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A VISION FULFILLLED

The grace of God Almighty is best reflected in parents with integrity and children who strive hard to realize their dreams. The late **Sri P. M. Shahul Hameed B.A (1920-1995)** gave his children the best gift in life, quality education, at a time when few realized the wonders that education could work in the lives of men and women. The PMS College of Dental Science and Research is a monument to the memory of that great soul. It was established in 2002 under the able guidance of **Dr. P.S. Thaha,** a visionary with over three decades of experience in dental education and patient care in India and abroad. This college is the first self-financing dental institution in Kerala State, the first to achieve the ISO 9001-2000 certification and NAAC accreditation among dental colleges in Kerala. In addition to undergraduate and postgraduate courses, college is currently conducting PhD programs in different specialities of dentistry recognized by Kerala University of Health Sciences and NITTE University. The college provides an excellent environment for students as well as faculty in developing knowledge, clinical skills and attaining academic excellence. PMS College is currently ranked among the best 40 dental institutions of the country as per survey conducted by INDIA TODAY.

ABOUT THE JOURNAL

Journal of MaxilloFacial Science and Research (JMFSR, ISSN 2348-9030) is the official publication of the PMS College of Dental Science and Research. The journal started with the aim of providing our students and faculty a platform to showcase their research projects and interesting clinical cases. We also accept articles from outside the institution on topics related to all the dental specialities and related sciences. Authors are encouraged to submit research papers, case reports (new / interesting / rare cases/ cases with clinical significance and interdisciplinary cases), and short communications. Special effort is made to ensure rapid publication. Articles written in English alone will be accepted provided they have not been and will not be published elsewhere. The editor and or its publisher cannot be held responsible for errors or for any consequences arising from the use of the information contained in this journal. The appearance of advertising or product information in the various sections in the journal does not constitute an endorsement or approval by the journal and or its publisher of the quality or value of the said product or of claims made for it by its manufacturer.

JMFSR

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MESSAGE FROM THE CHAIRMAN

As Albert Einstein said, *"Wisdom is not a product of schooling but of the lifelong attempt to acquire it."* Research is an essentiality of acquiring new information. Journals are a good platform to take information to the masses.

I am happy to learn that PMS College of Dental Sciences and Research is bringing out the "Journal Of MaxilloFacial Science and Research". This journal is a compilation of original articles, case studies and reports and review articles from all over India and has an advisory board of eminent researchers from all over the globe.

I congratulate all those who have contributed to bring out this publication and wish all success.

Dr. P.S. Thaha
Chairman

I am immensely privileged to edit the first issue of Journal Of MaxilloFacial Science & Research [JMFSR], the official publication of PMS College of Dental Science & Research for the year 2021. Scientific publications are always helpful to disseminate knowledge and to help the readers to get updated with the current trends and evidence in clinical practice as well as research. The objective of Journal Of MaxilloFacial Science & Research is to provide an opportunity for our students and faculty to showcase their clinical and research work.

I would like to express my sincere gratitude to our visionary chairman Dr P.S. Thaha for his unconditional support in all the research activities of our college. This journal is another proof of his desire to achieve excellence in dental education and research.

I would like to thank all the members of the editorial and reviewer team for their untiring efforts to bring out the journal on time without compromising the quality of the articles. I expect the same enthusiasm for our future endeavours too.

I request all the staff and students of our college to continue your support by contributing good quality articles which has the potential to elevate the scientific standards of our speciality. I sincerely hope that this journal will become a medium through which our scientific community will publish and cherish.

Dr. Ambili R
Editor-in-Chief

NEXT-GENERATION SEQUENCING – A REVOLUTIONARY TOOL FOR TRANSCRIPTOMIC STUDIES IN PERIODONTAL DISEASES

Dr. Nisha K.J[1]

ABSTRACT

Over the last three decades, the molecular biology revolution has provided a much better understanding of the aberrant pathways in the etiopathogenesis of periodontitis, which is reflected in advances in periodontal diagnostics. The aim of personalized medicine are becoming more attainable, thanks to recent rapid developments in 'omics' technologies. Considerable progress has been made in understanding the transcriptome of cells over the last decade. The transcriptome analysis reveals gene expression pattern regulation, alternative splicing and transcript structure, complex regulation of transcripts in different tissues, and extensive information on gene regulation in normal and diseased states. Next generation sequencing (NGS) was introduced in the early 2000s and their use has steadily grown since then, due to increase in throughput and decrease in costs. NGS has enabled researchers to characterize miRNA patterns in body fluids such as serum, plasma, and saliva on a large scale. Our understanding of the oral microbiome has been largely expanded owing to the ability of NGS to differentiate bacteria by sequencing the variable regions of the gene coding for the 16S ribosomal RNA (rRNA). Due to its ultra-high throughput, scalability, and speed, NGS enables researchers to conduct a wide range of applications and study biological systems at a level never before possible. Further research looking into the different applications of NGS can be expected to revolutionize periodontal diagnostics, prognostics, and therapeutics in the near future.

Keywords : *Periodontitis, Transcriptome, Next Generation sequencing*

INTRODUCTION

Periodontal diseases, comprising of gingivitis and periodontitis, are one of the most common disease of mankind. Periodontitis is the leading cause of tooth loss in adults worldwide, putting them at risk of multiple tooth loss, edentulism, and masticatory dysfunction, affecting their nutrition, quality of life, and self-esteem while also imposing significant socioeconomic and healthcare costs.[1]

The current concept of periodontal pathogenesis involves complex interaction between the microbial biofilm and host immune responses that leads to the alteration of bone and connective tissue homeostasis.[2] Understanding the molecular mechanisms underlying the pathogenesis as well as development of efficient therapeutics is furthermore important since periodontitis is linked to other metabolic and/or systemic diseases including diabetes, cardiovascular diseases, and rheumatoid arthritis.[3] Despite extensive studies, the specific genes and mechanisms contributing to disease initiation and progression are poorly understood.

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Periodontal treatment is time-consuming and expensive and therefore its prevention, early detection and management yield considerable health-care benefit. However, despite numerous advances in our understanding of the pathogenesis of chronic inflammatory diseases, periodontitis is still diagnosed only after connective tissue and bone destruction has occurred.

A paradigm shift has occurred in clinical and basic scientific researches which are currently designed to improve diagnostic processes via host-based tests based on understanding the progression and pathophysiology of periodontal disease. In periodontal diagnostics, concepts have evolved in order to keep pace with advances in microbiology, biochemistry, immunology, molecular biology, genetics and connective tissue biology.[4] Since early detection of disease plays a crucial role in successful therapy, researchers are devoted to searching for diagnostic biomarkers with high sensitivity and specificity that can identify periodontal risk before extensive clinical damage occurs.[5]

The principal biological media within which biomarkers for periodontal diseases are sought include serum, subgingival plaque, periodontal tissue, saliva and gingival crevicular fluid. There is a rich history of biomarker research within the field of Periodontology, but exemplary improvements in analytical platform technologies offer exciting opportunities for discovery. Multiple "omics" technologies have recently been used to enhance understanding of the progression of periodontitis by overcoming the limitations that candidate approaches have brought. The most prominent approaches are genomics, transcriptomics, proteomics, and metabolomics of the host as well as metagenomics of the oral microbiota, which provide information on global scales that can match the complexity of the disease.

TRANSCRIPTOME ANALYSIS

Transcriptomics is one of the most developed fields in the post-genomic era. It refers to the study of transcriptome encoded by the genome of a specific cell or organism at a specific time or under a specific set of conditions. The first step in all biological and physiological processes is the transcription of specific genes into mRNAs and noncoding RNAs as prerequisite for the generation of functional proteins. Gene expression is a dynamic process that adapts rapidly to physiological changes or exogenous stimuli and thus the transcriptome with its enormous number of alternative spliced mRNAs, large and small noncoding RNAs reflects the current physiological situation in different tissues, organs, and even in single cells. Therefore, monitoring the transcriptome is, potentially, a very promising approach for detecting biomarkers for specific physiological situations, diseases, or treatments. Transcriptomics focuses on the gene expression at the RNA level and offers the genome-wide information of gene structure and gene function in order to reveal the molecular mechanisms involved in specific biological processes. The first attempts to study the whole human transcriptome began in the early 1990s, and the technological advances since the late 1990s have made transcriptomics a widespread discipline.[6]

TRANSCRIPTOMIC TECHNOLOGIES

Transcriptomics has been developed through a series of technological breakthroughs that have changed the field. There are two key contemporary techniques in the field for high throughput analysis of whole transcriptomes: microarrays, which quantify a set of predetermined sequences, and RNA sequencing (RNA-Seq), which uses high throughput sequencing to capture all sequences. Genome-wide transcriptome studies, as performed by microarrays or massively parallel sequencing, are usually carried out for exploratory analysis as a guidance for subsequent analysis of specific target genes such as reverse transcription quantitative polymerase chain reaction (RT-qPCR), or in situ hybridization (ISH).

NEXT-GENERATION SEQUENCING

With the introduction of Next-generation sequencing (NGS), a technology that allows for the

simultaneous sequencing of millions of nucleotide fragments, RNA sequencing has emerged as a powerful tool for studying the transcriptome. The identification of nucleic acid sequences has become a ubiquitous and essential tool across all areas of biological science since the advent of modern sequencing techniques.

NGS technologies offer high-throughput, rapid and accurate methods of determining the precise order of nucleotides within DNA/RNA molecules. NGS has enabled us to robustly profile thousands of genes in a single experiment and overcome the background signal and cross-hybridization issues of microarrays.[7] This technology uses a combination of a high-throughput sequencing methodology with computational methods to capture and quantify transcripts present in an RNA extract. NGS technologies have been widely used to analyse small RNAs, including identification of differentially expressed microRNAs (miRNAs), prediction of novel miRNAs, and annotation of other small non-coding RNAs.

High-throughput sequencing generates large amounts of sequence data providing powerful approach for the determination of accurate information from nucleotide fragments. The use of bioinformatics tools is central to the interpretation and application of these biological data. Bioinformatics is the science that uses information to understand aspects of biology. Using mathematical and statistical methods implemented by a wide range of programmatic languages, bioinformatics tools organise, analyse and interpret biological information at the molecular, cellular and genomic levels.

ADVANTAGES OF NGS

Though microarrays are high-throughput and economical, RNASeq offers numerous advantages over microarrays. Some of the key benefits of using RNASeq over microarrays are:

- Genome-wide coverage of transcripts is offered by RNASeq.
- Unlike microarray, which requires known a priori information about a transcript, RNA- Seq can discover novel transcripts with single-nucleotide resolution even without a genome reference.
- Improved sensitivity and specificity: RNASeq offer enhanced detection of transcripts and differentially expressed genes and isoforms. Moreover, RNASeq is known to be more accurate in terms of fold change detection for both high and low abundance genes.
- Ability to pool and sequence multiple samples in one lane of a sequencer. This significantly lowers the costs, without compromising the ability to construct comprehensive expression profiles for every assessed sample.
- No or minimal background signal: While mapping the reads to the genome, one can consider reads mapping unambiguously, which results in noise reduction. On the other hand, cross-hybridization increases the noise-to-signal ratio in microarrays.
- Single nucleotide polymorphism (SNP) detection: RNASeq data can be used for SNP detection especially for high and medium expressed genes.

Because of its wider detection range, more sensitivity, genome-wide capture of expression profile, and rapidly decreasing cost, RNASeq technology is being preferred over array-based methods for transcriptome profiling.

EVOLUTION OF TRANSCRIPTOMIC TECHNOLOGIES

Rapid determination of DNA sequence base pairs, first reported by two-time Nobel Laureate Frederick Sanger and his colleagues in 1977, provided a tool to decipher genes. This method, known as the "Sanger sequencing" or the "chain termination method" worked on the principle that when given enough time and enough starting material, at least one DNA sequence of every possible length will be produced with a tagged nucleotide at the end.[8]

The automated Sanger method is considered as a 'first-generation' technology, and newer methods are referred to as next-generation sequencing. However, low throughput and high cost hindered using this sequencing technology for deciphering the human genome. A break through came in 2005 when the sequencing-by-synthesis technology developed by 454 Life Sciences was published.[9]

Since then, several NGS platforms, such as Roche /454's GS FLX Titanium, Illumina Genome (Illumina, Inc., San Diego, CA, USA) and SOLiD™ (Life Technologies Corporation, Carlsbad, CA, USA), have been developed and applied to various fields of biological and medical research, including measuring expression levels of known miRNAs and detecting unknown miRNAs. A third-generation sequencing method based on nanopore DNA sequencing is gaining traction with one available platform designated single molecule real-time (SMRT) system from Oxford Nanopore (Figure1).

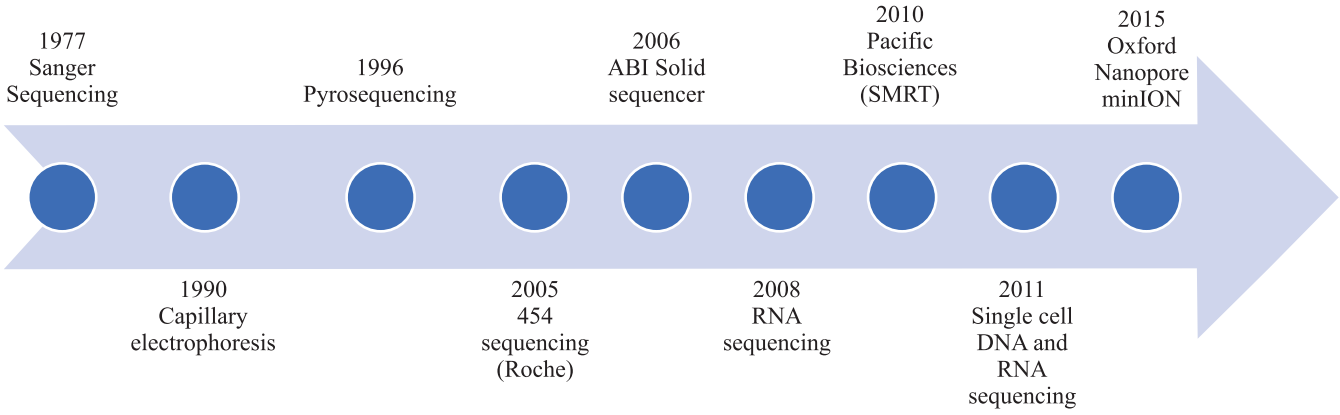

Figure 1: A summary of milestones during the evolution of transcriptomics technologies.

Steps in RNA sequencing

One of the first steps while designing the RNASeq experiment is choosing an appropriate sequencing platform. Several sequencing platforms such as Illumina, Roche, PacBio, and Ion Torrent, which are based on different sequencing chemistry and technology, are available. Current leading platform for RNASeq (and other NGS-based analyses) is the HiSeq (https:// www.illumina.com/systems.html) because it provides high throughput, deep sequencing, low sequence error, and long enough read data to be useful in multiple applications.

In general, a population of RNA (total or fractionated, such as poly(A)+) is converted to a library of cDNA fragments with adaptors attached to one or both ends. Each molecule, with or without amplification, is then sequenced in a high-throughput manner to obtain short sequences from one end (single-end sequencing) or both ends (pair-end sequencing). The reads are typically 30–400 bp, depending on the DNA-sequencing technology used. Following sequencing, the resulting reads are either aligned to a reference genome or reference transcripts, or assembled *de novo* without the genomic sequence to produce a genome-scale transcription map that consists of both the transcriptional structure and/or level of expression for each gene.

Analysis of RNA sequencing Data

Analysis of the RNASeq data is a multistep process that typically includes quality check, data pre-processing, transcriptome assembly (reference-guided and *de novo* transcriptome assembly), quantification, statistical analysis, and functional annotation. These steps are described in detail in the following section.

1. **Quality check and data pre-processing:** Next generation sequencers assign a Phred quality score, which is the probability of the base call being inaccurate, to the called bases. Low Phred scores (Q< 30) indicate read data of poor quality. Poor-quality read data can arise from problems in the library preparation or from sequencing itself. Additionally, PCR artifacts, sequence-specific biasness, untrimmed adapter sequences, and other possible contaminants can lead to poor data quality. These factors can affect the downstream analysis and data interpretation and can give inaccurate results. In order to assess quality of raw sequenced data several tools such as FastQC and PRINSEQ are available. Once the data are checked for quality, they should be processed to remove reads with low-quality bases, adapter sequences, and other contaminating sequences using tools such as Cutadapt, Trimmomatic, TrimGalore, FASTXToolkit, which trim adapter or other contaminants based upon user-provided parameters.
2. **Transcriptome assembly and profiling analysis:** Once the read data are filtered and trimmed to remove low-quality bases, adapter sequence, and contaminants, they are ready for transcriptome assembly and profiling analysis - reference-based assembly when a reference genome is available and de novo assembly when the reference genome is not available.

   a. Reference-based transcriptome assembly and profiling : Here, the computational workflow starts with aligning the quality-checked reads to the reference genome or transcriptome using a suitable read aligner. The aligned reads are then used to quantitate the genomic features (genes/isoforms). The quantity of the features needs to be normalized before comparison between different experimental conditions. The normalized feature counts are then used for drawing statistical inference on their difference in expression between samples under study. Finally, the differentially expressed set of genes is processed to derive biological insights relevant to the experimental setup.

   Reference genome and annotation files of many species are available from a number of publicly available resources such as Ensembl, the National Center of Biotechnology Information, and UCSC genome browser. These resources generate genome annotation for vertebrates and other eukaryotic species, and the information is made freely available to the research community.

   B. De novo transcriptome assembly: Building a transcriptome using *de novo* methods is a powerful way to create the transcriptome of a divergent or novel species.
3. **Quantification:** Once the read data is aligned to the reference genome, the gene expression can be quantitated by read counting at exon, transcript, or gene-level. These can be expressed as Read count, CPM (Counts Per Million mapped reads), RPKM (Reads Per Kilobase of transcript per Million), FPKM (Fragments Per Kilobase of transcript per Million) or TPM (Transcripts Per Million).
4. **Normalization:** Normalization is a process that aims to ensure that expression estimates are comparable. RNASeq experiments have multiple sources of systematic variations introduced through intersample differences such as difference in library size (sequencing depth) or unwanted variations due to batch effects such as sampling time or different sequencing technology or through intra-sample differences such as difference in read length or GC content between genes. These variations, if ignored, can dramatically reduce the accuracy of statistical inference and hence should be removed or controlled during statistical analysis. There are various normalization methods such as Total count, Upper quartile, Median, Quantile, Trimmed median of M-values and Median of ratio.

5. **Differential expression analysis:** Differential expression analysis helps identify genes that are important in the experimental conditions being tested and hence is the most routine analysis performed using the RNASeq data. The goal of differential expression analysis is to compare these read counts for a feature between distinct sample groups and perform a statistical test to determine whether the difference is significant.
6. **Annotation and pathway analysis:** The most discernible result of an RNASeq experiment is a list of differentially expressed genes. It is critical to define functional categories of differentially expressed genes and biological pathways that are enriched as a result of these differentially expressed genes in order to derive biological in sight from this list of genes. Enrichment analysis is usually conducted using publicly accessible resources such as GO databases, KEGG pathways, Bio Carta, and Reactome.

APPLICATIONS OF NGS

NGS is a powerful tool for characterising and profiling the transcriptome on a genome-wide scale because it offers an unparalleled view into the complexity of the transcriptome. Some of the applications in the field of medicine are listed below.

- Cancer Research and Diagnosis: Gene expression profiling has been widely used in cancer research and diagnosis since changes in gene expression patterns play a pivotal role in tumorigenicity, metastasis, prognosis, and relapse.
- Developmental disorders: Gene expression profiling has been used extensively in Autism and genes involved in neuronal action potential, myelination, axon ensheathment, cellular development, and cellular proliferation have been found to be differentially expressed in autistic children.
- Gene expression profiling can be used in number of other human disorders such as diabetes, hypertension, psychiatric disorders, and infectious

Application of NGS in oral disease diagnostics

NGS has been used to detect genomic changes in a variety of cancers, including oral cancer, as well as to determine genetic anomalies in hereditary conditions such as cleft lip and palate and a variety of microbial diseases.[10]

Oral squamous cell carcinoma (OSCC)

The use of NGS has enabled researchers to identify the genomic alterations evident in oral squamous cell carcinoma (OSCC). Whole exome sequencing studies have identified alterations with TP53, CDKN2A, PIK3CA, NOTCH1and HRAS genes.[11,12,13] Evaluation of miRNA in oral squamous cell carcinoma has revealed a differential expression of miR-204-5p, miR-370, miR-1307, miR-193b-3p, and miR-144-5p, miR-30a-5p and miR-769-5p.[14] In another study three miRNAs (miR-222-3p, miR-150-5p, and miR-423-5p) were altered in oral leukoplakia and oral squamous cell carcinoma thereby suggesting their utility in early detection and to monitor the progression of oral leukoplakia to OSCC.[15] The role of miRNA in metastasis of oral squamous cell carcinoma has also been analyzed. Literature data has reported significant upregulation of 45 miRNAs in OSCC tissues than the normal controls among which miR-21-3p may have a potential role in cell metastasis in OSCC progression. Thus, targeted therapy aimed at inhibiting the action of miR-21-3p may possess clinical utility and improve prognosis.[16]

Periodontal Disease

Considering its effectiveness for whole transcriptome analysis, the use of RNA sequencing in periodontitis research would facilitate the elucidation of pathogenesis. Most RNA sequencing studies in periodontitis research have focused on identifying the microbiome that makes up the periodontal biofilm. Wei et al in 2019 performed a pilot study using next-generation sequencing of 16S RNA gene, to characterize the microbiota in two oral habitats (buccal mucosa and subgingival pocket) in patients with different forms of periodontitis. They found

that the subgingival and buccal mucosa microbiome in health and periodontitis largely differed, with higher bacterial abundance in periodontitis. They found 10 genera in both buccal and subgingival plaque samples of both chronic and aggressive periodontitis groups significantly increased when compared with healthy periodontium group.[17]

A systematic review which was published in 2020 which evaluated the change of oral microbiome based on NGS-metagenomic analysis following periodontal interventions among systemically healthy subjects depicted a complex change in oral microbiome after periodontal intervention. *Porphyromonas, Treponema, Tannerella, and Prevotella* were the most frequently detected genera before intervention, while *Streptococcus and Actinomyces* typically increased and were the dominant genera after intervention. The topology of the network after intervention was different from the pre-interventional samples, according to correlation network analysis.[18]

The findings from a study done by Kim et al using RNA sequencing provided novel insights into the pathogenesis mechanism of periodontitis in terms of gene expression and alternative splicing. The pooled RNAs of 10 gingival tissues from both healthy and periodontitis patients were analyzed by deep sequencing followed by computational annotation and quantification of mRNA structures. The differential expression analysis designated 400 up-regulated genes in periodontitis tissues especially in the pathways of defense/immunity protein, receptor, protease, and signaling molecules. The top 10 most upregulated genes were CSF3, MAFA, CR2, GLDC, SAA1, LBP, MME, MMP3, MME-AS1, and SAA4. The 62 down-regulated genes in periodontitis were mainly cytoskeletal and structural proteins. The top 10 most down-regulated genes were SERPINA12, MT4, H19, KRT2, DSC1, PSORS1C2, KRT27, LCE3C, AQ5, and LCE6A.[19]

Salivary transcriptomics in periodontal diagnosis

Recent advances in transcriptomic high-throughput technologies are shedding new light on salivary biomarker discovery, which can elevate salivary diagnosis of periodontal diseases to a higher level. Profiling of healthy and periodontal transcriptomes will help to find the most significant candidate genes for the onset and progression of periodontal diseases. Those discriminatory candidate genes must be validated for their sensitivity and specificity as salivary biomarkers. The results from the approaches that has been successfully applied to the detection of oral cancer-associated biomarkers in saliva has prompted David Wong and his team to do investigation for discovering gene signatures in periodontitis patients by performing multiplex transcriptomic analysis of mRNA in human saliva. They believe that biomarkers found in saliva may predict bursts of periodontal disease activity.

A recent review article revealed the possible functions of miRNAs in periodontal inflammation, demonstrating their importance in periodontitis.[20] As has been shown in the case of oral cancer, using miRNA for non-invasive diagnostics appears to be feasible, and thus could be used as a salivary marker for periodontitis. A study which explored the potential application of NGS technology for profiling miRNAs in periodontitis identified 40 upregulated and 40 downregulated known miRNAs in chronic periodontitis compared to healthy controls. miR-143-3p was identified as the most highly expressed miRNA in periodontitis and was proposed as a novel salivary biomarker for chronic periodontitis.[21]

CONCLUSION

Transcriptomics has changed the way we think of how genes are expressed. The list of newly recognised species and phylotypes inside subgingival biofilms has grown over time, thanks to advancements in DNA sequencing technology and comprehensive applications in the field. In addition to characterization

of oral microbiome, next-generation sequencing technology can also be successfully employed for miRNA expression profiling from oral fluids like saliva. The use of bioinformatic tools for target gene mapping of these novel biomarkers in periodontitis would increase their utility in periodontal diagnostics.

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ZYGOMATIC AIR CELL DEFECT: A PANORAMIC RADIOGRAPHIC STUDY

Shabna Fathima S[1*], Vivek V[2], Sunila Thomas[3], Jincy Thomas[4]

ABSTRACT

Objective: To determine the prevalence and pattern of occurrence of zygomatic air cell defect using panoramic radiograph among general dental clinic population.

MATERIALS AND METHODS: Dental panoramic radiographs of 250 patients were examined. Radio graphs were interpreted and zygomatic air cell defect were classified as unilocolar, multilocular, trabecular types and as unilateral and bilateral varieties.

RESULTS: Zygomatic air cell defect were identified in 13 subjects out of 250, with an overall prevalence of 5.25%. Out of the subjects with zygomatic air cell defect, 4(30.8%) were males and 9(69.2%) were females. 11(84.6%) patients presented with unilateral and 2(15.4%) presented with bilateral zygomatic air cell defect. Among patients with unilateral zygomatic air cell defect, 9(81.8%) were on the on right side, 2(18.2%) were seen on the left. Out of the 15 zygomatic air cell defects identified in our study 12(80%) were unilocular, 2(13.3%) were multilocular and 1(6.7%) was trabecular types.

Conclusion: Zygomatic air cell defect is not a rare anatomic variant. Clinicians planning eminectomy or other surgical procedures involving zygomatic arch are advised to identify this entity to avoid complications.

Keywords: *Zygomatic air cell defect, pneumatized articular eminence*

INTRODUCTION

Pneumatization is the development of air-filled cavities in bone. Pneumatization of the mastoid begins in the 33rd week of embryonic life and continues until 9 years of age. Pneumatization may also occur in paranasal air sinuses, temporal bone, including the root of the zygomatic arch and its articular eminence.[1] Zygomatic air cell defect [ZACD] have been defined as "accessory air cells in the zygomatic process and articular eminence of the temporal bone which appears similar to the mastoid air cells and do not extend further anteriorly than the zygoma ticotemporal suture".[1-3] The term ZACD was coined by Tyndall and Matteson in 1987[4]; which was first introduced in 1985 as 'pneumatized articular eminence' by the same authors.[2,3]

Radiographically, ZACD are present as asymptomatic, non-expansile, non-destructive radiolucency in the root of the zygomatic arch.[5] These are classified into three types based on the pattern of radiolucency as unilocular, multilocular and trabecular types and based on laterality as unilateral and bilateral.[6] Unilocular type appears as an oval radiolucency with well-defined borders. Multilocular variant appears as numerous small cavities within, resembling mastoid air cells and trabecular type is a multilocular variant with internal bony striations.[1,5,7.]

ZACDs can serve as potential pathways for intracranial infections, so when identified preoperatively in radiographs they may become contraindication for performing surgical procedures like eminectomy and eminoplasty.[1,2.]

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The aim of the study was to determine the prevalence, pattern of occurrence and characteristics of zygomatic air cell defects among a general population.

MATERIALS AND METHODS

250 routine panoramic radiographs of patients aged between 15-65 years who visited our institute during the period of July 2016 to June 2017 were examined retrospectively to evaluate variations and characteristics of ZACDs. Cases in which the articular tubercle was not adequately displayed for anatomical or technical reasons were not included in the sample. Patients with developmental craniofacial malformations, any systemic conditions affecting growth, any history of trauma and with clinical and radiographic pathologies in jaw and face region, and those who had undergone surgical interventions were excluded from the study.

Digital radiographs were obtained with ORTHOPHOS XG 5/XG 5 DS, Model No. 5884999D3352, panoramic digital radiographic machine operating at 65 to 80 Kvp, 10 mA, 18 s. A written informed consent was obtained from all the patients prior to the study. The images were analyzed on the monitor and magnification tool provided along with the SIDEXIS XG computer software was used. Diagnosis of ZACD was made only if the defect was in the articular eminence or root of zygomatic arch, posterior to the zygomaticotemporal suture as a well-defined unilocular or multilocular radiolucency. The gender of the patient with ZACD, and its location and radiographic characteristics were recorded. To assess for intraobserver variability, re-evaluation of the radiographs were done after 2 weeks.

RESULT

There were 250 subjects aged between 15-65 years in the study, of which 108 were females and 142 males. The overall prevalence of our study was 5.25% and the mean age of occurrence was 32.6 years.

ZACD was seen in 13 subjects. Out of 13 ZACD subjects 4 were males [30.8%] and 9 were females [69.2%]. The bilateral involvement was seen in only 2 subjects. Out of 11 [84.6%] unilateral cases, 9 [69.2%] were on the right side. Based on the locularity, 12 [76.9%] cases were unilocular, 2 cases were multilocular and1 was of trabecular type [Figure1,2,3 &Table 1]

Figure1: Unilocular variant showing radiolucency with well defined borders

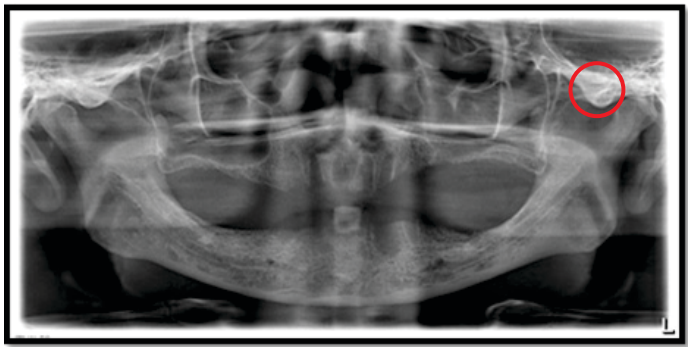

Figure 2: Trabecular variant showing multilocular radiolucency with internal bony striations

Figure 3: Multilocular variant showing radiolucency as numerous small cavities

Total	Prev.	Sex		Site			Locularity		
		M	F	Rt.	Lt.	Bilat.	Uni.	Multi.	Trab.
250	5.25%	9	4	9	2	2	12	2	1
		30.8%	69.2%	69.2%	15.4%	15.4%	80%	13.3%	6.7%

Table 1: Distribution and location of ZACD in the present study

Prev.-Prevalence; M-Male; F-Female; Rt.-Right; Lt.-Left; Bilat-Bilateral; Uni.-Unilocular; Multi-Multilocular; Trab.-Trabecular

DISCUSSION

The pneumatized air cells occurring in the zygomatic process of temporal bone are termed as ZACD.[1] ZACD appears to be comparable with mastoid air cells and has been reported as accessory air cells which do not cross zygomaticotemporal suture anteriorly.[6]

ZACDs are asymptomatic and appear radiographically as non-destructive, non-expansile radiolucencies in the zygomatic process of temporal bone or the articular eminence. It is of importance to radiologists, diagnosticians and surgeons to be aware of this entity during procedures like eminectomy and eminoplasty to prevent potential complications.[2]

The prevalence of ZACD in the present study was 5.25% which is similar to the studies done by Thriveni et al.[1] Our study showed a female predilection which is in accordance with that of Zamininasar et al.[7] and Thriveni et al.; while other studies by Khojastepour and Gadda et al.[5] showed almost similar occurrence in males and in females and the study by Nagaraj et al.[6] showed male predilection. 11 out of 13 cases with ZACD in our study were unilateral. This is in accordance with the previous studies. Out of the total cases with ZACDs, 9 were seen on the right side as in accordance with Srikanth et al.[3], Gadda et al.[5] and Kulkarni et al.[2]; whereas studies by Zamininasar et al.[7] and Orhan et al.[4] showed equal predilection on both sides. Our study showed 12 unilocular cases as with Thriveni et al.[1]; and 2 multilocular and 1 trabecular variant. This was opposite with other studies where there was a predominance of multilocular cases. These differences might be due to variations in the sample sizes, as well as the populations studied.

Due to the superimposition of adjacent anatomic structures, radiographic visualization of ZACD is more difficult in panoramic radiograph. High-resolution CT or CBCT can give a better visualization in the evaluation of bony structure allowing exact delineation of temporal air spaces, but it is not justified because of cost and increased radiation exposure.[5,8]

ZACD requires no treatment.[7] If being detected preoperatively, it would serve as a contraindication for procedures like eminectomy and eminoplasty used to treat recurrent temporo mandibular dislocations.[3,4,6] Therefore preoperative imaging evaluation is necessary to detect this entity and to prevent untoward infections.[2]

CONCLUSION

Recognition of ZACD by oral radiologists, oral surgeons and general dentists is extremely important to prevent untoward complications. Inadvertent penetrations of ZACDs can lead to intracranial infections or hemorrhage. Further research with large data could provide further insight to this entity.

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UNUSUAL MAXILLARY PATHOLOGIES – UNRAVELING A CLINICAL PARADOX

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ABSTRACT

Sinonasal papilloma is a rare locally invasive benign tumor with an incidence rate of 0.2 - 1.5 cases per 100,000 people/year. Collectively, it represents <5% of all sinonasal tract tumors. In 1854, Ward first documented the occurrence of inverted papilloma in the sinonasal cavity. They are benign tumors that are found in three histologic types: the squamous papilloma, the inverted papilloma, and the cylindrical cell papilloma. Of these three types, the inverted papilloma has a 15% incidence of becoming a squamous cell carcinoma, while the cylindrical cell papilloma will histologically resemble an adenocarcinoma. The tumor is well known for its invasiveness, tendency to recur, and association with malignancy. The present article describes successful diagnosis and management of a rare case of inverted Sinonasal papilloma.

Keywords : *Inverted papilloma, Sinonasal papilloma, human papilloma virus*

INTRODUCTION

Maxillary sinus is a part of faciomaxillary skeleton in close anatomical relationship with the oral cavity, nasal cavity, and orbital cavity. Maxillary lesions are usually confusing due to its ambiguous appearance. Due to its complex anatomy and nature of vascularity often these lesions pose a great challenge to the oral and maxillofacial surgeons in diagnosing and rendering apt treatment. Moreover, these pathologies are imperceptible clinically / or eclipsed radiologically until size becomes significant.

In 1854,[1] Ward first documented the occurrence of inverted papilloma in the sinonasal cavity. However, in 1935,[2] Reingertz histologically described the nature of the tumour and noted its classic inverted nature in underlying connective tissue stroma. In 1971,[3] Hymans reviewed several cases of this tumour and subdivided sinonasal papilloma into inverted, fungiform, and cylindrical cell types. Here we are reporting a case of rare inverted sinonasal papilloma that we have successfully treated.

CASE PRESENTATION

A 53 year old male reported with complaint of left side swelling of the face and associated pain since 2 months (Figure1).

Figure1: Pre-operative Extra- oral view

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History revealed an intermittent nasal obstruction and nasal discharge and swelling gradually increased over 2 months. No significant past medical and surgical histories were reported. On clinical examination, there was diffuse swelling on the left side of the face, extending from the left supraorbital rim to the left angle of the mouth and mediolaterally from the left ala of the nose to the left malar region.

The swelling was firm and hard on palpation. The overlying skin was intact and was not attached to the tumour. The lesion was extending into the lateral wall of the nose causing nasal obstruction. The mouth opening was within the normal limit. Intraorally mild obliteration of vestibule was seen extending from 23 to 27 region, which was soft in consistency. CBCT scan revealed an erosive lesion with the destruction of anterior wall of maxillary sinus measuring about 42.0 X 47.1 mm (Figure 2 a & b).

Surgical Procedure

Following which an explorative biopsy of the entire lesion under general anesthesia (GA) was planned. Lip split incision was given and intra-operatively the lesion had a gel like consistency with extensive vascularity (Figure 3).

A Gross amount of lesion was enucleated out and sent for histopathological analysis which revealed polypoidal tissue lined by columnar cells with an admixture of mucin containing cells. Tissue enclosed in basement membrane which grows endophytically into the underlying stroma (Figure 4).

Clinicohistopathologic correlation was suggestive of a final diagnosis of Inverted sinonasal papilloma. Seeing the aggressiveness of this lesion reported in the literature, the patient was informed about the possible recurrence in future and the need for further intervention.

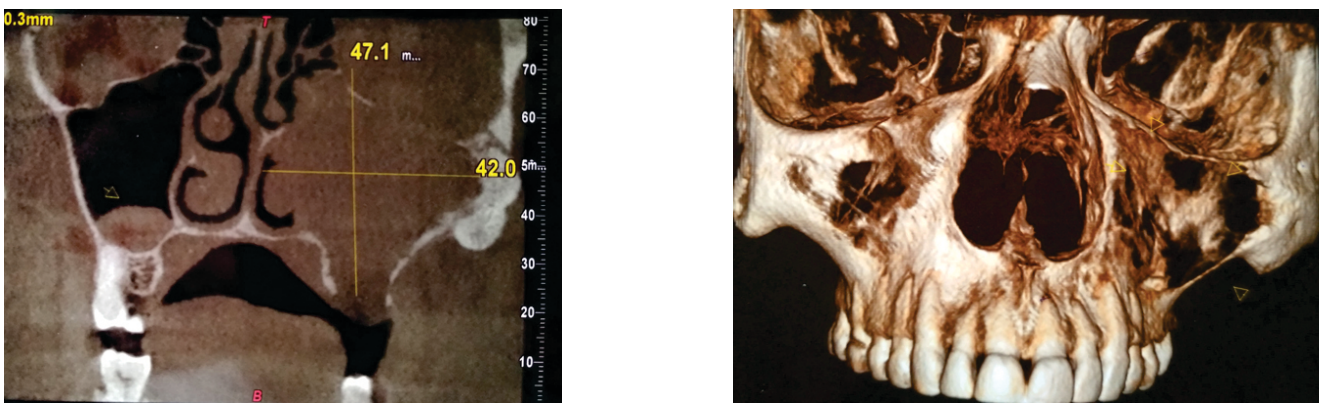

Figure 2: CBCT Images (a) coronal view, (b) 3D Reconstruction view

Laterally mass was extending up to the roof of the sinus, inferiorly it was eroding the hard palate. Since the aspiration results were negative lesions like Odontogenic Keratocyst and other cystic lesions were ruled out, and the presence of solid tumor was established. Considering the extensive destructive lesion, we came to a provisional diagnosis of ameloblastoma, carcinoma of maxilla. Incisional biopsy was done on the anterior part of the lesion and later from the posterior most region. Both the biopsies were inconclusive, showing benign inflammatory lesion.

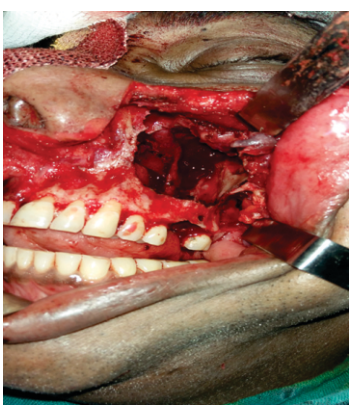

Figure 3: Intra-operative view of defect after removing the lesion

Three months later, patient reported back with swelling in the left maxillary vestibular region (Figure 5) and an MRI was taken which showed extensive lesion, so a radical procedure was planned under GA. A Weber – Fergusson's incision was given to expose the full lesion and partial maxillectomy was performed (Figure 6). 3 months follow – up was done and the patient was disease-free.

Figure 5 Intra Oral View
3months Post Operative

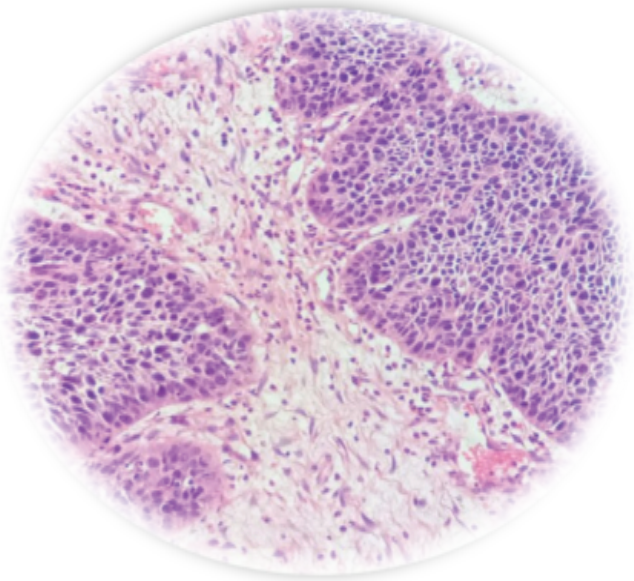

Figure 4 Histopathological Picture

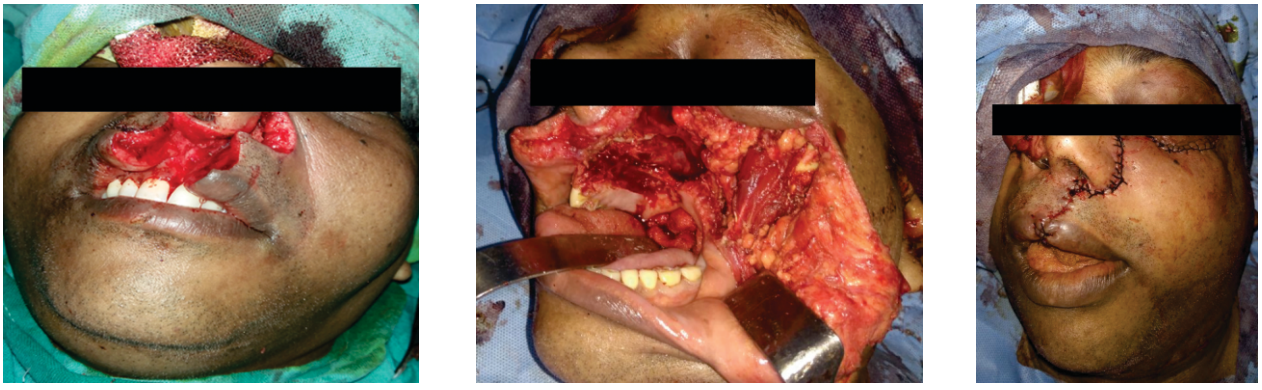

Figure 6 Intra-Operative View
(a) Weber – Fergusson Incision, (b) Hemimaxillectomy, (c) Immediate Post-operative View

DISCUSSION

Rare and the unusual lesion should always come into mind while diagnosing any pathology especially when it is a mixed radiolucent lesion. Sinonasal papillomas usually arise from the ectodermally derived ciliated epithelium of the nasal cavity, called the 'Schneiderian membrane'. Sinonasal inverted papilloma is a benign and relatively rare tumor of the nasal cavity and paranasal sinuses which was first described by Ward in 1854[1] who documented the development of inverted papilloma in the sinonasal cavity.With an incidence between 0.2 and 1.5 cases per 100,000 persons per year, Inverted sinonasal papillomas account for 0.5% - 4% of all sinonasal neoplasms".[4-6] Inverted sinonasal papilloma most commonly has its origin from the lateral nasal wall or maxillary sinus from the schneiderian sinonasal epithelium.[7] There is a male predominance with a

male-to-female ratio of 3.4:1.1. As the mass enlarges over time, it results in bony remodeling and resorption and most often extends into the maxillary sinus. Due to its peculiar location, impairment of normal drainage of the maxillary sinus is common.[8]

While the morphological features and clinical characteristics of Inverted sinonasal papilloma have been almost well described, its etiology and risk factors still remain controversial. The viral etiology has been suggested in a number of studies and inverted papillomas are reported to be associated with human papillomavirus (HPV) on in situ hybridization and/or polymerase chain reaction. The HPV-6, HPV-11, HPV-16, HPV-18, and Epstein-–Barr virus has been isolated from many cases.[9] Other possible etiological factors may include smoking, exposure to pollutants and toxic chemicals, nasal allergy, sinusitis, nasal polyp, non - sinonasal malignancies, and genital and dermal warts.[10] In our case, the lesion could have been viral but immunohistochemistry was not done to rule out the viral origin and also we were not able to correlate with any other etiological factors mentioned above.

Diagnosis is often attained by radiological confirmation in addition to clinical and histological examination. 2-dimensional radiographs will not suffice and clinicians should opt for 3-dimensional imaging like CBCT or CT face which can give more accurate details about its borders and invasiveness. Radiological studies of inverted papilloma with CT scan and magnetic resonance imaging (MRI) scan are the gold standard. Bony changes inclusive of bowing of the bones located near the mass are common CT findings.[11] "Bone remodeling" is the term used to describe the changes that occur secondary to the constant pressure and mass effect on surrounding bony structures from inverted papilloma, commonly seen at the medial wall of the maxillary sinus and lamina papyracea.[12] MRI often demonstrates a characteristic appearance, referred to as convoluted cerebriform pattern, seen on both T2 and contrast-enhanced T1 weighted images.[13]

On gross appearance, the inverted papillomas manifest as exophytic, polypoidal and vascular. This is in accordance with our case which showed high vascularity. It is pink to gray in color, with frond-like projections extending from the bulk of the lesion, which varies from firm to friable consistency.[14]

Excluding the common lesions, the differential diagnosis most commonly includes the sinonasal inflammatory polyps, non-keratinizing respiratory carcinoma and verrucous carcinoma to name a few rare lesions. Sinonasal inflammatory polyps are clinically similar but histopathologically epithelial alterations are seen in inverted papillomas which are absent in the inflammatory polyps. Sometimes non-keratinizing respiratory carcinoma mimics inverted papillomas but can be differentiated by the presence of dysplastic features in carcinoma. In verrucous carcinoma, distinctive, cleft-like spaces lined by a thick layer of parakeratin extending from the surface deep into the lesion which is the hallmark of verrucous carcinoma, is seen and is missing in inverted papilloma.[15]

Treatment includes complete surgical excision with the lateral nasal wall (medial maxillectomy) via an external incision, including the adjacent uninvolved mucosa, as the latter is necessary as growth and extension along the mucosa results from the induction of squamous metaplasia in the adjacent sinonasal mucosa.[7] Increasingly advanced endoscopic techniques have been used to limit the size of resection and morbidity.

CONCLUSION

It is one such lesion which often creates a surgical dilemma among the surgeons due to its overlapping clinical and histopathological characteristics with similar lesions. Careful inspection is required to identify etiology of lesion and should be correlated clinicopathologically and histopathologically for successful diagnosis and treatment of such rare lesions. A clinician should always keep in mind the possibilities of occurrence of such lesions in the maxilla and if in doubt should never hesitate and go for further evaluation.

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LASER ASSISTED LIP REPOSITIONING FOR THE CORRECTION OF EXCESSIVE GINGIVAL DISPLAY

Resmi PG [1*], Reshma PG [2], Ambili R [3], Neethu Suresh [4], Roopesh R [5], Madhav Manoj [6]

ABSTRACT

Excessive gingival display (EGD) is a common aesthetic concern. Lip repositioning surgery (LRS) was introduced as one of the treatment options to manage EGD. LRS can be used for skeletally and/or muscularly induced EGD. This report describes the use of laser assisted lip repositioning technique for the management of a gummy smile associated with vertical maxillary excess and short upper lip. The procedure restricts the muscle pull of the elevator lip muscles by shortening the vestibule, thus reducing the gingival display when smiling. Laser assisted lip repositioning can be used for patients desiring a less invasive alternative to orthognathic surgery.

Keywords : *Diode laser, Lip, Gingivectomy*

INTRODUCTION

Smile is a curve that sets everything straight. An attractive smile goes a long way in enhancing a person's self-confidence, whereas a "gummy" smile often becomes a matter of aesthetic concern. The hallmark of an "ideal smile" is the exposure of the entire length of maxillary teeth with 1 mm visibility of the midfacial maxillary gingiva.[1] Gingival exposure within a permissible limit of 3 mm may be considered aesthetically acceptable. A gingival display exceeding 3 mm is unpleasant and termed as "excessive gingival display (EGD)" or also known as "gummy smile.[2] Although a gummy smile has limited impact on the functional capabilities, it does have a strong influence on the person's psychology. Management of gingival and skeletal deformities is most challenging and of aesthetic concern to the patient in day-to-day life. The various causes of gummy smile include vertical maxillary excess, anterior dentoalveolar extrusion, altered passive eruption, short or hyperactive upper lip, or combinations thereof.[3]

Moderate gingival display that ranges between 4 and 8 mm which is due to vertical maxillary excess not of skeletal origin can effectively be treated by surgical repositioning of maxillary lip.[4] This technique is contraindicated in patients having inadequate width of attached gingiva. Surgical lip repositioning procedure was first described by Rubinstein and Kostianovsky in 1973 as part of medical plastic surgery.[5] Later, it was introduced into dentistry by Rosenblatt and Simon in 2006, after being modified.[6]

Conventional lip repositioning can have an increased patient morbidity, and the use of a scalpel can result in bleeding with decreased visibility in the operatory field, postoperative swelling, and bruising. Laser-assisted lip repositioning surgery can be a viable, minimally invasive alternative. The present report aims to demonstrate Laser assisted lip-repositioning technique for the management of excessive gingival display.

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CASE PRESENTATION

A 22-year-old female patient undergoing orthodontic treatment at PMS College of dental science and research was referred to Department of Periodontics with the chief complaint of gummy smile. The patient's medical history was non-contributory with no contraindication for surgery. Clinical examination revealed moderate amount of maxillary gingival display. With full smile, patient's teeth were visible from maxillary right first molar to maxillary left first molar. The upper lip length was 17 mm and 7 mm of gingival display was noticed which is a diagnostic indicator for excessive gingival display (Figure 1).

On lateral cephalogram analysis anterior dental height of 31.2 mm which is more for females and clockwise rotation of palatal plane was noticed which was indicative of vertical maxillary excess tendency. Orthognathic surgery as a treatment option was discussed with the patient. However, patient preferred less invasive lip repositioning procedure over orthognathic surgery.

SURGICAL PROCEDURE

Informed consent was obtained prior to the procedure. Adequate local anaesthetic (lignocaine 2% with epinephrine 1:100,000) was administered in vestibular mucosa and lip from maxillary right first molar to maxillary left first molar. The patient was noticed to have a short clinical crown due to altered passive eruption in the maxillary anterior region, towards which external bevel gingivectomy was carried out in relation to tooth # 13 to #23(Figure 2).

The alveolar mucosa apical to mucogingival junction was de-epithelized and extent of de epithelization was double the amount of gingival display. De-epithelization was carried out using a 400 µm laser tip using Diode laser [AMD Picasso 810nm] in a continuous mode at 0.8 to 1 W. Deepithelization was carried out in relation to maxillary right second premolar to maxillary left second premolar without involving the maxillary labial frenum. Area was irrigated with saline and wound margins were approximated. The entire surgical procedure is given in Figure 3.

Figure 1 : (A) Gingival display on full smile (B) Intra-oral (frontal) view (C) Upper lip length (D) Incompetent lip posture at rest (E) Lateral cephalogram – Pre OP

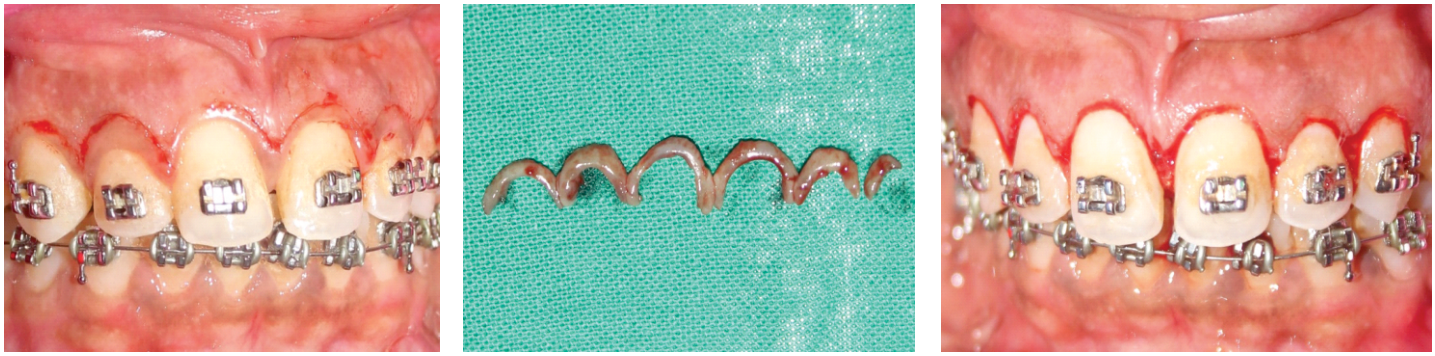

Figure 2 : (A) Outline for gingivectomy (B) Excised gingival tissue (C) After external bevel gingivectomy

Figure 3 : (A) Outline for de-epithelialization (B) Marked area de-epithelialized without intervening frenum (C) Simple interrupted sutures placed keeping the lip in new position coronally.

The patient was prescribed analgesic, anti inflmmatory meditaion (combination of ibuprofen and paracetamol) postoperatively. Dietary instructions were given and patient was advised intermittent ice pack application over the surgical area for 24 hours.

Patient was advised to limit activities that caused excessive lip movement. Suture removal was carried out after 10 days (Figure 4).

Healing was uneventful. Results after 3 months showed a marked reduction in gingival display (Figure 5).

Figure 4 : (A) Two weeks post-op (suture removal) (B) Lip posture at rest two weeks after the procedure

Figure 5 : (A) pre-operative and (B) 3 months post-operative .
Amount of dento-gingival display during maximum smile

As part of the orthodontic treatment, intrusion of maxillary anterior teeth is also planned using TADs of 1.6 mm diameter and 8 mm length inserted between lateral incisor and canine bilaterally to achieve an intrusion of 3mm.

DISCUSSION

The present case report describes the treatment of excessive gingival display with a novel laser-assisted lip repositioning surgical procedure. We could achieve optimal result with 5 mm reduction in gingival display. More importantly patient was highly satisfied with the treatment results. Three-month postoperative evaluation showed stable results.

Lip repositioning procedure began as a plastic surgical treatment and variations have been reported.[6] The original technique did not include severing the muscle attachment after flap reflection.[7] Some authors suggested performing myectomies to detach smile muscle attachment to prevent relapse.[8,9] Another method to prevent reattachment of smile elevator muscles is the placement of spacer between elevator muscles of lip and anterior nasal spine thereby preventing superior displacement of repositioned lip.[10]

Silva et al. in 2012 reported successful management of excessive gingival display in a study wherein thirteen patients with excessive gingival display were treated with a modified lip repositioning technique.[11]

Treatment consisted of the removal of two strips of mucosa, bilaterally to the maxillary labial frenum and coronal repositioning of the new mucosal margin.

Most of these procedures resulted in complications such as severe discomfort, postoperative bruising, and damage to minor salivary glands resulting in mucocele formation.[12] Taking into consideration these factors, we have used laser-assisted lip repositioning. The primary advantages of laser application in soft-tissue surgery are relatively less bleeding and reduced bacteraemia with minimal discomfort postoperatively.[13] In our case also there was reduced intraoperative bleeding and patient presented with minimum postoperative discomfort.

Relapse is commonly reported with lip repositioning procedure. [6,14,15] We need long term follow-up to verify the same in our case. A recent randomized clinical trial demonstrated that mean relapse of gingival exposure ranged between 0.13 and 0.52 mm from 6 to 12 months.[16] We could find very few reported cases of laser assisted lip repositioning. Future well controlled studies can be carried out assessing the chance of relapse after conventional and laser assisted lip repositioning procedures.

CONCLUSION

This case report showcased that laser-assisted lip repositioning surgery yielded promising results in

the correction of gummy smile. Literature is sparse reporting the long-term follow-up of results obtained through laser-assisted lip repositioning. Still considering the ease of the procedure, excellent patient acceptability and also providing satisfactory treatment outcome, this technique can be considered as a feasible alternative in aesthetic correction of gummy smile.

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VERRUCOUS CARCINOMA – CAUSING EXTENSIVE DESTRUCTION OF LEFT MANDIBLE: A CASE REPORT

Anjana Menon R [1*], T.T Sivakumar [2], Anna P Joseph [2], Varun B. R [2], Vinod Mony [3], Reshmi A [4]

ABSTRACT

Verrucous carcinoma (also known as Ackerman tumor) is a rare exophytic low-grade well-differentiated variant of squamous cell carcinoma. Verrucous carcinoma affects the oral cavity, skin, larynx, esophagus, and genitalia. Due to its slow-growing clinical behaviour, it has low metastatic potential. Principal etiological factors include tobacco use, smoking, alcoholism, poor oral hygiene and human papilloma virus strains 6, 11 and 18.

In this article, we report a case of verrucous carcinoma of the mandible in a 45-year-old female showing an unusual presentation of the marked endophytic component along with exophytic growth and significant local invasion into the jaw bone, causing trismus.

Keywords : *Verrucous carcinoma, Ackerman's tumor, Trismus*

INTRODUCTION

Verrucous carcinoma (VC), first reported by Ackerman in 1948, is an uncommon low-grade clinical variant of oral squamous cell carcinoma(SCC). It is well-differentiated, slowly growing, verrucous in nature and has a tendency to invade local structures. Etiological factors include smoking, alcoholism, tobacco use, human papilloma virus (HPV) strains 6, 11, 18, and poor oral hygiene. A significant proportion of cases occur in individuals without tobacco use. The mucous membrane of the head and neck are sites of predilection with the oral cavity and larynx, especially at risk.[1] In addition, it can be found in extra-oral sites, including vulvo-vaginal, penile, anorectal, and sinonasal regions. Verrucous carcinoma of the skin is termed epithelioma cuniculatum, while verrucous carcinoma of the anogenital region is called giant condyloma acuminatum of Buschke–Löwenstein. Verrucous carcinoma appears as well demarcated, diffuse, painless, thick plaque with papillary or verruciform surface projections. It shows the aggressive local invasion of adjacent structures such as bone and cartilage around the lesion, and it rarely spreads to lymph nodes or undergoes metastasis. The rate of malignant transformation of leukoplakia to a VC is higher if it is located in the gingiva as compared with other sites.[2] Verrucous carcinoma has a relatively good prognosis due to its low metastatic potential. It can be treated by surgical excision without radical neck dissection.[3] The epidemiology of verrucous carcinoma is not clearly known. Studies have reported that the incidence of verrucous carcinoma varies between 4.5 and 16.08% of all SCC cases.[4] It is mandatory to correlate the clinical and histopathological findings to establish a diagnosis. The purpose of this article is to report a case of verrucous carcinoma of the mandible in a 45-year-old female showing an unusual presentation of the marked endophytic component along with exophytic growth and significant local invasion into jaw bone causing trismus. Appearance of keratin pearls and church-spire configuration which are the uncommon histopathologic findings are also discussed in the literature.

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CASE REPORT

A female patient aged 45 years reported to a private dental clinic with a complaint of swelling, difficulty in mouth opening and pain in the lower region of the jaw for six months. The patient gave a history of placing tobacco snuff in the lesional area for many years. Extraoral clinical examination revealed a palpable firm swelling measuring about 3cm x 2cm on the left side of the mandible (Figure 1A).

Figure 1 A : Clinical photograph showing swelling on the left half of mandible,
B : Clinical photograph showing exophytic verrucous proliferation in left posterior edentulous alveolar ridge

Intra-oral examination revealed a warty, exophytic, verrucous proliferation measuring 3x2 cm on the left lower alveolar ridge extending from the distal aspect of 33 to the left posterior alveolar ridge. Teeth in the area were missing (Figure 1B).

The surface of the lesion appeared keratotic, of size 3 x 2 cm, and extending below the line of occlusion. In addition, a white leukoplakic patch was noted along the gingival mucosa in relation to 33 to 43. On palpation, the lesion on the left side was tender, and soft in consistency. Submental and submandibular lymph nodes were tender and palpable. Based on clinical examination, a provisional diagnosis was given as malignancy. OPG showed an osteolytic lesion approximately of size 4 x 5 cm involving edentulous space in relation to 33 to 36 (Figure 2).

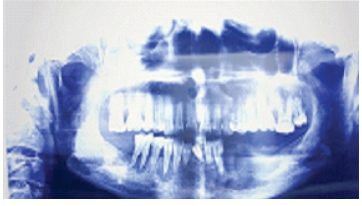

Figure 2 OPG shows well defined radiolucency involving distal aspect of 33 to edentulous ridge of 36

The CT report showed evidence of a destructive lesion involving the left half of the mandible measuring 2.8 x 2.1 cm with extension in lingual and labial cortex with infiltration of gingivobuccal spaces and tethering of hyoglossus and mylohyoid muscles. Enlarged lymph nodes involving left side 1a & 1b group with largest level Ia lymph node measuring 1x1 cm and level Ib lymph node measuring 1.4x1.2cm. An incisional biopsy was performed, and the excised mass was sent for histopathological examination to the Department of Oral pathology and Microbiology, PMS College of Dental Science and Research. Based on the results, excision of the lesion followed by hemimandibulectomy and selective neck dissection with primary closure was done.

On gross and macroscopic examination of excised left mandibular resection specimen tissue, measuring 9.5x7x3.5 cm in size and level I a nodes, largest measuring 1.5x1.4x1.2 cm and smallest measuring 0.9 x 1 x 0.9 cm in size was observed (Figure 3A and B).

Histopathology showed a predominantly endophytic proliferation of well differentiated neoplastic squamous epithelial cells infiltrating in broad pushing borders into the underlying connective tissue. The neoplastic epithelium showed keratinization with parakeratin-lined clefts, parakeratin plugging, and church spire configuration: intra epithelial microabcesses and thin fibro vascular connective tissue cores were seen (Figure 4A, B, C, & D).

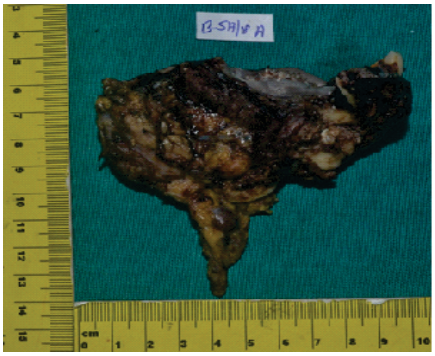

Figure 3A : Photograph showing gross specimen

Figure 3B :Photograph showing gross specimen of lymph nodes largest measuring 1.5x1.4x1.2 cm and smallest measuring 0.9 x 1x 0.9 cm in size

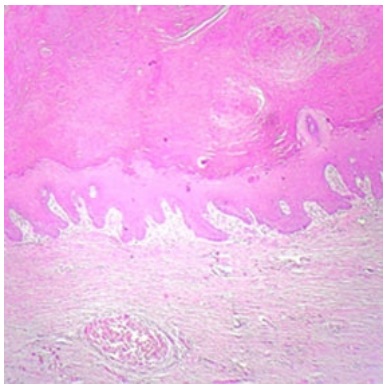

Figure 4 A : Photomicrograph shows marked and abundant keratinization and pushing rete ridges. A small island of neoplastic epithelial cells noted within the . connective tissue, with surrounded chronic inflammatory cell infiltrate. (H and E stain 10x)

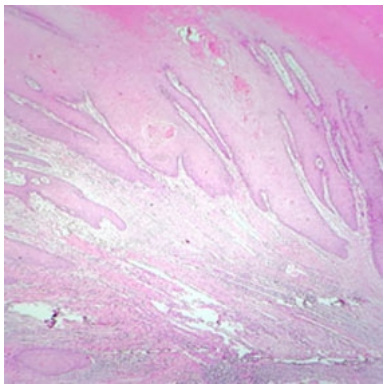

Figure 4 B : 5 Photomicrograph shows elongated broad pushing rete ridges and abundant keratinization (H and E stain 10x)

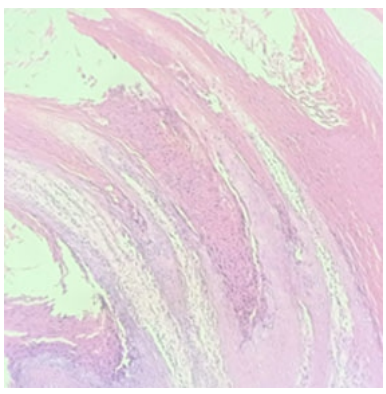

Figure 4 C : Photomicrograph shows church spire configuration of neoplastic epithelium (H and E stain 40 x)

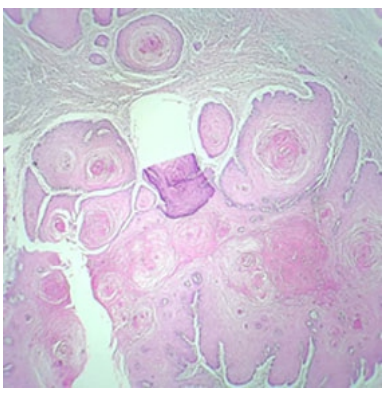

Figure 4 D : Photomicrograph shows few neoplastic squamous islands with keratin pearl formation within the connective tissue. (H and E stain 4 x)

Few small islands of neoplastic cells were seen within the connective tissue, but no breach in the basement membrane was noted. Diffuse stromal chronic inflammatory cell infiltrates, comprising of lymphocytes, plasma cells, and a few foreign body giant cells were present. Lymph nodes showed reactive changes (Figure 5). The diagnosis of verrucous carcinoma was confirmed based on histopathologic findings.

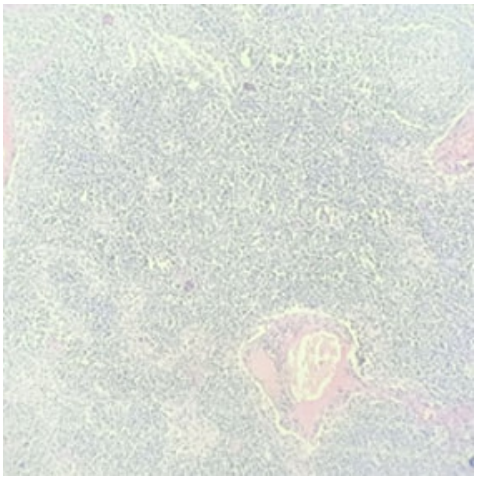

Figure 5 : Photo micrograph shows enlarged reactive lymph nodes (H and E stain 10x)

DISCUSSION

Verrucous Carcinoma, also known as Ackerman's Tumour, is an indolent variant of oral squamous cell carcinoma characterized by a predominantly exophytic overgrowth of well-differentiated keratinizing epithelium having minimal atypia and with locally destructive pushing margins at its interface with underlying connective tissue and no or only low metastatic potential.[5] VC has been reported in under a variety of terms, including florid oral papillomatosis, epithelioma cuniculatum, Buschke–Loewenstein tumor, cutis papillomatosis carcinoides of Gottron, and carcinoma cuniculatum.[6] Various aetiological factors include chewing betel nut, poor oral hygiene, and human papilloma virus infection. Tobacco, mostly in snuff dipping and chewing form, is considered as the main etiological agent. Few cases are reported with Epstein Barr virus infection, Plummer-Vinson syndrome, and chronic dental infections.[1] Ackerman's tumor can be found predominantly in men older than 55 years of age. VC was seen in elderly women and strongly associated with the use of smokeless tobacco (conventional chewing with tobacco includes betel leaf, arecanut, slaked lime). In the oral cavity, buccal mucosa is more commonly involved, followed by the alveolar ridge, mandibular sulcus, gingiva, palate, and floor of the mouth. The present case showed extensive lateral spread. The exophytic papillary surface proliferation was accompanied by a prominent and marked endophytic component with characteristic pushing borders, causing extensive destruction of bone of the mandible. The patient also had pain with restricted mouth opening for 4-6 months. In our case VC was associated with leukoplakia in the gingival mucosa in relation to 33 to 43. Lymph nodes were tender and showed reactive changes microscopically.

Histopathologically, VC has a benign microscopic appearance. Characteristic features of VC include parakeratin lined clefts, parakeratin plugging, and wide and elongated rete ridges that appear to "push" into the underlying connective tissue. Marked epithelial proliferation with downgrowth of the epithelium into connective tissue which has been variably termed as "Pushing margin of Ackerman/ bulbous rete ridges and elephant foot rete ridges". The epithelium shows minimal mitotic activity, pleomorphism, or hyperchromatism with intact basement membrane. The present case exhibits unusual finding of appearances of church-spire configuration of keratin, keratin pearl formation and intra epithelial microabcess (Figure 4 C and D) in our case.

Verrucous carcinoma has unique histopathologic features, and it is extremely challenging to diagnose it accurately. The histopathological differential diagnosis includes squamous papilloma, verrucous hyperplasia, and proliferative verrucous leukoplakia are misleading, often leading to misdiagnosis. All these lesions show atypical epithelial hyperplasia with varying degrees

of dysplasia. It is very important to rule out foci of conventional oral squamous cell carcinoma in verrucous carcinoma. Clinicohistopathological similarities between the wide spectrum of verruciform lesions like verrucous hyperplasia, proliferative verrucous leukoplakia, non-invasive verrucous carcinoma, and invasive well-differentiated OSCC make the diagnosis difficult.[8] Lack of atypia and intact basement membrane helps to rule out conventional SCC and papillary SCC from verrucous carcinoma. Foci of squamous pearl formation can frequently be mistaken for oral squamous cell carcinoma. It is very important that several biopsies from the margin of the lesion be taken and be of adequate size and depth.[9] A deeper adequate biopsy and sufficient volume of biopsy specimen must be taken whenever the clinician suspects verrucous carcinoma for definitive diagnosis. In fact, multiple biopsies may be required to confirm the diagnosis of verrucous carcinoma.

There are different treatment modalities for verrucous carcinoma, which include surgery, radiotherapy, chemotherapy, cryotherapy, laser therapy, photodynamic therapy, and recombinant interferon therapy. Surgical excision is usually preferred .Treatment of verrucous carcinoma remains controversial in many cases.Verrucous carcinoma can become extensive by the lateral spread. Despite its histologically benign appearance, it can cause substantial destruction by local invasion, as seen in the present case . On pathological examination, the most important and typical pathological features of VC are infiltration of all rete pegs to the connective tissue in the same depth, which forms pushing borders.

CONCLUSION

Verrucous carcinoma is a distinctive variant of squamous cell carcinoma with progressive and persistent nature, presenting as an exophytic, papillomatous mass. Mandibular lesions of longer duration can gradually invade and destroy a considerable part of mandible, as seen in the present case invade muscle tissue, and causing trismus. It is mandatory to rule out foci of conventional squamous cell carcinoma which could arise in verrucous carcinoma, in order to institute appropriate treatment.

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ROLE OF MAGNETS IN PROSTHODONTICS

Arvind Kumar Uikey [1], **Indu Raj** [2*], **Rajesh C** [3]

ABSTRACT

Magnets have been used for various applications in Orthodontics and Prosthodontics. The unavailability of small size magnets restricted the use of magnets for very long time. After the introduction of rare earth magnets with their unique properties of retentive force, stress-breaking characteristics, corrosion resistance, biocompatibility and their availability in smaller sizes, their use has been increased considerably. This article reviews the types of magnets available and their applications in overdentures, maxillofacial prosthesis, dental implants followed by their advantages, disadvantages and future perspectives.

Keywords : *Magnets, retentive devices, overdentures*

INTRODUCTION

Magnets have been in use for various applications, their history comprising of approximately 3000 years.[1] The use of magnets started as early as 1000A.D. in the making of south pointer compass with iron and lodestone magnetic material. Later around 1500A.D to 1820A.D they were used in dip circle and horseshoe magnet. In 1820, Oersted's accidental discovery of the relationship between electricity and magnetism led to the electrification of the planet. Later in the 1900s magnets were used in radar, television, magnetic resonance imaging (MRI), consumer electronics and thin film devices.[2]

Medical references to magnetism were made by Hippocrates (460–360 BC), who used the styptic iron oxides magnetite and hematite to stop bleeding and to control hemorrhage. The medical use of magnets is not confined to treatment approaches, but also extends to the most powerful modern diagnostic methods such as positron emission tomography (PET) and MRI.

The first use of magnets in dentistry dates back to the 1940s, when Freedman attempted to improve the retention of dentures in patients with severely resorbed edentulous mandibles. Early work with magnets involved platinum cobalt alloys.[3] Alnico alloy was then used owing to its favorable height-diameter ratio. Further developments are seldom seen till the late 1970's, when the rare earth cobalt magnets were developed and put to practical use.[4] The miniaturization of magnets as a result of the introduction of rare earths or lanthanide elements enhanced the potential for this relatively non-fatiguing source of stored energy. Experiments were done using sintered samarium cobalt (SMCO) alloys and the stored energy and forces were found to be superior to alnico.[5]

The conventional magnets have been used as retentive devices for removable partial dentures, obturators and maxillofacial prosthesis. But now the rare earth magnets overtook conventional magnets with their unique properties of retentive force, stress-breaking characteristics, corrosion resistance, biocompatibility and compactness which have resulted in widespread use for the over dentures. This article gives the overview on the use of magnets in prosthodontics.

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2. CLASSIFICATION[1]

2.1 Based on alloy used

- Those containing Cobalt
  eg: Alnico, AlnicoV, Co-Pt, Co5Sm.
- Those not containing Cobalt
  eg: Nd-Fe-B, Samarium iron nitride.

2.2 Based on ability to retain magnetic properties (intrinsic coercivity or hardness)

- Soft (easy to magnetize or demagnetize) (less permanent)
  eg: Pd-Co-Ni alloy, Pd-Co alloy, Pd-Co-Cr alloy, Pd-Co-Ct alloy, magnetic stainless steel, Permendus (alloy of Fe-Co), Cr-Molybdenum alloy
- Hard (retain magnetism permanently)
  eg: Alnico alloy, Co-Pt, Co5Sm, Nd-Fe-B

2.3 Based on surface coating (material may be stainless steel, titanium or palladium)

- Coated
- Uncoated

2.4 Based on type of magnetism

- Repulsion
- Attraction

2.5 Based on type of magnetic field

- Open field
- Closed field - Rectangular close field sandwich design
  -Circular close field sandwich design

2.6 Based on number of magnets in the system

- Single
- Paired

2.7 Based on arrangement of poles

- Reversed poles
- Non-reversed poles

In the various dental applications of magnets, the following materials have been used

1) Conventional magnets

a) Platinum cobalt

b) Aluminium-nickel-cobalt (Alnico)

c) Ferrite

d) Chromium-cobalt-iron

2) Rare Earth Magnets

a) Samarium-cobalt

b) Neodymium-iron-boron

3. REVIEW OF LITERATURE

Behrman in 1954 described the technique for the implantation of magnets in the jaw to aid in denture retention. He implanted first Al-Ni-Co V magnets in human mandible consisting of aluminium – nickel – cobalt iron alloy coated with acrylic resin. Similar magnets were placed in conventional complete dentures.[6] **Nadeau** was the first to use magnets in maxillofacial prosthesis in **1956**. He showed the use of "magnetic stabilizers" to be of great value in maintaining and stabilizing facial prosthesis related to oral prosthesis. Maxillofacial prosthesis, in order to be functional, should be of a very simple design, with ease of manipulation for the patient. The use of magnets for stabilizing these restorations can make them simple and effective.[7] **Lothar Probster et al in 1995** described a technique for implant retained epistheses in which auricular prosthesis is retained using two retroauricular titanium implants to which a cast bar carrying two titanium encapsulated magnet is secured. Also an elastic clasp in the epistheses fits into a loop attached to the bar and prevents the loss of epistheses which is retained in its original position by the attraction force of magnets.[8]

Marco Cune et al in 2005 studied to determine patient satisfaction with implant-supported mandibular overdentures using magnet, bar clip, and ball-socket attachments and assess the relation between maximum bite force and patient. They concluded that mandibular implant-supported overdenture treatment reduced various denture complaints. The VAS (visual analogue scale) score

better reflected patient preferences than scale score. Patients strongly preferred bar-clip (10/18 subjects) and ball-socket attachments (7/18 subjects) over magnet attachments (1/18 subjects). Patients' preferences could not be predicted on the basis of baseline observations. Maximum bite force was not correlated to scale or VAS score. Hence, patients with higher maximum bite forces were not necessarily more satisfied.[9]

Yoshinobu Maeda et al in 2011 did a study aimed to clarify the efficacy of a newly developed self-adjusting magnetic attachment (SMAT) that allowed 0.4mm of vertical and 8 degrees of rotational movements using an in vitro model. Comparison between the SMAT and a conventional magnetic attachment (CMAT) was performed for the retentive force under different dislodgement directions. Lateral forces to the abutment were also compared among the SMAT, CMAT, dome shaped magnetic attachment, and a ball attachment. The SMAT maintained retentive force more effectively than the CMAT, even in oblique directions of dislodgement. A smaller lateral force to the abutment was found for the SMAT compared to the CMAT or ball attachment.[10]

Kwok-Hung Chung et al in 2011 evaluated the retentive and morphologic changes of over denture attachments independently after repeated insertion and sinusoidal loading on implant abutments. Stud and magnetic attachments were embedded in over denture housings (n=5). The over dentures were subjected to both repeated insertion and removal for 5,400 cycles or sinusoidal cyclic loading for 100,000 cycles. A 67.8% decrease in retentive force was observed after 100,000 loading cycles ($p < 0.05$), and a 73.9% decrease of retentive force occurred after 5,400 insertion-removal cycles ($p < 0.05$). Stud attachments showed more loss of retention and physical deterioration than magnetic attachments tested under identical conditions.[11]

4. APPLICATIONS IN PROSTHODONTICS

1. Magnet retained tooth supported overdentures
2. Magnet - retained implant - supported overdentures
3. Magnets in maxillofacial prosthesis

4.1 Magnet retained tooth supported overdentures

The over denture design was found highly effective in the mandible. Greater stability and retention of over dentures can be achieved by the use of attachments. Since these techniques are time consuming and costly, we suggest the use of magnets within the root as an economic and functional alternative.

The advantages of this approach over the buried magnetic implant technique are:

- The magnet is not buried in bone or soft tissue, and therefore there is no surgery involved;
- There is no danger of compression of soft tissue between the implant and the magnet;
- Tthe implant does not interfere with the normal function of any of the tissue; and
- The implant is easy to observe and maintain or replace.[12]

The magnetic retention unit consists of a denture retention element and a detachable "keeper" element. The denture-retention element has paired, cylindrical, cobalt-samarium magnets, axially magnetized and arranged with their opposite poles adjacent. The detachable keeper element is a stainless-steel disk that is fixed to a decoronated, root filled tooth. The denture-retention element is cured into the over denture base so that it grips the keeper element in the root magnetically with a force of approximately 250gm.

Keeper Types

Three different versions of the keeper have been developed: the preformed cement-in keeper, the preformed screw-on keeper, and the cast root cap and dowel keeper. Each has its own advantages and disadvantages.

4.2 Magnet-retained implant-supported overdentures

Magnets were first used in conjunction with implants in the late 1950's. Behrman implanted Teflon-coated cobalt-platinum bar magnets in the mandibles of edentulous patients. After the recipient site had

healed and bone filled in over the magnetic implant, a denture that contained a similar magnet embedded in the denture base was constructed so that the opposite poles were oriented toward each other.[13] Thus, the attractive forces of the magnetic flux would act across the bone, periosteum, gingival tissues, and base acrylic resin sandwiched between the two magnets and thereby seats the denture on the ridge.

In any magnetic retentive system, the component parts must be in intimate contact to take advantage of the attractive forces of the magnetic flux field. As the air gap between the component parts increases, the attractive force falls off dramatically. Furthermore, if the implant magnet and the embedded magnet were located close enough to each other for there to be an appreciable attractive force, the implant magnet would be pulled through the bone, periosteum, and gingival tissues, and would eventually become exposed in the oral cavity. The Jackson Rare Earth magnetic system has keeper screw inserts compatible with the Brånemark pure titanium implant, the Core-Vent titanium alloy implant system, and the Calcitek calcium hydroxyapatite, plasma-coated implant system. The Jackson magnetic system adapted to tissue-integrated prostheses has also been successfully used to retain facial prostheses (eyes, ears, and nasal defects).

4.3 Magnets in maxillofacial prosthesis

The use of magnets is the most efficient means of providing combined prosthesis with retention and stability in patients with deformities requiring complex rehabilitations. The majority of prosthesis with magnets are sectioned and have a magnet in each section. The retention of the prosthesis that are located in the maxilla is affected by naturally existing gravitational forces acting on it. Constant pull applied on the prosthesis by the gravity also has been found to have ill effect on the remaining natural teeth, which support the prosthesis. A lightweight prosthesis will not only combat this problem but it will also enhance the resonance of speech. Magnets are thus used in orbital prosthesis, auricular prosthesis, large and small maxillary defects and intra oral-extra oral combination prosthesis.

SUMMARY

This article has discussed in brief the history of magnets, classification and their applications in prosthodontics. From the earliest, large sized Alnico materials to the recent small sized yet powerful rare earth elements have been used in prosthodontics for retention of different prosthesis like complete dentures, over dentures. Magnets also find uses in multi component maxillo facial prosthesis where the extra oral component has been attached to intra oral component or the bulb portion of the defect has been attached to the intra oral prosthesis.

The advantages of using magnets are their ease of placement, automatic reseating, constant retention with many cycles, easy replacement if needed, they have a small size with strong attractive forces, can be placed within the prosthesis and dissipate lateral functional forces, there is less need for parallel abutments, can be used for implant-supported prosthesis and can be easily cleaned.

The disadvantages of using magnets are low corrosion resistance, cytotoxic effects of the leachants, high cost and a short track record.

Improvements in sealing techniques (namely, laser welding) have resulted in more effective sealing of magnet encapsulations thereby preventing its corrosion. However, further work is required to find more corrosion- and wear-resistant encapsulation materials.[3] The development of samarium-iron-nitride may offer better resistance to corrosion.[14]

CONCLUSION

Dentistry is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment are required. The intra oral magnets are shaping the course of esthetic and retention for both complete and removable partial denture. The clinical procedures for the fabrication do not require any special skill and the option offered by the various manufacturers gives the dentist a wide variety of choice.

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THE MAXILLARY MIDLINE DIASTEMA: A MISHAP DURING MIXED DENTITION PERIOD

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ABSTRACT

One of the most common aesthetic complaint in the mixed and permanent dentition period is the presence of midline diastema. Treatment of midline diastema depends upon the etiological factors associated with it. Innovative therapies from restorative and orthodontic therapies to surgeries are available in the treatment of midline diastema. This paper aims to provide an overview about the etiological factors associated with midline diastema and management options available to correct it.

KEYWORDS : *Mixed dentition period, Diastema closure, Ugly duckling stage, Frenectomy*

INTRODUCTION

Diastema, which means interval in Greek, is a gap or space between two or more consecutive teeth. It occurs more frequently in the median plane of the maxillary arch between the two central incisors and hence called the median, central or midline diastema.[1,2]

Broadbent consider midline diastema as an 'ugly duckling stage' and explain this phase as a transitional phase in the dental development. When the incisors first erupt, they may be separated by bone and the crowns incline distally because of crowding of the roots. With the eruption of lateral incisors and permanent canines, midline diastema reduces or even closes[3].

However for some individuals, the diastema does not close spontaneously. Factors that plays an important role in the etiology of diastema are genetics, physiological, arch length & tooth material discrepancy, physical impediment like abnormal labial frenum and mesiodens, pernicious habits, racial predisposition & even iatrogenic due to rapid maxillary expansion or Milwaukee braces.

Treatment modality, timing and retention protocol depends on the etiology of the diastema. To ascertain the cause and nature of diastema proper diagnosis is necessary which should include medical and dental history, clinical and radiographic examination, tooth size evaluation and "blanching test" may be used to evaluate the aberrant frenal attachments.

The treatment of maxillary midline diastema involves general practitioners & specialists such as orthodontists, pedodontist, oral surgeons, & periodontist. Treatment methods usually include orthodontic correction with a fixed or removable appliance and restorative and prosthetic correction with composites and crowns respectively. In most cases, simple removable appliances incorporating finger springs or a split labial bow can give good results. But the drawback of using removable appliance is only tipping movements can be achieved. Fixed appliance incorporating elastics or springs bring about the most rapid correction of midline diastema.

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MIDLINE DIASTEMA ETIOLOGY

It has been reported that numerous etiological factors are contributing to the development of midline diastema. There is no agreement on a single etiological factor. The prevailing view seems to consider its development as a multifactorial phenomenon.

1. Genetics of midline diastema

Nainar and Gnanasundaram (1997), in their study of midline diastemas in a South Indian population sample, examined 9774 individuals from 13 to 35 years of age in order to determine the consequences and possible etiological factors of this feature. The relatively increased frequency of familial occurrence led the authors to propose the presence of a genetic factor contributing to midline diastema expression.[3] Shashua and Artun (1997) report that genetic predisposition is a probable precondition contributing to midline diastema development. The authors concluded that the family tree of diastema was one of the only two important risk factors for diastema relapse. The other factor was diastema size before treatment.[4] Gass et al. (2003) note that preliminary results from thirty families show a possible genetic basis for this diastema. More specifically, "heritability" was estimated at 0.32 for the white and 0.04 for the black population. "Heritability" is defined as the ratio of the total genotypic diversity to the total phenotypic diversity with values ranging from 0 to 1. Data from family trees suggest a dominant autosomal hereditary type .[5]

2. Abnormal labial frenum

One of the major etiological factor considered for midline diastema is the presence of a hypertrophic labial frenum. In a thick and fleshy labial frenum, the fibro-elastic band crosses the alveolus and inserts into the incisive papilla, preventing the approximation of the maxillary central incisors. Though there is still controversy over whether an abnormal frenum attachment is the cause or effect of a maxillary midline diastema.[6] Most of the researchers, like Angle,[7] Sicher,[8] Gardiner,[9] and Edwards,[10] are of the opinion that superior labial frenum causes midline diastema. Some researchers, like Popovich et al, believe that there is an inverse relationship between high frenal attachment and midline diastema.[11] According to them, labial frenum persists owing to the existing diastema and, as the dentition applies little or no pressure on the tissues, there is little or no atrophy of the frenum. But most of the researchers agree that removal of the high bulbous labial frenum is important for the stability after the closure of the midline diastema.[12] The blanching test is a simple diagnostic test to predict whether the frenum will unfavorably influence the development of the anterior occlusion. It is performed by applying intermittent pressure on the frenum by elevating the lip. If it blanches on applying pressure and if a heavy band of tissue with a broad fan base is attached to the palatine papilla, it can be concluded that the frenum is at an unfavorable position for the existence of a normal tight contact between the central incisors.

3. Abnormal maxillary arch structure

Tooth-size discrepancies are caused by excessively large maxillary arch size (rather than small teeth) or bony defects that inhibit approximation of the incisors. These abnormal maxillary arch structures include:

a. Open suture, W-shaped, or spade-shaped

b. Idiopathic midpalatal suture due to orthodontic or orthopedic treatment (e.g., rapid palatal expansion, Milwaukee Brace®)

c. Excessive skeletal growth (associated with certain physical conditions such as cerebral palsy and endocrine imbalances such as acromegaly)

d. Loss of bone support (periodontal disease, systemic disease).

4. Dental anomalies and other malocclusion

Abnormal size, shape, or position of adjacent teeth can leave spaces between them that are not the result of other forces (e.g., muscular imbalances, excessive frenum tissue, etc.) These etiologies include:

a. Tooth and/or arch size discrepancies including peg laterals

b. Supernumerary teeth at the midline (mesiodens)

c. Missing teeth (congenital, from caries, or orthodontic treatment)

d. Abnormal occlusal patterns such as rotated incisors, class II division 1 malocclusion

5. Pernicious Habits

Prolonged pernicious habits can change the equilibrium of forces among the lips, cheeks, and tongue and cause unwanted dentofacial changes. The outward pressure from prolonged oral habits (light continuous force over 6 hr.) with inadequate lips seal can cause the maxillary incisors to flare out, which leads to the midline diastema. Examples include: lower lip biting and digit sucking.

Diastemas caused by habits will gradually decrease in size after terminating the habit. Closure is deferred until the oral habit stops. Even after discontinuing the oral habit, patients with persistent diastemas may require orthodontic treatment to correct the malocclusion.

DISCUSSION

Because of the potential for multiple etiologies, the diagnosis of a diastema must be based on a thorough medical/dental history, clinical examination, and radiographic survey. Diagnostic study models also may be necessary for analysis and measurement when the diastema may be due to malocclusion, or tooth and/ arch size discrepancy. The medical/dental history should investigate any pertinent medical conditions (such as hormonal imbalances), oral habits, previous dental treatment and/or surgeries, and family history of diastemas or other related dental problems. The clinical exam should include evaluation of possible pernicious oral habits, soft tissue imbalances (e.g., macroglossia), improper dental alignment (rotated teeth, excessive overbite/overjet), missing teeth, or other dental anomalies. The "blanching test" may be used to evaluate the frenal attachments. Panoramic and periapical radiographs are necessary to evaluate the patient's dental age and any physical impediments, abnormal suture morphology, missing teeth, dental anomalies, improper dental alignment, or abnormal eruption paths. In some instances, complete orthodontic records and a Bolton's analysis may be necessary to rule out skeletal/dental malocclusions as well as possible jaw size and/or dental size discrepancies.

The practitioner must consider the contributing factors before determining the optimal treatment which should include normal growth and development, tooth size discrepancies, excessive incisor vertical overlap of different causes, mesiodistal and labiolingual incisor angulation, generalized spacing and pathological conditions. A carefully developed differential diagnosis allows the practitioner to choose the most effective orthodontic and/or restorative treatment.

Restorative and prosthetic solutions are most amenable for diastemas based on tooth-size discrepancy. Though the most appropriate treatment often requires orthodontically closing the midline diastema. The following treatment options are in practice.

In some cases, orthodontic closure of the diastemas is limited to the central incisors. In patients with good posterior occlusion or who have economic considerations, the diastema can be closed simply with removable orthodontic appliances. A removable Hawley appliance with finger springs is commonly used. Simple fixed appliances often have been used. [13] These devices involve a U- or V shaped sectional wire and some double helical closing loops and are bonded directly to the incisors or attached to lingually bonded tubes. Micromagnetic devices have been described.[14] These fixed appliances also can serve as post-treatment retainers. Diastema closure in these cases should be deferred until the canines erupt.

In certain instances closing a diastema requires bodily approximation of the incisors. Full banded/bracketed orthodontic arch appliances can move incisors bodily to close the space. However, if time or cost factors prohibit this type of treatment, or if the diastema is the only malocclusion needing

treatment, sectional arch wire techniques are a useful alternative.[15] This technique involves bonding brackets directly on the four maxillary incisors and using a 0.018- in. sectional wire. An elastomeric chain or elastic thread should be placed from the mesial wing of one lateral incisor bracket through the brackets of the centrals to the mesial wing of the other lateral. Overstretching the elastomeric chain can cause unwanted mesial rotation of the lateral incisors if the elastomeric chain is connected from the distal wing of one bracket to the distal wing of the other. Treatment with a "2x4 appliance" or utility arch can provide better control of incisors during closure of the midline spaces and also can retract any minor incisor flaring. Although treatment is best delayed until canine eruption, it can be initiated after the lateral incisors have erupted.

In many cases of protruded maxillary incisors overeruption of the incisors are demonstrated in both arches. Decreasing the overjet by simply moving the incisors lingually can cause a significant occlusal contact. Removable appliances often will cause this unwanted overbite and should be used carefully and only in patients with minimal overbite and when the maxillary incisors are not in contact with mandibular incisors. Hawley-type retainers with a labial bow and clasps are useful for this limited therapy. In most cases of increased overjet, treatment requires the use of a full-arch fixed appliance technique to intrude the incisors while closing the diastema. Both arches may require treatment. In some of these cases headgear may be needed for appropriate anchorage.

In general, fixed-type appliances can provide better control in crown/root angulation, overbite, and overjet. Bracketed/banded appliances can close diastemas due to improper tooth inclination, deleterious occlusal patterns, posterior bite collapse, deep bite with insufficient torque, or skeletal and/or dental class II division 1 malocclusion.[16] Some patients may need to wear a headgear or Class II elastics to distalize the posterior teeth. Class I relationships should be achieved before the diastema is closed. Removable orthodontic appliances can be used cautiously in diastema cases with Class I dental and/or skeletal relationship and mild or acceptable overbite.

Management of maxillary midline diastema with missing lateral incisor in early mixed dentition by 2×4 appliance included closure of space between maxillary central incisors, space created between permanent central incisor and deciduous canine to be closed by prosthetic replacement.[17] Maxillary permanent canines to be guided in the place of lateral incisor and achievement of appropriate canine and molar relationship. Alternative treatment based upon the proclination of anterior teeth and molar occlusion, either canine could be retained in lateral incisor position and molar relationship finished in class II, or canine moved into its place and molar relationship finished in class I with replacement of missing lateral incisors.

However, closure of midline diastema with a prominent frenum is more predictable with frenectomy and concomitant orthodontic treatment than frenectomy alone. Performing frenectomy and concomitant orthodontic treatment after canine eruption is found to be a predictable treatment option for maxillary midline diastemas. Frenectomy before canine eruption may be indicated for larger diastemas, when spontaneous closure is questionable. There is confusion as to whether to carry out a frenectomy before or after orthodontic space closure. As one study has shown, in some cases, some midline space closure is seen after a frenectomy without orthodontic treatment. This makes it tempting for the dentist to advice patients to undergo this procedure before the orthodontic space closure. However, another author advises a frenectomy procedure after the correct positioning of the central incisors when the diastema is closed.[18] The basis behind this thought is that, if the excess tissue is removed after the teeth have been squeezed together, the healing and the scar tissue will be formed around the closed teeth which will help retain the result of treatment. Some

orthodontists support a viewpoint that there is a need for an early removal of the frenum, so as to prevent any obstacles to complete diastema closure. But if frenectomy is done prior to the orthodontic space closure, the scar tissue is formed between the teeth, increasing the risk of relapse. Nevertheless, occasionally, when the frenum is particularly hypertrophic and inhibits the orthodontic closure of the diastema, it is necessary to surgically reposition the frenum nasally before the end of orthodontic treatment. The above options must be performed only when the diastema persists after the eruption of permanent canines, as, in most cases, the eruption of the canines leads to spontaneous closure of the maxillary midline diastema.[18,19]

Relapse of the maxillary midline diastema appears, according to Sullivan et al. (1996), in almost 34% of cases, while, according to Shashua and Artun (1999) this rate rises to 50%. The reason for relapse is the placement of teeth in a position where no equilibrium exists with their functional environment.[20]

It has been speculated that the tendency for relapse will be reduced if the etiology for diastema is eliminated with treatment, while the tendency will be enhanced if the causative factor cannot be removed. The former may be demonstrated in patients with deficient tooth structure due to missing or peg laterals or in patients lacking mesially directed force due to impacted or displaced teeth. In these situations, etiology is removed either through the orthodontic treatment or through concomitant restorative procedures. If on the other hand etiology is not eliminated, as may be the case with the presence of a habit, a genetic tendency, extensive loss of periodontal support, or posterior bite collapse, the diastema may reopen readily after appliance removal.[20]

As a general rule, treatment is unlikely to produce assured and stable results, thus the use of permanent retention for a considerable period of time or even for life, is essential in almost every case. The most appropriate method for achieving long-term retention after orthodontic treatment is through the use of palatally bonded multistranded stainless steel wire retainers, which allow teeth to maintain their physiologic mobility and are easy to fabricate. In cases where the retainer interferes in functional movements of the mandible, it can be bonded cervically or within a shallow rim constructed in the enamel of teeth.[20]

CONCLUSION

Midline diastema is usually a part of normal dental development and hence its presence during the mixed dentition period is not a matter of concern. However, if the diastema is more than 1.8 mm, even after the eruption of lateral incisors, an orthodontic intervention will be necessary. Several etiological factors are reported and discussed in the literature and no single etiological factor is agreed upon for the development of a midline diastema. A radiographic examination of the site will be beneficial to rule out any multifactorial etiology. To achieve an aesthetic and stable result, it is important to establish the underlying cause for the midline diastema. Retention protocol should depend on the size and the etiology of the midline diastema.

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RECENT ADVANCES IN ACCESS CAVITY PREPARATION: A REVIEW

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ABSTRACT

Access cavity preparation is of paramount importance as it is the vital stage that governs the success or ease of the endodontic treatment. An inadequate access cavity might turn all the treatment steps difficult from access to obturation. Traditional access cavity preparation aims towards sufficient access and thereby proper irrigant penetration into the root canal. But with advent of newer methods in magnification, diagnostic modalities, irrigation techniques and obturation, minimally invasive methods of access cavity preparation open up a new scope. This review describes the latest trends in access cavity preparation and their advantages and disadvantages over traditional access cavity preparation and techniques employed.

KEY WORDS : *Minimally Invasive Endodontics, Access Designs, newer methods*

INTRODUCTION

Structural integrity of the tooth is a significant factor that determines prognosis as it relates to the post endodontic survival rate of the endodontically treated tooth. In the quest of eliminating the microorganisms from the canal system one should also make sure that there is no extensive loss of tooth structure in this process. During access opening minimal removal of dentin is advised and while cleaning and shaping of the root canal one must retain as much sound dentin as possible.[1]

In this era of enhanced magnification coupled with the availability of increasingly more flexible nickel-titanium rotary instruments, there has been a paradigm shift in endodontic access preparation from a conventional to conservative approach. Within the last decade, the goal of access preparation is towards reducing its size to the natural dimensions of the pulp chamber. This improved survival outcomes as it is less invasive and preserves a lot of tooth structure.[2]

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PRESERVATION OF TOOTH STRUCTURE

Endodontic access should be considered as the key to endodontic success, as well as restorative success. The long-term retention of endodontically treated teeth and fracture resistance of tooth are related to the amount of residual tooth structure.[3,4] The long-term retention of tooth can be ensured by the preservation of the following:

1. Pericervical dentin (PCD): Pericervical dentin is the dentin near the alveolar crest which is roughly 4 mm above the crestal bone and extending 4 mm apical to the crestal bone. This is called the irreplaceable critical most zone.[5] Pericervical dentin is crucial for the transfer of occlusal load to the root. Pericervical dentin preservation is hence of utmost importance as it helps in the prevention of fracture and ferrule.
2. Banking of tooth structure (Soffit): In architecture, a soffit is described as the underside of an architectural feature such as the ceiling, the corner of the ceiling, and the wall.[6] According to Clark and Khademi, a small piece of roof of pulp chamber is retained around the pulp chamber to preserve pericervical dentin, which is known as the soffit.[7] Maintenance of soffit is a perfect example of banked tooth structure. It can be 0.5 mm or as large as 3.0 mm. Attempts at removing soffit which is a small piece of roof around the entire coronal portion of the pulp chamber may also damages the surrounding Pericervical dentin. The primary reason to maintain the soffit is to prevent the occurrence of the gouging of the lateral walls (Figure 1).

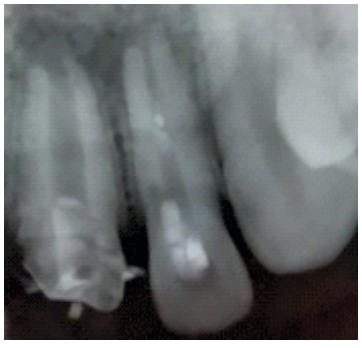

Figure 1: Gauging (here the bur axis is positioned wrongly which results in excessive removal of dentin)

3. Three-dimensional ferrule (3DF): Ferrule is the axial wall dentin covered by the axial wall of the crown and has been described as the backbone of prosthetic rehabilitation.[8,9] Three-dimensional ferrule is an available dentin that will buttress the crown which has 3 components.

- Vertical component - around 1.5 to 2.5 mm
- Thickness of dentin (Girth)-Absolute minimum thickness-1-2 mm
- Total occlusal convergence or Net Taper, which is 10 degrees in 3mm of vertical ferrule, 20 degree in 4mm, possible in the traditional stainless steel crowns. Porcelain crowns demands 50 degree or more taper due to its deep chamfer marginal zones.

NEWER ACCESS PREPARATION DESIGNS

- Truss access
- Ninja Endodontic Access Cavity
- Caries leveraged access.
- Cala Lilly Enamel Preparation
- Guided endodontic access.
- Dynamic Guided access

Truss access[10]: Here separate cavities are prepared to approach the canal systems. The main objective of these access cavity designs is the preservation of dentin by leaving a truss of dentin between the two cavities thus prepared. Two separate cavities are made usually for multiple canal tooth. However, many factors like experience of the practitioner, calcifications, abnormal anatomy along with magnification and illumination determines the success. This minimal invasive approach almost avoids the need for conventionally placed crowns after endodontic treatment.

Ninja endodontic access cavity (Orifice-Directed Dentin Conservation Access): To obtain outline for "ninja" access, the oblique projection during access preparation is made in an occlusal plane

towards the central fossa of the root orifices . Here all canals cannot be seen at a straight view and we need to change the angulation of the mouth mirror to view canals.[11]

Caries leveraged access: According to this concept described by Clark and Khademi, low or zero value tooth or restorative structures i.e., existing restorative materials, decay and less strategic tooth structure are removed for access preparation. This access design thus allows for direct conservation of healthy dentin by removing discontinuities in tooth structure.[7,12.]

Figure 2: Cala Lilly flower

Cala Lilly enamel preparation: In Cala Lilly enamel preparation, shape of the access preparation resembles cala Lilly flower (Figure 2). In this preparation a bevel of 45^0 is given on the enamel portion of access cavity to remove undermined enamel which resembles a cala Lilly flower.[13] While removing the old fillings and caries an uncomfortable C factor is formed and in order to eliminate those weak enamel rods this technique is being used.[7,10.]

CAVITY DESIGNS	AUTHORS
Contracted access cavity	Clark and khademi[7]
Truss access cavity	Abou-Elnaga et al [10]
Ninja access cavity	Plotino et al [16]
Guided access cavity	Krastl G,Zehnder and connert[15]

Table 1: Conservative access opening techniques and name of authors who introduced it

Image Guided endodontic access preparation: Guided Endodontics method utilizes 3D printed templates to gain minimal invasive access to root canals. Intraoral scanning is done followed by CBCT scanning.Virtual drill path is then planned on the computer screen which is designed by a combination of data acquired from intraoral scanning and CBCT and virtual sleeve is made for guiding the bur.Templates are prepared based on this and their fitting is checked. Access is then prepared in this area using specific bur to gain access to the root canal.[15]

Dynamic Guided access using augmented reality: Dynamic guidance which has been used for implants was recently introduced to endodontics as an alternative to milled drill guides.[16] Dynamic guidance was recognised as a solution for the difficulties faced during the use of static drill guides in guided endodontics. It uses an overhead three-dimensional camera system (X-NAV System) which helps to relate the position of the hand piece and the jaw of the patient during the clinical procedure. Interaction of the clinician with the system is via voice commands allowing the bi-manual operation. Also, dentist is able to review radiographs during the procedure without the need to divert attention away from the patient and look at a separate monitor. Experiments are performed to evaluate the accuracy of the measurements.

CONCLUSION

Traditional access cavity has been practiced over a long time. However, with the advancement in technologies like CBCT, other imaging modalities and with the advancement in rotary systems and newer methods of irrigation, thermo plasticised obturation techniques, the practitioners became equipped to conserve the tooth structure while doing root canal procedures. Proper illumination and magnification too aid in the process. This conservation markedly increases the strength of tooth structure which was a problem seen after endodontic treatment. Latest trends are now with the aid of artificial intelligence and guided access which opens scopes for tele-dentistry.

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