and characteristics of SpCC, immunohistochemistry is useful. It is debatable how an illness may progress. While patients with early-stage tumours have a favourable prognosis, individuals with highly invasive tumours often have a bad prognosis.

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Case Report

ORAL VERRUCOUS CARCINOMA - A CASE REPORT WITH REVIEW OF LITERATURE

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Abstract

Oral verrucous carcinoma (OVC) is considered as a low-grade, verrucous variant of oral squamous cell carcinoma (OSCC), with specific clinical, morphological and histological features. It clinically presents as proliferative lesion on the buccal mucosa followed by other oral sites such as alveolar crest, gingiva, and tongue. Tobacco in both smoking and smokeless form, alcohol, and opportunistic viral infections are the associated etiologies in most of the reported cases. Though it appears remarkably harmless, the diagnosis of OVC should be given with utmost care since it has greater chances to become cancer. Global burden of cancer has increased because of aging and growth of population with the increase of cancer-causing behaviours, particularly smoking. The Global Cancer Observatory (GCO) data shows that the annual incidence of OSCC in 2020 was 377,713 cases worldwide, with the highest number recorded in Asia (248,360). In this case report we discuss a case of 70-year-old female diagnosed with Oral verrucous carcinoma of the right buccal mucosa.

Key words: *Oral verrucous carcinoma, Oral verrucous hyperplasia, Oral squamous cell carcinoma*

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Introduction

Head and neck malignant carcinoma is the world's fifth most common cancer with incidence exceeding half million of the people. Oral squamous cell carcinoma (OSCC) represents 95% of head and neck malignant carcinomas. A low-grade, well-differentiated verrucous variant of OSCC, the oral verrucous carcinoma (OVC) accounts 2–12% with 5-year survival rate of approximately 50%.¹

OVC is a malignant tumour characterized by slow exophytic growth, which usually present as cauliflower-like, multi nodular and pebbly lesions. The history of OVC can be traced back as early as 1948 when it was first described by Lauren V. Ackermann. So it also referred as 'Ackermann's tumour' or 'verrucous carcinoma of Ackermann'. Its pathology was not studied independently until mid-1980's. Differentiation of OVC from OSCC is important regarding their different molecular mechanisms and prognosis. However, it is difficult to differentiate them by merely observing clinical and pathological features, because OVC has similar biological behaviour as OSCC,

including tendency to local invasion, lymph node metastasis and malignant transformation. Undoubtedly, it is critical to seek histo-pathological and molecular findings of OVC to resolve such challenges.^{1, 2}

The etio-pathogenesis of OVC is not very clear, though it has strong association with the use of tobacco, areca nut, poor oral hygiene and alcohol.¹ Areca nut extracts contain N-nitroso amines and arecoline as carcinogens, it may cause DNA single-strand breaks and mutations, facilitating tumour formation and growth, so it plays an important role in oral carcinogenesis.¹

Oral microbes also plays role in oral carcinogenesis through their impacts on local metabolism of alcohol and smoking-related carcinogens. It is found that five bacterial phyla, including Firmicutes, Proteobacteria, Bacteroidetes, Actinobacteria, and Fusobacteria, are associated with oral cancer. They can convert ethanol to acetaldehyde (genotoxin) exposing the oral and gastrointestinal tract directly to carcinogenic aldehyde and amines.¹



Among other potential causes of OVC, pathogenic role of human papillomavirus (HPV) shows conflicting research result. Some researchers considered that HPV is the possible pathogen and in contrast other scholars argued that the role of HPV might be occasional as there was no verified correlation between OVC and HPV in their work.¹

The most common sites of oral mucosal involvement include the buccal mucosa, followed by the mandibular alveolar crest, gingiva and the tongue. A proliferative condition known as Verrucous hyperplasia was described by Shear and Pindborg in 1980, which has been considered as early stage of oral verrucous carcinoma.³ Both of these lesions closely resemble each other clinically as well as pathologically.

Excision with wide margins considered as the primary mode of treatment. Surgery combined with radiotherapy also the preferable treatment and shows good prognosis, particularly in cases of extensive lesions.³

Case Report

A 70-year-old female patient reported to the department of Oral and Maxillofacial surgery with chief complaint of growth and discomfort on right cheek since last six months. The swelling was gradual in onset, slowly progressed to the present size. Patient gave history of areca quid chewing since childhood. Patient is diabetic and hypertensive under medication. Patient has cardiac issues since last 4 years.

Intra orally exophytic lesion of size 3x2cm was seen on right buccal mucosa extending antero-posteriorly 4cm from right corner of the mouth to retro-molar area along the occlusal plane. Proliferative areas were also seen on the anterior mucosa, and gingiva. Keratotic and plaque like areas were seen over the lesion and it was not associated with bleeding or pus discharge. The lesion was non tender, non-fluctuant, non-compressible, indurated and fixed.



Figure 1- Preoperative intra oral photographs



Figure 2- Preoperative intra oral photographs

Lesion was provisionally diagnosed as carcinoma of alveolar and buccal mucosa. Incisional biopsy was done under local anaesthesia.



Figure 3: Photograph of incised lesion



Figure 4: Photograph of specimen

The soft tissue specimen was dirty white in colour, firm in consistency and measuring 1.3x0.7x0.5cm in size, irregular borders and proliferative areas seen as finger like projection. Cut L.S into two and both bits was put for processing.

The microscopic examination of given H & E stained section showed parakeratinized stratified squamous epithelium proliferating as exophytic and endophytic components. Exophytic component showed proliferation in a papillary fashion with hyperkeratosis. Endophytic component was seen as elongated broad rete ridges with pushing margins. Superficial parakeratin clefting, micro abscess, increased individual cell

keratinization with pool of keratin and koilocytes were also noted. Basilar hyperplasia was evident and in some area the cells showed increased nuclear cytoplasmic ratio.

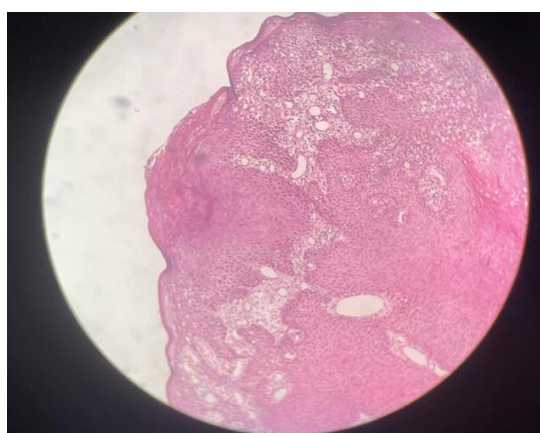


Figure 5: Parakeratinized stratified squamous epithelium with exophytic and endophytic components

Sub-adjacent connective tissue shows intense inflammatory cell infiltrate. Pseudo epithelial islands are evident in the connective tissue. Basement membrane is inconspicuous in few areas where the inflammation was intense. Numerous capillaries and extravasated RBCs were also seen in the connective tissue.

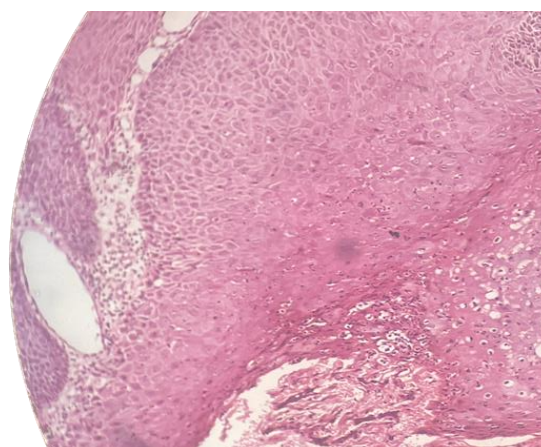


Figure 7: Koilocytes (cells with pyknotic and crenated nuclei, surrounded by edematous or clear zone) and basilar hyperplasia

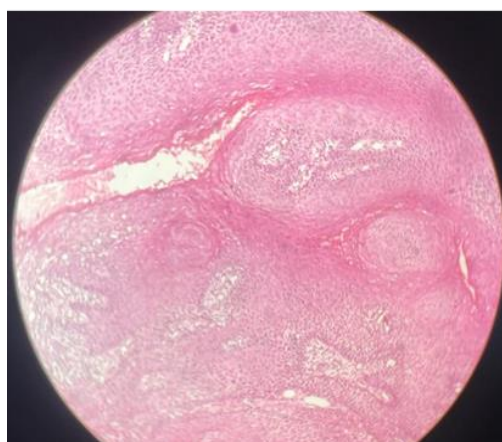


Figure 6: Inflammatory cell infiltrate & Pseudo epithelial islands

DISCUSSION

Oral verrucous carcinoma (OVC) is a rare but well differentiated form of oral squamous cell carcinoma (OSCC) mainly seen in sixth or seventh decade of life with male predominance. The terms refers to exophytic mucosal or cutaneous squamous tumours that are heaped above the epithelial surface with a papillary micro-nodular surface and pushing margins.⁸ It is very difficult to differentiate OVC clinically. Hence, a thorough clinical and in-depth microscopic evaluation is required for appropriate diagnosis.

Analysing the clinical manifestations and prognosis, Tang *et al* divided OVC into three types: exogenic type, cystoid type, and infiltrative type¹. The exogenic type of OVC is characterized by exophytic growth, cauliflower-like warty lesion and slow tumor growth. The other two types of OVC grow rapidly, forming bean dreg-like white dry keratosis, with poor prognosis compared to the exogenic type¹.

Betel nut chewing, poor dental hygiene and human papillomavirus (HPV) are implicated

in the development of OVC. Use of tobacco in the smokeless and inhaled forms has been predominantly reported in the affected patients, followed by use of areca nut chewing and alcohol. In Ackerman's study, 11 out of 18 patients (61%) with buccal mucosal cancers were tobacco chewers. Shear and Pindborg reported that out of 28 patients with verrucous lesions, 24(86%) used tobacco. Tobacco appears to be a major factor in the causation of verrucous lesions. Chen *et al.* in his study of OVCs in Taiwan, areca quid chewing was found to be 97.3%.² In our case report the use of areca nut chewing habit may have been the cause of the lesion.

Histo-pathologically the present case showed koilocytosis, suggesting HPV infection. Large number of lymphocytes and plasma cells infiltrated into the connective tissue enhance the diagnosis of OVC. It may arise via dysplasia–carcinoma in situ sequence, may finally transform into invasive OSCC.⁴

In three dimensional views OVC under transmission electron microscope shows thick and intact basement membrane and thicker substrate than the normal cells in local areas with increased inflammatory cells (e.g., lymphocytes and plasma cells). Under electron microscopy the exogenic type of OVC shows well differentiated epithelial cells with keratocyst, large nucleus, obvious nucleoli without pseudopodia on the membrane and cytoplasmic vacuoles. However, the cystoid type and the infiltrative type of OVC shows poorly-differentiated epithelial cell with obvious hetero-morphism, large, irregular and lobulated nucleus, clear pseudopodia and cytoplasmic vacuoles.

Biomarkers and gene expression can be used for better understanding of aggressiveness, genesis and molecular mechanisms. OVC has its own specific clinical manifestations, molecular mechanism and pathological features. Pentenero *et al* found the OVC and OSCC could differently characterised by the chromosomal instability biomarkers. Differences in aggressiveness and prognosis of OVC and OSCC also can be reflected by

DNA characteristics. Other tumour genes and molecular markers including Cyclin-D1, laminin-332 $\gamma 2$, PCNA, moesin, MMP-2, MMP-9 can be used for comparative evaluation of OVC and OSCC.¹

The most common differential diagnosis encountered clinically include oral verrucous hyperplasia, hybrid VC, oral squamous papilloma and OSCC.¹⁰ It has been proved that 20% of the OVCs has small foci of well differentiated OSCC within them.^{9, 10}

OVC and Oral verrucous hyperplasia are two distinctive lesions inspite of their similar morphologies. From the clinical aspect, both of them have a thick, extensive, white plaque, or exophytic verrucous appearance. The most common sites for the two lesions are buccal mucosa, tongue and lip. So to differentiate them effectively, specific histo-pathological features may be used. OVC has the explicit 'pushing border' (all rete pegs of the epithelium tend to project into the underlying connective tissue, more or less in the same level) with destructive edges at the junction of lower connective tissues,

whereas OVH does not show invasion of the hyperplastic epithelium into the connective tissue.

Generally abrupt transition from normal epithelium to endophytic ingrowth is an important parameter to differentiate it from benign verrucous growths. A classic case of OVC shows minimal or no pleomorphism of cells and no mitotic activity above the basal and suprabasal layers of the epithelium.¹¹

Oral squamous papilloma (OSP) shares similar morphology to OVC. From the histo-pathological point of view, it is possible to differentiate them. OVC forms 'pushing border' whereas OSP often presents as long, thin and finger-like exophytic projections, the differentiation can also be achieved by using some protein markers, which include the cytokeratins (CKs) family (e.g., CK 10, 13, 14 and 16), whose expression relates to the biological behaviour of both lesions.^{1,11}

In case of Hybrid VC (HVC) for proper evaluation, it is necessary to examine an adequate size of biopsy

specimen extending to the underlying bone, in-order to assess periosteum and the mucosa-connective tissue interface. In case of HVC, it invade underlying connective tissue and bone.¹

Prioleau et al. (1980) in their study on VC of rectum, plantar surface of the foot and oral cavity found marked focal thickening in certain areas of basement membranes. They also reported that ultra-structural examination of the tumours revealed reduplication of normal basal lamina as a proliferative basal zone underlying a thick layer of well differentiated, non-proliferating keratinocytes. These findings emphasized that basement membrane may play an important role in determining the nature of VC. Jiang et al. (2001) detected that VC cases showed a thicker basement membrane with reduplication at abundant places and greater inflammatory cell infiltration.¹

OVC can be misdiagnosed, so an adequate, full thickness biopsy specimen must be taken when clinician suspects oral verrucous carcinoma and also multiple biopsies are recommended from the

pathologist's side.³ It is essential that the pathologist alerts the clinician regarding the progressive nature of the lesion after thorough evaluation by considering the study of GCO, it alarmed that by 2040, the incidence of OSCC predicted to increase up to 40% with a corresponding increase in mortality.¹⁰

The general treatment principles of OVC are consistent with OSCC, which mainly include surgery, cryotherapy, chemotherapy, radiotherapy or combinations and excision. It shows excellent prognosis following complete surgical removal in the early stages. The success of surgery also depends on the surgeon and on the techniques involved during surgery. However, surgery for wide area usually results in poor cosmetic appearance and dysfunction. Chemotherapy or radiotherapy may have poor response and anaplastic transformation. So un-conventional treatment modalities have been put forward recently, including photodynamic therapy and CO₂ laser therapy.

Conclusion

The presence of malignant foci has been reported in few oral OVC cases, so it becomes mandatory for the pathologists to identify OVC. The differential diagnosis of OVC remains difficult and requires clinical, pathological and IHC evaluation with effective treatment and scheduled follow up.

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Review

JAW MOTION TRACKING SYSTEM AND 3D IMAGING

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Abstract

The review article introduces a groundbreaking software application, SICAT Function, which combines 3D cone beam CT (CBCT) and electronic jaw motion tracking (JMT) data. CBCT, known for its utility in the dental field, offers detailed 3D images of facial and dental structures. The SICAT JMT+ system, based on 3D ultrasound measurements, captures lower jaw movements in all degrees of freedom. The system comprises essential components, including a facebow, lower jaw sensor, SICAT Fusion Bite tray, SICAT Fusion Bite adapter, para-occlusal T-attachment, and application software.

The CBCT device used in conjunction with the SICAT Fusion Bite tray acquires images efficiently with minimal radiation exposure. The acquired CBCT data are reconstructed into 3D images, allowing for precise visualization and analysis. Data acquisition involves the use of silicone impression material, ensuring accurate tracking of jaw movements.

The SICAT JMT+ system records various mandibular movements, including opening, lateralization, protrusion, and chewing, over consecutive days, showcasing its potential for high repeatability. Subsequently, the CBCT and JMT data are merged within the SICAT Function suite.

Keywords: *CBCT, SICAT fusion bite tray,*

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Introduction

The masticatory system is an important part of the craniofacial complex.¹ The temporomandibular joints (TMJs), together with the dentition, the masticatory muscles, the vascular and nervous systems supplying these tissues, constitute the major components of any healthy stomatological system.^{6,7} Jaw recording of the system has been done by gnathologists for the understanding of the normal function of the stomatognathic system and also for the diagnosis and treatment of diseases of TMJs such as temporomandibular disorders (TMDs). The masticatory system is, however, dynamic and the main component lies in the mandible.¹

Various devices have been developed to record and analyse the mandibular movement. Two systems of magnetometry, the mandibular kinesiograph, and the Sirognathograph, which depend on the changes in the magnetic flux occurring when a small bar magnet moves relative to a sensor, have been used to measure mandibular movements in three dimensions for a long time.^{1,2} Optoelectronic tracking systems obtain mandibular movements using cameras to tracking the spatial position of

light-emitting diodes.² They also have an advantage of less disturbing to individual chewing pattern.

Three-dimensional (3D) TMJ morphology is made up of hard and soft tissue structures. These structures have been reconstructed by spiral and helical computed tomography (CT) and magnetic resonance imaging (MRI).^{2,3} Data sets have been merged with 3D TMJ reconstruction by CT and electromagnetic tracking device or optoelectric measuring systems, and ultrafast MRI and jaw movement recordings by optoelectric measuring systems. The main disadvantage of MRI imaging is that the patient is lying supine on the scan bed, which might alter the mandibular movement.^{4,5}

Introduction of new software application, SICAT Function (SICAT, Bonn, Germany), which can directly combine and merge 3D cone beam CT (CBCT) and electronic jaw motion tracking (JMT) data. CBCT, which offers a 3D image of facial and dental structures, has been widely used in the dental field.⁷ The SICAT JMT+ system is an electronic recording system that is based on 3D ultrasound measurements. The ultrasound-based system converts the propagation times of multiple acoustic

signals into spatial information, which therefore could record the lower jaw movements of the patient in all degrees of freedom.⁵

SICAT jaw motion tracking+ tracking system

SICAT JMT+ system mainly includes a facebow, a lower jaw sensor, a SICAT Fusion Bite tray, a SICAT Fusion Bite adapter, a para-occlusal T-attachment, a SICAT JMT+ basic unit, and SICAT JMT+ application software . The facebow has a nose pad to help locate the facebow, an upper headband, and a rear headband to secure the position. It contains six ultrasonic microphones to receive the information from four ultrasound transmitters in the lower jaw sensor .Both the receiver and transmitter modules are connected with the evaluation electronics in the SICAT JMT+ basic unit via a connecting cable. The SICAT Fusion Bite tray is a fiducial transfer tray, and it could be connected to the lower jaw sensor by the SICAT Fusion Bite adapter. There are eight radiopaque markers on the tray, which will serve as landmarks for the fusion of CBCT data and JMT. The paraocclusal T-attachment is attached to the lower teeth and move with the mandibular movement to

make the recording of movement possible and it could be connected to the lower jaw sensor by the magnetic attachment.⁵



Figure 1: Main components of the SICAT jaw motion tracking+ system

Cone beam computed tomography

The CBCT device (Sirona Galileos, Bensheim, Germany) was used, which acquires the images with a scan time of 14 s, capture the maxilla-mandibular region in a 210° rotation, and has a reported radiation dosage of only 29 μ Si to 54 μ Si according to the manufacturer. The field of view is a spherical volume of 15 cm. The voxel size is between 0.15 mm and 0.30 mm, and the grayscale is 12 bit. The voxel size of CBCT scans in this study is 0.30 mm. The acquired CBCT data were transferred from the scanner to a work station where 3D images were constructed by GALAXIS 3D software (Sirona Galileos, Bensheim, Germany). The

data were saved as DICOM (digital imaging and communication in medicine) format⁶

Data acquisition

A CBCT scan was originally taken to examine the condylar status for diagnostic and treatment purposes of patient for TMDs. Considering the TMD problems, the CBCT was taken with the SICAT Fusion Bite in the mouth. To transfer the coordinate system of jaw tracking device is prepared with (1) silicone impression material was put in both the maxillary and mandibular side of the Fusion Bite reference tray, (2) the patient was asked to bite on the impression material, (3) the bite was taken out of the patient's mouth after the impression was done and was trimmed to remove excess materials.⁶



Figure 2: Preparation of SICAT Fusion

Bite and paraocclusal T-attachment

To prepare the tracking, the paraocclusal T-attachment was shaped according to the lower dental arch. Autopolymerizing composite was applied such as Luxatemp to the bending part of the T-attachment, and adapted to the tooth surfaces or to the study model, and it was left to harden. Excess material and sharp edges were removed and it was made sure that the upper teeth and the SICAT Fusion Bite are not in touch with the paraocclusal T-attachment.⁷

The facebow was positioned stably on the patient's head making sure that the upper headband was on the patient's skull, and the nose pads were not too tight to stretch the skin in the nasion area, and the elastic rear headband was tightened comfortably for the patient. The SICAT Fusion Bite was placed in the mouth and the patient was asked to bite into the impression. The occlusion was checked by examining if the teeth were in the right position of the impression and stability was checked by moving the Fusion Bite. The paraocclusal T-attachment was mounted firmly in the patient's mouth using medical acrylicglue such as Histoacryl.



Figure 3: Device on the patient's head.

(a) The SICAT Fusion Bite in mouth. (b) The paraocclusal T-attachment attached to the lower arch in mouth. (c) The facebow was stably positioned on patient's head. The lower jaw sensor was attached to the SICAT Fusion Bite. Later, the lower jaw sensor would be attached to the paraocclusal T-attachment.

The software SICAT JMT was started.



First, the SICAT JMT lower jaw sensor was attached to the SICAT Fusion Bite



“Record” was clicked and the software guided the program.



The position relationship between the upper jaw and the head was recorded.

The SICAT Fusion Bite was left in mouth and the lower jaw sensor was attached to the paraocclusal T-Attachment and then “record” was clicked. The original position between the mandible and the head was recorded. The SICAT Fusion Bite was removed. Then, the functional jaw movement such as opening, right and left lateral movement, protrusion, and chewing were recorded. The jaw movements including opening, right and left lateral movement, and protrusion of this participant on day 1(T1), day 2 (T2), and day 3 (T3) were recorded.⁷

Data fusion

The CBCT data and JMT files were loaded in the software SICAT Function suite. Axial slices were scrolled through until at least one spherical radiopaque marker was shown, marker was marked, and it was repeated until three spherical markers were marked [Figure 4a]. All eight radiopaque markers were automatically found after three radiopaque markers on the Fusion Bite tray were identified, and the tray was located. Then, the CBCT and JMT data was automatically merged.

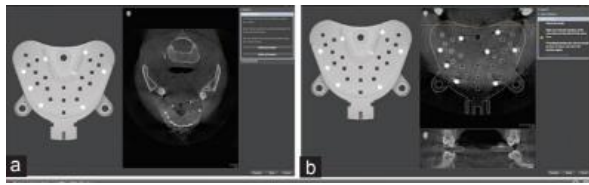


Figure 4: Merge of cone beam computed tomography and jaw moving tracking data and segmentation of the mandible.

(a) Scroll through the axial slices until at least one spherical radiopaque markers is shown, mark the marker, and repeat until three spherical markers are marked.

Segmentation of mandible

Segmentation of the mandible could be performed semi-automatically in the software. When the approximate position of the mandible was indicated by drawing marks on the radiographic sectional slices, the software calculated the data, and presented a 3D image of the cropped mandibular segment on the screen .

The blue color was used to represent the mandible and the green color for the fossa. The procedures for dynamic real-time jaw tracking and CBCT simulation are summarized

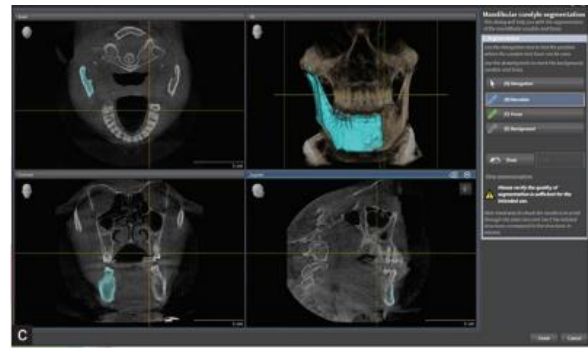


Figure 5: Merge of cone beam computed tomography and jaw moving tracking data and segmentation of the mandible.

(a) Scroll through the axial slices until at least one spherical radiopaque markers is shown, mark the marker, and repeat until three spherical markers are marked. (b) All of the eight radiopaque markers were automatically found after three radiopaque markers on the Fusion Bite tray were identified, and the tray was located. (c) Segmentation of the mandible

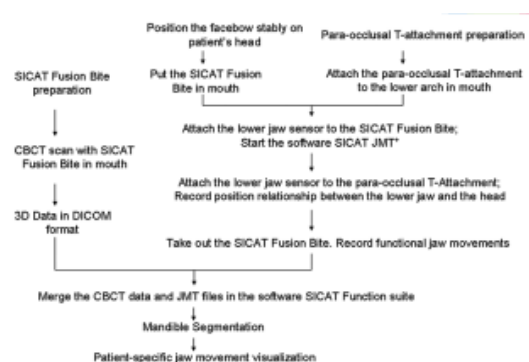


Figure 6: The procedures for dynamic real-time jaw tracking and cone beam computed tomography simulation

Recording of mandibular movement by SICAT jaw motion tracking+

Mandibular movements, including opening, right/left lateralization, and protrusion were recorded. The incisor ranges of these movements were automatically displayed. The movements were observed in dynamic mode and from different angles. The tracings of opening, right lateral movement, left lateral movement, and protrusion in selected planes are presented in Figures 6-9. It can be seen from images and recording radios that the mandible shifted to the right when opening and protrusion. The movements of the left and right lateralization were not symmetrical. From the results of the 3 continuous days, the mandibular movements of the patient were similar on the different days but not exactly the same. Merge cone beam computed tomography and jaw motion tracking data in SICAT function suite. The CBCT reconstructed mandible was successfully segmented.⁷

In addition, the segmentation of the glenoid fossa was also successfully completed. After merging the CBCT and JMT data, the visualization of patient-specific movement of the mandible including the translation of the condyles was displayed. In the dynamic

mode, the movement path of any selected point on the condyle and the mandible body such as interincisal point movement of the lower mandibular teeth were depicted on the simulation. Selected simulation images of the movement are presented in Figures 10-12. Based on the anatomical information provided by CBCT data and movement information by the JTM data, we could observe the movement of the condyle in the patient's fossa. The precision of the simulated condylar position. According to the simulation of condylar movement presented by the SICAT Function Suite, the extensive displacement of the condyle during opening was noticed. It raised a question that whether the positions of the condyle stimulated by the SICAT Function according to the CBCT data and the JMT data are correct. While the patient had pain in her left joint and was treated in the Prosthodontic Department, another CBCT was obtained to record her condyle status with mouth open after the muscle deprogramming treatment. We loaded the second CBCT data into the SICAT Function Suite, segmented the mandible and fossa, and the condyle position was therefore showed. We compared the simulated condylar position by SICAT Function with the real condyle position in the

second CBCT. When the mouth opening distances were the same, the condylar positions were coincident with each other Figure 3, which indicated that the predicting and the presentation of condylar movement by SICAT Function suite were accurate and reliable.⁷

Real-time recording of mandibular movements

Jaw tracking devices and methods in the past have greatly improved the understanding of masticatory system and mandibular movements. However, more sophisticated technology has made it easier, but methods are still needed for accurate evaluation and extensive exploration of the normal and pathological functions of TMJs. This article demonstrated the use of SICAT Function software (SICAT, Bonn, Germany) and how it creates dynamic real-time JMT data with individual imaging data and provides visualization of true mandibular movements. The ranges of the movements are easily obtained and are instantaneously presented after the recording. In addition, the simulation images and the entire tracking data of the movements of the mandible are clearly presented. The recordings over 3 sequential days showed that this method may

have high repeatability. Although the data is not exactly the same, the possible reason for this might be that the patient has TMD problems, and the movement is not stable. Further studies are needed to validate its accuracy. The introduction of cone beam computed tomography and SICAT jaw motion tracking+ system Compared with conventional CT, CBCT has the advantages of lower radiation dose, improved image accuracy, shorter scanning time, and less image artifacts.¹² It will therefore reduce the radiation exposure to the greatest extent. In many dental hospitals and clinics, CBCT has become a routine examination before orthodontic treatment. Although the previous study has used 3D CT to reconstruct maxillofacial skeletal 3D images and to achieve patient-specific mandibular movement analysis,⁶ the use of CBCT has not been reported yet. The SICAT JMT+ system consists of an arc-shaped upper jaw sensor consisting of six ultrasonic receiver microphones on the head bow and an arc-shaped lower jaw sensor with four transmitter modules. During the recording, the ultrasonic transmitters on the lower jaw sensor continuously emit impulses, and the system measures the operating time between the transmitters and receiver microphones;

then, calculates the absolute room coordinates of the markers using a triangulation method, and thus converts the propagation times of multiple acoustic signals into spatial information. The system records mandible positions relative to the head at rest and during movements, so head position and head movement have no clinical impact on the results. It then will be much more convenient and accurate when it is used for clinical and research purposes. Besides, the simple components and free movement of the lower jaw sensor in SICAT JMT+ system enable it to measure all the mandibular movements including chewing in all degrees of freedom. The position of condyle during movement. The condylar movement is more difficult to be observed because of the anatomy of the TMJ. Relying on the CBCT reconstructed condyle, and the JMT recorded data, the condylar displacements during different mandibular movements were clearly demonstrated by the software. After comparing with condylar position in the second CBCT, the result indicated that the condyle position was precisely predicated at rest and during movements by the SICAT Function software. This provides a visualization of the condyle in the joint fossa without taking additional CBCT records.

Future directions The SICAT Function software provides measurement and visualization of mandibular movement. Furthermore, it provides a way to predict the position of condyle without extra radioactive exposure when the tooth is in specific occlusion. Further studies can verify the repeatability of SICAT Function software and use the system to study the movement of healthy and diseased TMJs, to diagnose patients with jaw deformities and to help the treatment of TMJ problems.⁷

The SICAT Function software is a system capable of measuring and visualizing patient-specific jaw movement relative to the patient-specific anatomy of the jaw. Further studies are needed to validate its accuracy and its potential for future use.⁷

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Review

BIOPRINTING: A PARADIGM SHIFT IN PROSTHODONTICS AND MAXILLOFACIAL PROSTHESIS

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Abstract

This review article provides a comprehensive exploration of how bioprinting technology is reshaping dentistry, specifically in the realm of dentofacial and maxillofacial rehabilitation. The article delves into the applications, benefits, challenges, and future implications of using 3D bioprinting to create patient-specific oral and craniofacial structures. It highlights the potential for enhanced patient outcomes in terms of both functionality and aesthetics, while also addressing hurdles such as vascularization and regulatory considerations. The article is accessible to both experts and newcomers to the field, serving as a valuable resource for understanding the transformative role of bioprinting in the future of dentistry.

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Introduction

Additive manufacturing represents a paradigm shift in manufacturing at the individual patient level. Computer-aided systems employ algorithms to design customized, image-based scaffolds with high external shape, complexity and spatial patterning of internal architecture guided by topology optimization. 3D bioprinting and surface modification techniques further enhance scaffold functionalization and osteogenic potential through the incorporation of viable cells, bioactive molecules, biomimetic materials and vectors for transgene expression within the layered architecture.¹

3D Bioprinting, a combination of 3D printing and tissue engineering is a rapidly expanding technology in the field of regenerative medicine for autograft production. It is an additive manufacturing process in which there is computer-aided deposition of living cells with extracellular matrix (ECM) components with a biomaterial in particular combinations, for the fabrication of 3D biologically active tissue. The emergence of 3D bioprinting in prosthodontics and maxillofacial prosthesis has opened new

horizons for innovative and personalized solutions. It has remarkably enabled fabrication of patient-specific prosthetics and enamel, dentin and alveolar bone structures mimicking the natural structures. It holds potential for tissue regeneration by rejuvenating periodontal tissues, bone, cartilages, and other dentofacial and maxillofacial structures. The amalgamation of stem cells and 3D bioprinting further enhances aesthetics and functional quality, pleasing dental solutions. The field of bioprinting is rapidly evolving as researchers innovate and drive the field forward.

Method of bioprinting

3D bioprinting follows a three-stage process:^{2,3}

1. Pre-processing: CAD tools design the model's micro and macroarchitecture for precise layer-by-layer deposition.
2. Processing: Bioink is printed using a bioprinter, adhering to controlled parameters to shape the structure.
3. Post-processing: Printed models mature in an incubator with growth factors and culture medium, enhancing viability and function.

Bioprinting techniques:⁴

Several bioprinting techniques are being explored:

1. **Extrusion-Based Bioprinting:** This method involves depositing bioink, a mixture of cells and biomaterials, layer by layer. For maxillofacial prostheses, bioinks composed of biocompatible polymers and patient-specific cells can be used to recreate complex anatomical structures.
2. **Inkjet Bioprinting:** Inkjet printers are modified to deposit tiny droplets of bioink onto a substrate. This technique offers high resolution and the potential to mimic fine details in facial features.
3. **Laser-Assisted Bioprinting:** A laser is used to generate a pressure wave that pushes cells and bioink onto a substrate. This technique enables precise placement of cells and is suitable for delicate structures.

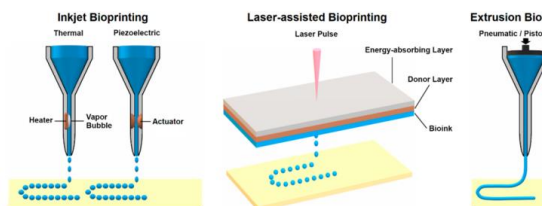


Figure1-: Laser associated Bioprinting

Materials:

Choosing appropriate biomaterials is crucial for successful bioprinting.

Selection criteria:

- ✓ Biocompatibility
- ✓ Printability
- ✓ Material biomimicry
- ✓ Mechanical and structural properties

Biomaterials⁶

- Bioceramics
 - Calcium phosphate
 - Hydroxyapatite
 - Bioglass
- Biopolymers
 - Alginate
 - Biogenic polyphosphate
 - Biogenic silica
- Composites
 - Calcium phosphate/collagen
 - Hydroxyapatite/polyamide
 - Cell-hydrogel
 - Other composites



- Metals
 - Titanium

Bioink:

The process of 3D bioprinting incorporates bioink, a solution or a blend/mixture of biomaterial preferably hydrogel that encapsulates the desired cell types, and creates tissue constructs⁷. These materials imitate the surrounding extracellular matrix environment, fostering the attachment, propagation, and distinct development of living cells.

Ideal requirements:

- Accuracy, rapid and controlled layered deposition
- Biocompatibility
- Adequate mechanical strength
- Adjustable gelation and stabilization properties
- Suitable for chemical modifications
- Biodegradability

Types of bioinks: ⁸

- ✓ Natural biomaterial based bioinks
- ✓ Synthetic biomaterial based bioinks
- ✓ Cell aggregate/pellet- based bioinks
- ✓ Commercial bioinks
- ✓ Composite bioinks/ bioinks with bioactive molecules.

Application of 3D bioprinting in prosthodontics and maxillofacial prosthesis

1. Customized Dental Prosthetics: Bioprinting allows for the creation of patient-specific dental prosthetics, such as crowns, bridges, and dentures. By accurately replicating the patient's oral anatomy, bioprinted prosthetics ensure optimal fit, comfort, and aesthetics.
2. Implant Abutments: Enables the fabrication of custom implant abutments, the connectors between dental implants and prosthetic restorations. Precisely matching the implant site ensures a secure fit and efficient load distribution.

3. **Guided Bone Regeneration:**
 Bioprinting can create scaffolds with intricate geometries that facilitate bone regeneration. These scaffolds provide a platform for new bone growth and can be used in procedures such as ridge augmentation and sinus lifting.
4. **Bite Splints and Night Guards:**
 Bioprinting can produce personalized bite splints and night guards that precisely match the patient's occlusal profile. This enhances their effectiveness in managing bruxism and temporomandibular joint (TMJ) disorders.
5. **Application of 3D bioprinting in related dental areas**

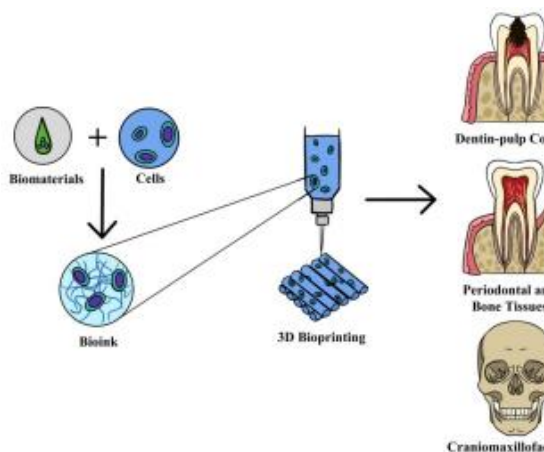


Figure 2:- Application of 3D bioprinting in related dental areas

1. Gingival Tissue Regeneration
2. Periodontal Ligament Reconstruction
3. Alveolar bone regeneration
4. Dentin regeneration.
5. Cartilage regeneration.
6. Guided Bone Regeneration
7. Composite Restorations

Application of bioprinting in non- dental areas include educational models, drug delivery systems and research and development.

Advantages and benefits of Bioprinting:

1. Patient-Specificity
2. Functional Restoration
3. Aesthetic Accuracy
4. Reduced Production Time

Challenges of bioprinting:

- Bioink Development
- Cell Viability
- Regulatory Approvals

Advancements and future outlook of bioprinting:

- 4D Bioprinting
- Soft Robotics
- Organ-on-a-Chip
- Vascularized Tissues

Conclusion:

Bioprinting holds immense potential for transforming the field of prosthodontics by enabling patient-specific, functional, and aesthetically pleasing restorations. While advancements have been made in terms of technique and material development, challenges related to tissue mimicry, cell viability, and regulatory approval must be addressed. The integration of bioprinting into prosthodontic practice has the potential to revolutionize the way dental prosthetics are designed and fabricated, ultimately improving patient outcomes and quality of life.

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Short Communication

EXPLORING BEYOND GRADES: A PARADIGM SHIFT IN STUDENT ASSESSMENT

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Abstract

Student assessment refers to the systematic evaluation of students' capabilities and accomplishments. Assessments are tools and techniques used by educators to measure a student's knowledge, skills, and abilities. They provide valuable insights into a student's progress and can inform teaching strategies.

Key words; *Summative Assesment, Formative Assesment, Self Assesment*

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Introduction

The idea of student assessment has experienced significant evolution in recent years. Student evaluation has evolved beyond the traditional methods of assessment, such as simple tests or pen-and-paper-based examinations. Currently, student evaluation encompasses a significantly broader spectrum of educational initiatives. Effective student assessment is an essential aspect of delivering high-quality education, as it necessitates educators to enhance their

efficiency and effectiveness in order to facilitate optimal academic achievement for all students.

Student assessment refers to the systematic evaluation of students' capabilities and accomplishments. Classroom instruction is an ongoing, uninterrupted, and daily endeavor that holds utmost significance in facilitating successful teaching. By correlating student outcomes with predetermined learning goals, teachers can gauge their own efficacy as educators. Teachers can then

systematize their best instructional decisions and modify their less effective ones.

What is assessment & why is it important??

In simpler terms, assessment refers to the comprehensive approach of collecting data to determine what students know (knowledge) and are able to do (performance).

Assessments have a crucial role in shaping the learning process at various stages, providing valuable insights on students' acquisition of knowledge and skills. Leveraging assessments as a means of providing feedback to teachers yields significant efficacy. The optimal utilization of this capacity is achieved when the evaluations are conducted in a timely manner, providing valuable insights and aligning with the content being taught by educators.

Collecting data regarding where students are in their learning and the progress they have made is essential for the development of strategies to further enhance teaching and learning in schools. A well-designed student assessment can also facilitate

agreement on educational objectives, standards, and criteria for measuring proficiency. They can promote innovation in education by emphasizing the types of learning that are regarded as valuable.

Assessment is More than Grading

Educators sometimes mix the concepts of assessment and grading. The current situation can be characterized as an error or oversight. It is imperative to comprehend that student assessment encompasses a broader scope beyond just grading. It is important to note that assessment serves the purpose of establishing a connection between student performance and specified learning objectives, with the aim of furnishing teachers and students with valuable insights on student progress.

Traditional grading, on the other hand, according to Stassen et al., does not provide the level of detailed and specific information essential to linking student performance with improvement. “Because grades don’t tell you about student performance on individual (or specific) learning goals or outcomes, they provide little information on the overall success of your course in helping students attain the

specific and distinct learning objectives of interest.”

Types of assessment

Assessments are tools and techniques used by educators to measure a student's knowledge, skills, and abilities. They provide valuable insights into a student's progress and can inform teaching strategies. There are various types of student assessments, each serving specific purposes. Following are some commonly used methods of student assessment:

Types of assessments are:

1. **Summative assessments**
2. **Formative assessments**
3. **Ipsative assessments**
4. **Norm-referenced assessments**
5. **Self assessment**

1. **Summative assessment (AOL- Assessment of learning)**

The objective of a summative assessment is to evaluate the learning outcomes of students. It serves to provide information regarding student performance as well as to select or group students based on their abilities. Additionally, summative

assessments play a role in certifying learning and awarding qualifications.

The commonly used methods are

- in-class examinations,
- standardized tests.
- projects,
- performance assessments,

Typically, the responsibility of conducting assessments lies with educators, while students assume a passive role in the assessment processes. The purpose of these tests is to determine the extent of a student's knowledge, and so they consist largely of closed-ended questions while also including some open-ended items to gauge the student's ability to apply concepts and engage in critical thinking. A salient feature of summative assessments is that they can be graded and are typically administered at the conclusion of a course, unit, or academic year to assess the cumulative learning outcomes. Since they aim to determine whether students have mastered the material or achieved specific learning objectives, these

assessments are often high-stakes, meaning they carry significant weight in grading and decision-making processes.

Summative assessments commonly fulfil the purpose of evaluating student learning. However, it is worth noting that these assessments also possess the potential to provide educators with valuable insights into the efficacy of their instructional approaches and curriculum.

2. Formative assessments (AFL- Assessment for learning)

Formative assessment is a type of ongoing evaluation in education that is designed to provide feedback and information to both educators and students during the learning process.

The primary purpose of formative assessment is to inform instruction, identify areas for improvement, and support student learning as it is happening. Therefore, formative assessment is typically not graded. There are two distinct forms in which it may manifest: spontaneous, which involves immediate question-and-answer interactions during instructional sessions,

and planned, which encompasses structured activities like quizzes and homework assignments aimed at evaluating student advancement.

Educators have a crucial role in delivering feedback and conveying information regarding students' academic achievements. However, it is important to acknowledge that students themselves also hold significant responsibility within the assessment process.

Commonly used formative Assessment tools used by teachers are

- Observations
- Homework
- Feedback sessions
- Peer tutoring
- Question-and-answer sessions
- Integrated approaches to learning and teaching,

These tools facilitate the practice of deep learning, foster the cultivation of critical thinking skills, and encourage active student engagement and the seamless progression of learning experiences.

3. Ipsative assessments

Ipsative assessment is a type of assessment that is often used to measure an individual's progress or growth over time, particularly in comparison to their previous performance. It allows students to be motivated to set goals and improve their skills. A two-stage assessment framework helps students learn from their mistakes and motivates them to do better. Plus, it removes the instant gratification of goals and teaches students that learning is a process rather than a final result.

There are some great advantages to following an ipsative assessment strategy, such as

- To encourage improvement and self-awareness. It provides valuable feedback for individuals to reflect on their strengths and areas for development.
- Ipsative assessments are self-referenced, meaning they compare a person's current performance to their past performance.
- Do not involve comparing individuals to external standards or the performance of their peers.

Instead, they assess how an individual's skills, knowledge, or abilities have changed over time.

- Can adapt to an individual's starting point and pace of development. They are particularly useful in contexts where each person has unique learning goals and trajectories.

4. Norm-referenced assessments

Norm-referenced assessments are a type of standardized test or evaluation method used in education and other fields to compare an individual's performance to that of a larger group, known as the "norming group" or "reference group." These are typically grounded in nationwide standards and occasionally modified to account for factors such as age, ethnicity, or other demographic variables. Rather than testing a person's absolute knowledge or competence, norm-referenced examinations primarily aim to discover where a person sits in relation to their peers.

Key features of norm-referenced assessments include

- Assessments are carefully standardized to ensure consistency

in administration, scoring, and interpretation. This standardization helps ensure that results are comparable across different test takers.

- Results are often reported in terms of percentile ranks, which indicate the percentage of test takers in the norming group who scored lower than the individual.
- The norming group ideally represents a diverse cross-section of the population to ensure fairness and accuracy in comparisons.

Examples of norm-referenced assessments include:

- College admissions tests like the SAT and ACT
- Standardized achievement tests, such as state assessments
- IQ tests
- Employment aptitude tests

5. Self assessment

Self-assessment can be defined as the process in which students engage in a descriptive and evaluative act wherein they reflect upon and evaluate their own work

and academic ability. There exists a diverse range of mechanisms and techniques by which students can assess and potentially evaluate the characteristics of their individual learning processes and outcomes.

Self-assessment holds significant value in facilitating personal growth, fostering development, and promoting self-awareness. It is a versatile tool that can be utilized across several domains, including schooling, professional pursuits, interpersonal connections, and other relevant fields.

Some key features of self-assessment include

- Individuals take the time to think critically about their strengths, weaknesses, achievements, and areas in need of improvement.
- Through a comprehensive assessment of their existing skills and a critical analysis of areas in need of enhancement, individuals can effectively develop attainable and realistic objectives and targets.

- Individuals evaluate their emotional self-awareness, self-regulation, empathy, and interpersonal skills.

Self-evaluation is not a one-time event but an ongoing process. Individuals can benefit from revisiting their self-evaluation on a regular basis in order to track progress, modify objectives, and adapt to changing circumstances.

Developing an ideal evaluation procedure

The process of selecting an appropriate student assessment requires a thorough examination of multiple aspects to guarantee that the assessment accurately evaluates the desired learning objectives and offers meaningful remarks regarding student achievement.

Setting clear goals for learning

Defining the specific learning objectives or outcomes you want to assess is the first and foremost step in a meaningful assessment. Objectives should be aligned with the course or program's final goal. An effective assessment can be attained through the development of extensive rubrics and

grading criteria that clearly delineate the anticipated standards for performance or responses. It is advisable to provide this information to students prior to the assessment in order to offer them a clear understanding of the evaluation criteria.

Assessing a Spectrum of Skills

The assessment process should not be limited to a superficial study of the content that students have received throughout the course. It is important to ensure that assessments encompass a variety of cognitive skills, such as knowledge recall, comprehension, application, analysis, synthesis, and evaluation. Additionally, it is important to consider the development of interpersonal skills, critical thinking capabilities, problem-solving aptitude, and effective communication talents as deemed suitable for the given context.

Aligning evaluation procedures with the goal

The importance of balancing assessment methodologies is a critical aspect of the evaluation process. It is advisable to employ a diverse range of assessment methods, such as formative, summative,

and ipsative assessments, in order to analyze various dimensions of the learning process. Utilizing many assessment methods can offer a more holistic perspective on students' abilities, thereby mitigating the potential biases and limits inherent in relying solely on a singular assessment approach.

Ensure inclusion and fairness.

It is vital to ensure that evaluations are inclusive and accessible to all students, including those with limitations. In the event that individuals require reasonable accommodations, it is necessary to ensure that such accommodations are provided. Additionally, it is important to aim for impartiality in the development of assessment designs and the process of grading. It is essential to promptly and effectively deliver positive comments to students subsequent to their tests. Furthermore, it is important to ensure transparency on the purpose, criteria, and learning outcomes that the assessment aims to evaluate.

Conclusion

In the present context, a significant number of educational institutions and educators prioritize summative assessment as the predominant method of evaluating student performance. Though it is important in education since it provides a glimpse of what students have learned by the conclusion of a specific term, They are most effective, however, when combined with formative evaluations, which provide continuing feedback to both students and instructors, allowing adjustments to instruction and learning tactics during the learning process. Each kind of evaluation serves a distinct purpose in the teaching and learning process. Effective educators frequently utilize a combination of these evaluation styles to acquire a thorough knowledge of their students' development and adjust their instruction to match individual needs.

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Case report

SYSTEMIC SCLEROSIS WITH SJOGREN SYNDROME: A CASE REPORT

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Abstract

Systemic sclerosis (SS) is an autoimmune connective tissue disorder which is characterized by fibrosis of visceral organs, skin and blood vessels. This condition may be localized or systemic. It is characterized by excessive deposition of extracellular matrix in the connective tissues causing vascular disturbances which can result in tissue hypoxia. These changes are manifested as atrophy of the skin and/or mucosa, subcutaneous tissue, muscles, and internal organs. About 80% of the patients present with symptoms in the head and neck region. Dysphagia, trismus, widening of the periodontal space, decrease in facial wrinkles owing to fibrosis of skin, orofacial telangiectasia, and resorption of mandibular angle are some of the changes which may occur in the oral and maxillofacial region. Systemic sclerosis can be associated with Sjogren syndrome. Here, we report a case of systemic sclerosis with Sjogren syndrome.

Key words: *Systemic Sclerosis, Sjogren Syndrome, Autoimmune Disease, Xerostomia, Arthritis*

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Introduction

The word scleroderma originates from Greek words “scleros” meaning hard and “derma” which means skin.¹ The first description of this disease as a separate pathological entity was given by Carlo Curzio of Naples in 1752 and its first name, “sclerodermie,” was given nearly a century later by Gintrac in 1847. For years, the disease was thought to be a dermatological disorder but after its distinctive characteristic of systemic involvement was proven, Goetz coined the term “progressive systemic sclerosis” in 1945.² Systemic sclerosis (SS) is a connective tissue disorder which is characterized by fibrosis of the skin, internal organs and blood vessels. It is categorized into two subgroups which are described as systemic and localized. Systemic sclerosis differs from localized scleroderma because it is accompanied by Raynaud’s phenomenon, acrosclerosis and involvement of the internal organs.¹

Normal collagen type I and III are thought to be deposited excessively at various tissues by immunologically over-activated fibroblasts.

Although the etiology of systemic sclerosis is not clear, genetic and environmental factors have been held responsible for the onset of this condition. First degree relatives of SS patients have a high probability of developing the disease. Silica powder, vinyl chloride, L-tryptophan, silicone breast implants and organic solvents are among the environmental factors which were suspected to cause this condition.¹

SS has been associated with orofacial manifestations including microstomia, xerostomia, tooth decay and periodontitis.³ SS is mostly seen in women whose ages are between 30 and 50 and its prevalence is 250 cases in a million. SS causes various changes at the oral and facial tissues both clinically and radiographically. Radiographic changes in SS patients are the widening of periodontal space, loss of lamina dura, and resorption of the mandibular angle.¹ The first specific clinical sign of SS is the swelling on the skin of hands and fingers. The aim of this case report is to present clinical findings and investigations of a patient diagnosed as having SS with Sjogren syndrome.

Case report

A 31-year-old female patient was referred to Oral and Maxillofacial Radiology Department, for difficulty in opening the mouth. She had history of acute parotitis and had undergone treatment before 1 month and was also on medication for rheumatic arthritis for 4 months. Extra-oral examination showed that the patient had difficulty to open her mouth.

Pigmentation with decreased number of wrinkles was also observed on the skin (Figure 1&2). Diffuse fibrosis of the buccal and labial mucosa with areas of hypo and hyperpigmentation giving a mosaic pattern (Figure 3) was also noticed. Multiple carious teeth and decreased salivary flow was noted on intra-oral examination. Panoramic radiography revealed there was no widening of periodontal ligament space or bone resorption (Figure 4). ANA profile was positive for anti URNP (antinuclear ribonucleoprotein, autoantibodies), anti CENP- B (anti-centromere protein), anti RO (anti-Sjögren's-syndrome-related antigen A anti SSO) which were consistent with

scleroderma with secondary Sjogren syndrome.



Figure 1: Increased pigmentation of skin



Figure 2: Decreased wrinkles on skin



Figure 3: Mosaic pattern of labial mucosa



Figure 4: Absence of periodontal ligament widening that is usually seen in systemic sclerosis

Discussion

SS is an autoimmune disease in which the antibodies target blood vessels and connective tissues.¹ Involvement of the facial skin by subcutaneous collagen deposition

results in the characteristic smooth, taut, mask-like facies. Similarly, the nasal alae become atrophied, resulting in a pinched appearance to the nose, called a "mouse" facies³ with characteristic furrows radiating from the mouth produce a "pursestring" appearance.

Excessive collagen deposition in the cutaneous tissues around the mouth causes microstomia which prevents the patient from opening and closing the mouth. Additionally, mandibular movements may be limited secondary to muscular fibrosis.⁴ Limited mouth opening (LMO) was found in 229 cases (69.8%), mainly in women (88.6%). It occurred early (1 year on average) after the diagnosis of SS. The youngest patient with LMO was 12 years old. LMO lasted up to 33 years after the diagnosis. Our patient also had limited mouth opening. Dysphagia often develops as a result of deposition of collagen in the lingual and esophageal submucosa, producing a firm, board-like hypomobile tongue and an inelastic esophagus, thus hindering swallowing.⁵ Widening of periodontal ligament was found in 67.3% of the cases, mainly in women, and occurred 1 to 33 years after the diagnosis of SS. Our

patient did not have widening of periodontal ligament space. Xerostomia was found in 63.4% of the cases and seemed to appear later than the previous oral manifestation, 4 years on average after the diagnosis of SS. It was also seen mainly in women. Our patient also had xerostomia. The fibrosis of the salivary glands determines reduced salivary flow, negatively impacting mastication and nutrition. Xerostomia aggravates dysphagia and impairs natural oral self-cleaning, thus raising the incidence of tooth decay, erosions, periodontitis and candidiasis.⁶ SS is also associated with secondary Sjogren syndrome. Our patient had Sjogren syndrome and a history of parotitis due to xerostomia. Telangiectasia of the oral mucosa was found in 36.2% of the cases, mainly in women.⁽⁷⁾ Loss of attached gingival mucosa and multiple areas of gingival recession may occur in some patients. High prevalence of periodontitis has been speculated to be related either to vasculopathy or to reduced mouth opening or due to xerostomia.

Joint pain is a frequent presenting feature of this disease. Joint symptoms have been noted in 12 – 66% of patients at the time of diagnosis and in 24 – 97% of patients at

sometime during the course of their illness. Histological evidence of synovitis has been found in upto 66% of synovial biopsies from patients with SS.⁶ Our patient also had joint pain and was under medication for arthritis.

On dental radiographs, diffuse widening of the periodontal ligament space is often present throughout the dentition, especially around the posterior teeth or soft tissue calcifications mimicking intraosseous lesions.⁸ Mandibular resorption either at the angle of the mandible, condyles, coronoid process or digastric region is a result of the increased pressure associated with the abnormal collagen production in the masticatory muscles.

In advanced stages resorption of the terminal phalanges (aero-osteolysis) and flexion contractures produce shortened, claw-like fingers and deformities, known as “sclerodactyly”. Progressively thin overlying skin of the fingers becomes prone to ulceration due to vascular events and the abnormal collagen deposition.

Fibrosis of the lungs, heart, kidneys, and gastrointestinal tract leads to organ failure. Pulmonary fibrosis is particularly significant,

leading to pulmonary hypertension and heart failure, a primary cause of death for these patients.

Mild variant of this condition, called localized scleroderma usually affects only a solitary patch of skin. Because these lesions often look like scar, coup de sabre ("strike of the sword") is used to describe them.

Lab test for systemic sclerosis ^{7,8}
Complete and differential blood count
Serum creatinine
Creatine Kinase (CK)
Urinalysis
Antinuclear antibody (ANA)
Anti- topoisomerase I (anti -sci-70) antibody
Anticentromere antibody (ACA)
Anti -RNA polymerase III antibody

Table 1: Investigations for systemic sclerosis

Treatment for scleroderma is selected and organized according to the affected organs. There is no consensus on the treatment protocol. Although being controversial, penicillamine has been used to inhibit collagen deposition. Corticosteroids have no effect on the progression of the disease.¹

Good oral care is essential for patients with systemic sclerosis helping them to keep the mouth free of dental caries and periodontal diseases. It is advised that patients with scleroderma should visit the dentist and dental hygienist at least once in three months to ensure the maintenance of good oral health care.⁹ Systemic sclerosis can give rise to various oral problems, most commonly limited mouth opening. Mouth-stretching and oral augmentation exercises have been proven successful in increasing mouth opening by 3-5 mm in microstomic patients. Bilateral commissurotomy, a surgical procedure used to increase the size of the labial opening, may be indicated in selected patients.⁶ Xerostomia and increased frequency of dental caries might be seen due to the secondary Sjögren syndrome.

A panoramic X-ray is necessary to show the possible widening of the periodontal ligament space, to appreciate any bony loss and to assess if any further examinations should be performed.⁴ Blunting of mandibular angles leads to radiographic features which are described as "tail of the whale".¹⁰ Rarely, mandibular resorption can lead to pathologic fractures.

Conclusion

Scleroderma is a systemic disease which causes significant radiographic and clinical changes in the oral and maxillofacial structures. Dental professionals must be aware of these changes since xerostomia and limited mouth opening are especially important for the right diagnosis and treatment. Multidisciplinary approach is of utmost importance for the scleroderma patients because of the complications of the disease.

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Review

DIGITAL DENTURES

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Abstract

This review article provides a comprehensive review that underscores the potential for combining conventional and digital approaches to enhance efficiency and patient acceptance in denture fabrication. Open digital systems allow dental professionals to embrace digital technology seamlessly, ushering in a new era of precision and convenience. The article highlights the numerous benefits of digital dentures, such as reduced clinical visits, simplified laboratory steps, improved retention and fit, and enhanced material properties. Traditional methods of complete denture fabrication have been fraught with complexities and inefficiencies, often resulting in inaccuracies and multiple clinical appointments. In contrast, the integration of computer-aided design and computer-aided manufacturing (CAD/CAM) technology in dentistry has ushered in a new era of digital dentures, streamlining the fabrication process and significantly improving precision.

Key words: *Digital Dentures, Digital Technology*

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Introduction

In the past decades, dentists have used the conventional method for complete denture fabrication, which is complicated, difficult, and time consuming.^{1,2,3} The conventional method uses functional impression, cast pouring, wax rim fabrication, mounting the models in an articulator, and curing the denture. The conventional process is associated with human processing errors, inaccuracies, and multiple clinical appointments. Recently, computer-aided design and computer-aided manufacturing (CAD/CAM) technology was applied to the fabrication of complete dentures. The introduction and evolution of computer-aided technology can overcome the complications related to the conventional method, thereby facilitating the fabrication process.⁴ The process of fabricating complete dentures with digital technology involves digitization of clinical information registered from the patient's mouth, digital designing of complete dentures on computer software, and an automatized process of manufacturing. The high accuracy of digitalized dental fabrication has been proved by several studies compared to conventional methods.⁹

This review describes the CAD/CAM fabrication of complete dentures based on digital impressions of edentulous jaws obtained using an intraoral scanner.

Intraoral scanning -

Use of Intraoral Scanners in Digital Denture Fabrication

Recently, few preliminary studies have suggested using intraoral scanners (IOS) for recording the denture-bearing tissues of edentulous patients. The listed advantages of IOSs include the capability of registering a truly mucostatic (no pressure) impression, decreased patient discomfort, elimination of stresses associated with impression deformation, and efficient space utilization. However, the scan accuracy is affected by the length and distribution of the edentulous area, the skill of the operator, and the size of the IOS tip.

Digital dentures- Digital Complete Dentures Computer-aided design and computer-aided manufacturing (CAD-CAM) technology has been successfully used for the fabrication of fixed prostheses for the last two decades.⁴ However, the application of this technology to the fabrication of removable complete dentures has only recently come to light.⁴



Since the last decade, there have been several advances in the technology of digital denture fabrication, a rapid increase in the number of providers, and the development of open digital systems. These systems also permit the in-house fabrication of digital dentures when the milling machines/ printers are available in dental clinics.¹¹ Digital dentures are suitable for all skeletal relationships.¹² Digital complete dentures have superior material properties and several studies have reported very high levels of patient satisfaction with them.

Digital Denture fabrication procedure

First, a trial denture is fabricated. Thereafter, the trial denture is used as a custom tray for the final impression. Finally, a final denture is fabricated by scanning the impression. The digital denture fabrication procedure is as follows:

Trial Denture Fabrication

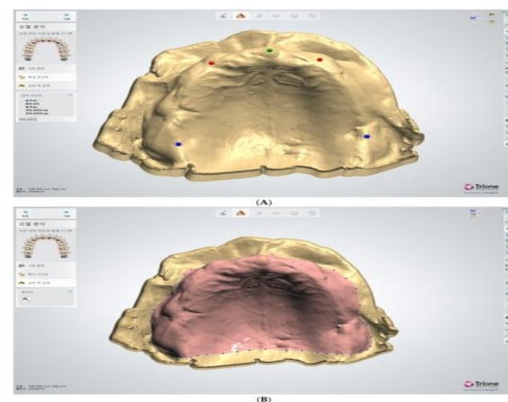
The procedure for fabricating a trial denture is as follows:

Trial denture design

After the images of the edentulous ridge and opposite teeth with the interarch relationship are obtained by recording the digital impression and all the jaw relationships are

recorded using an intraoral scanner, trial denture designing begins using the 3Shape Dental software (3Shape, Copenhagen, Denmark). Anatomic structures (incisal papilla, retro-molar pad, and tuberosities) are identified on the edentulous image to correctly place the teeth.

Thereafter, the limit of the future denture base is drawn. The occlusal plane is determined by considering the jaw relationships, the curve of Spee, and the curve of Wilson. Subsequently, denture teeth are arranged using the denture designing software



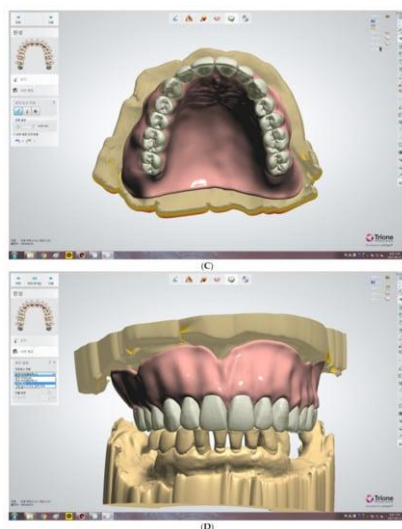


Figure 1: Trial denture fabrication.

a:Anatomic structures are identified on the edentulous ridge image. **b** :Limit of the future denture base is drawn. **c**: Denture teeth are arranged.**d**: Denture base is designed

Fabricating trial denture:

After the design is finalized, the digital STL files are sent to the three-dimensional (3D) printing machine. The trial denture is 3D printed as a monolithic denture, teeth, and base in one unit

Verifying jaw relation with trial denture

At the trial placement, the horizontal and vertical jaw relationships are evaluated with the trial denture.

Verifying vertical relationship: The vertical jaw relationship is evaluated by considering the following aspects:

Midline regarding the maxillary midline being aligned with the center of the nose;

Resting interocclusal distance;

Phonetics and esthetic appearance;

Vertical dimension at the rest position;

Verifying Centric Relation (CR): After verifying the vertical relationship, the patient is guided into CR. Any error in CR will be apparent when the teeth slide over each other; Occlusal adjustment After confirming the CR, occlusal adjustment is carried out to achieve a bilateral balanced occlusion.

Final Impression

Border molding

The trial denture is checked in the mouth to ascertain that the borders are approximately 2 mm short of the vestibular reflections. Border molding is performed by adding a modeling compound to the trial denture borders and moving the tongue, lips, and cheeks for adjustment. The trial denture is adapted closely to the tissues of the vestibule before making the final impression;



(A)



(B)



(C)



(D)



(E)

Figure 2. Final impression using trial denture.

a: Trial denture borders are approximately 2 mm short of the vestibular reflections.

b: Border molding is performed by adding modeling compound to the trial denture borders.

c: Final impression is obtained with the border-molded trial denture.

d: The trial denture is scanned using an intraoral scanner.

e: Scan image of the trial denture.

Recording final impression:

The final impression is made with the border-molded trial denture ([Figure 2c](#)). After obtaining the impression, the denture is removed from the mouth and is scanned using an intraoral scanner ([Figure 2d](#)). The denture scanning area should include all areas of the denture, such as the denture base, border, teeth, and palate ([Figure 2e](#)).

Final Denture Fabrication

Digital images of the trial denture obtained by scanning the final impression are used to design the definitive denture). If any modifications in the jaw relationship or teeth arrangement are required, these are made in

the digital images. After the modifications are made, the definitive denture is fabricated during either milling or 3D printing. In the case of using a 3D printer, it can print the artificial teeth and the pink denture base separately or both in a single unit.

When the artificial teeth and denture base are printed in one unit, tissue-colored composite resin is applied onto the denture flange. In the case of using a milling machine, the denture base is milled from a pink block of prepolymerized cross-linked polymethyl methacrylate (PMMA) disks. The teeth are also milled from the PMMA disk. The milled teeth are securely bonded onto the milled denture base. The monolithic denture is more accurate than the bonded denture because of the lack of bonding processing errors.

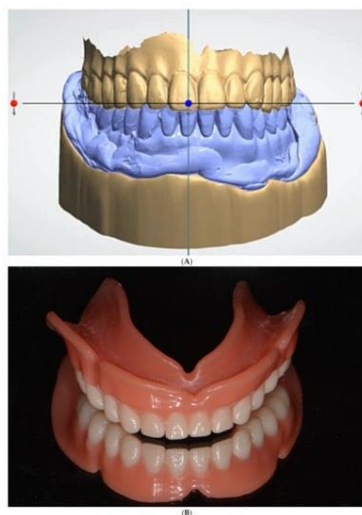


Figure 3. Final denture fabrication.

a: Final denture is designed using the digital images of the trial denture obtained by scanning the final impression.

b: Printed final denture.

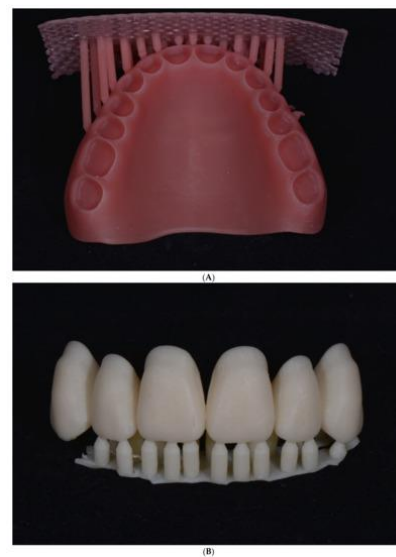


Figure 4. Bonded printed denture.

a: Printed denture base. b: Printed artificial teeth. c: Printed artificial teeth are bonded onto the printed denture base.



(A)



(B)

Figure 5. a: Milled denture base. b: Milled artificial teeth.

Different systems of digital dentures-

- 1) **BALTIC-** The Baltic Denture System process opens up a new way of manufacturing full dentures in a digital workflow. Combining the work steps in the dental practice and processes in the lab into a single workflow stands for quality and

economy. It's a shortened process with only 3 appointments needed.

- Less manual work,
- predictable results,
- high-quality materials and reproducibility,
- reduced allergenic potential,

are the quintessence of this innovative concept.

2) AVADENT-

AvaDent™ is the first to introduce a digital prosthetic using Computer-Aided Engineering (CAE). CAE is a process that goes far beyond mere CAD/CAM fabrication by developing sophisticated, scientific algorithms to create a comprehensive digital platform.

This digital platform drives a level of control and consistency never before possible while ensuring that all clinical protocols are met. With AvaDent,™ the dental professional has the ability to create a prosthetic completely within a digital environment. AvaDent™, whose name is derived from Ava meaning rebirth and Dent meaning dentition, allows dentists to offer a digital denture based on accepted clinical protocols, using standard



clinical procedures, with no computer skills or capital investment required.

3) DENTCA-

The benefits of using DENTCA system is as follows:

Only 1 patient visit needed before Try-in denture processing. • Total chair time: 90 mins. (Dentca) vs. 5+ hours (conventional). • No initial Investment necessary. (Except for tray purchase). • Deliver 100% accurate final dentures from just one impression. • Provide replacements or re-orders with no additional chair time. • Accurate design with CAD technology. • Advanced manufacture process allows for less distortion. • Comfortable to wear.

4) GENEVA PROTOCOL-

This manufacturer-independent alternative clinical technique uses a modified clinical protocol to fabricate maxillary and mandibular CDs in just 3 clinical visits, by using a CAD-CAM milling technique. This technique combined the benefits of traditional clinical procedures and the use of conventional materials and instruments for capturing the clinical records. No elaborate armamentarium or added investment was

required to practice this protocol. With the aid of its modified custom tray, all necessary clinical records were captured in a single block.

Advantages-

Fewer clinical visits:

1. The fabrication of digital complete dental prostheses requires a fewer number of clinical steps compared to conventional complete dentures; It is possible to record all the clinical information in one appointment and place the CAD-CAM dentures at the next appointment.

2. Simplified and reduced laboratory steps: The laboratory procedures are greatly reduced and simplified as the arduous task of teeth setting and denture processing are accomplished with CAD-CAM technology.

3. Superior retention and fit: Digital complete dentures are reported to have superior retention and fit compared to conventional complete dentures due to minimal fabrication distortion.¹⁵

4. Lower incidence of sore spots: As the digital dentures are milled from a prepolymerized block of acrylic resin, there



is reduced polymerization shrinkage and a lower incidence of sore spots and microbial colonization.

5. Superior physical and mechanical properties: Digital complete dentures are reported to have superior physical and mechanical properties compared to conventional complete dental prostheses thereby permitting the fabrication of digital denture bases with a reduced thickness.^{14,15}

6. Minimal denture tooth movement: Digital fabrication results in minimal denture tooth movement thereby decreasing the need for repeated occlusal adjustments.¹³

7. Try-in: Digital technology can be used to print a trial prosthesis that can be used to evaluate the aesthetic and function prior to its finalization.

Limitations

Adjustments and relines associated with IOS use: When the IOS is used to record the denture-bearing tissues, relines and repeated adjustments of the intaglio surface and borders are needed to achieve an optimal fit of the digital prostheses.

- Suboptimal esthetics due to elimination of try-in: Several digital protocols advocate the elimination of try-in procedures to save time and cost as they permit virtual evaluation of patient esthetics.³⁷ However, the prostheses may not have the desired result when placed in the patient's mouth thereby resulting in patient dissatisfaction and treatment failure.

- Learning curve: Fabrication of digital complete dental prostheses requires specialized clinical training and there is a learning curve attached to it. To achieve a successful outcome, the dental practitioner needs to invest time and effort in assessing digital previews and should also actively participate in electronic communication with the laboratory.

- Impossible to digitally register the interocclusal records: It is currently impossible to digitally register the interocclusal records (for patients without existing dentures) and challenging to record digital functional impressions, thus the full digital workflow for the complete denture rehabilitation remains questionable.

- Inability to balance digital dentures: It is not possible to balance digital dentures during the designing phase of denture fabrication.

Conclusion

Conventional and digital approaches can be combined together to reduce the number of clinical visits and increase the patient's acceptance. The use of open digital systems allows dental professionals to use growing digital technology without affecting practice efficiency.

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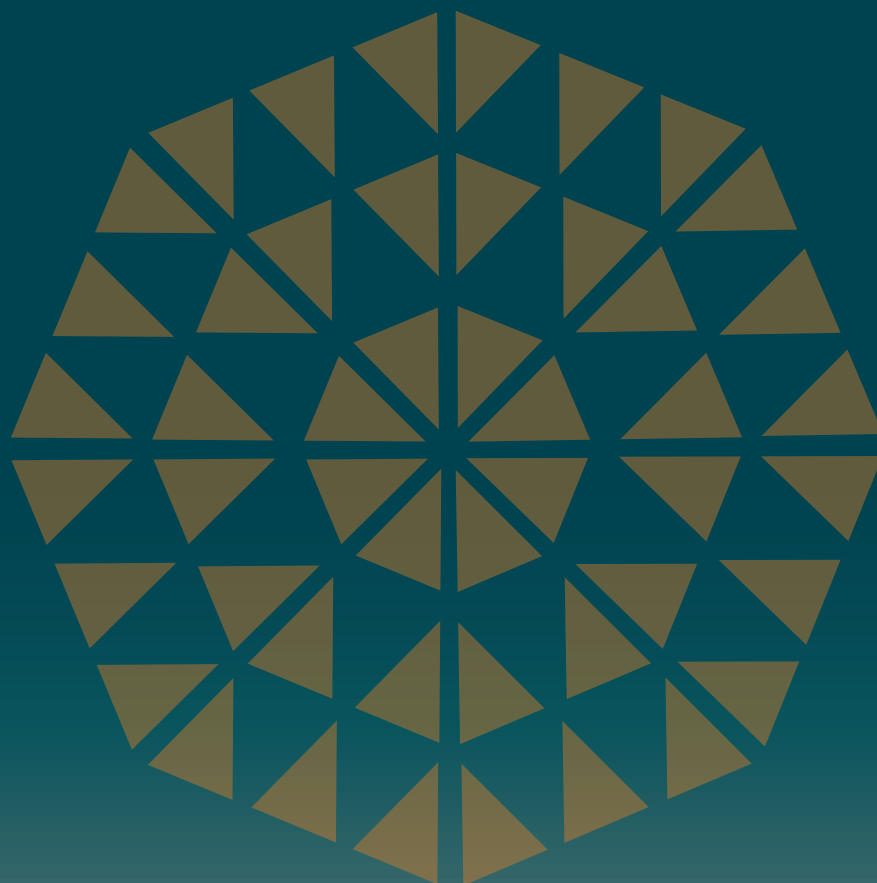
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