Editorial

Dental Bites, the quarterly publication of KMCT Dental College, was started in the year 2012. Its initial title was Dentalight. Now into its fifth year of existence, it is time to review its progress, and chart a roadmap for its remodeling strategy in order to impart a new direction. This journal, devoted for publication of exclusive scientific articles, is now in the process of restructuring thereby ensuring quality in the articles selection process, peer reviewing, and timely publishing. This process shall take some time to be completed systematically and methodically.

Hope all our regular readers, contributors, and well wishers shall extend their support for the above process by way of honest feedback, constructive suggestions, and frank opinions. It is our wish that this publication hence would become a priority journal for scientific publications in general and speciality dentistry by virtue of its content, quality assurance in selection and peer review, and regular publishing process. We also have a plan in the pipeline to apply for accreditation by indexing organizations in a step by step and humble manner. Seek blessings from all well wishers.

Best Regards

Dr. Pradeep Kumar. C
(Principal)
Chief Editor

TABLE OF CONTENTS

COCONUT WATER: AN EMERGING STORAGE MEDIUM FOR AVULSED TOOTH

*Dr. Binu Purushothaman, **Dr. Naseem K T, ***Dr. Nizaro Siyo,
****Dr. Sreeshan S, *****Dr. Fawas, ****** Febina Ahmed Palayat

Abstract

Dental avulsion is the most severe type of traumatic tooth injuries because it causes damage to several structures and results in the complete displacement of the tooth from its socket in the alveolar bone. The ideal situation is to replant an exarticulated tooth immediately after avulsion. Maintaining the tooth in an adequate wet medium that can preserve, as longer as possible, the vitality of the periodontal ligament cells that remain on root surface is the key to success of replantation. Recent research has led to the development of storage media that produce conditions that closely resemble the original socket environment, and thus create the best possible conditions for storage: coconut water is one among them.

Keywords: coconut water, storage medium, dental avulsion, tooth replantation

Corresponding author: Dr.Binu Purushothaman

Professor & Head,Reader,***Professor, ,****Senior Lecturer,*****Post Graduate Student, Department of Orthodontics & Orofacial Orthopaedics, ******Final BDS Part I Student, KMCT Dental College, Manassery, Kozhikode 673602, Kerala, India*

Introduction

Appearance is related to facial structures, and it is recognized as the important key factor to social interactions throughout life. Face is the most visible and vital feature to human appearance and function. Facial injuries can impair patients ability to eat, speak, interact with others, and perform other important functions.[1] Among all the facial injuries, dental injuries are the most common to occur[2] and among this dental avulsion is the most acute form.[3]

Dental avulsion is the complete displacement of tooth from its socket in alveolar bone owing to a trauma. Reported incidence of dental avulsion is 1-11% of all dental injuries to the permanent dentition, with the maxillary central incisor being the most frequently involved tooth. The age group of 7-10 years appears to be most affected.[4]

Depending on the complexity of avulsion, neurovascular supply is severely compromised and usually results in loss of pulp vitality. The desirable treatment option is replantation of the tooth. A vital periodontal membrane has been found to be of ultimate importance for the successful healing of replanted teeth.[4]For ensuring vital periodontal ligament cells in cases where immediate re-plantation is not possible, effective storage medium to maintain the vitality of the periodontal cells becomes the ultimatum. Storage media can improve the

outcome of the treatment by protection of teeth from desiccation due to drying of the periodontal ligament tissue.

An ideal storage medium would be one that is capable of preserving the viability, mitogenicity, and clonogenic capacity of the damaged PDL in order to facilitate repopulation of the denuded root surface thereby preventing further root resorption.[5] Different storage mediums recommended are saliva, saline, milk, viaspan, HBSS, Gatorade, propolis, coconut water.[6,7]Coconut water due to its biologically pure and sterile characteristics is considered to be a very effective storage medium.

Causes for avulsion

- Fall
- Accidents
- Sports
- Assaults or altercations
- Battered child
- Other causes

Incidence

Avulsion occurs in 1–16% of all dental injuries.[8]The peak age for avulsion is between 7 and 9 years when permanent incisors are erupting, and the teeth most commonly avulsed in both primary and permanent dentition are maxillary central and lateral incisors.[9,10]

Management

The main aim at managing an avulsed tooth is immediate replantation. This could be done at the site of injury as well as at the dental office.

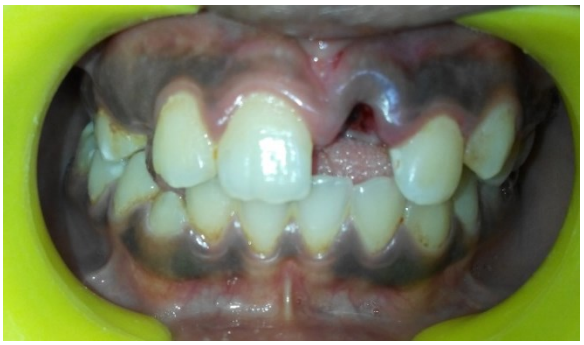

Fig 1a: Avulsed 21

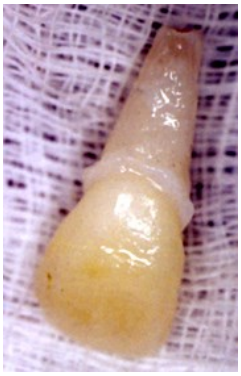

Fig 1b: Avulsed 21

1. At the site of injury

Many a time replantation at the site of injury becomes in executable as there may be life threatening situations where replantation of the tooth becomes secondary. There could also be situations where more than one tooth will be avulsed and the layman will not have the knowledge of how and which tooth to replant.In that case the best thing to do would be rushing to a dental office. When the teeth are covered with debris, it must be washed off with a physiological solution and should never be scrubbed. This should then be stored in the best available storage medium.

2. At the dental office

The avulsed tooth should be examined for obvious contamination. If

visibly contaminated, the tooth surface should be rinsed gently with a stream of saline from a syringe until visible contaminates have been washed away. The debris on the root surface should never be scraped off because then viable periodontal ligament cells could be scraped off as well. It is better to replant the tooth with minor debris on it than risk removing or destroying periodontal ligament cells. No effort should be made to sterilize the tooth surface because this may damage or destroy vital periodontal tissue and cementum.

The alveolar socket should be examined. If needed, the socket can also be rinsed with a flow of saline to remove the contaminated coagulum. If there is evidence of socket collapse or fracture, the fractured bone should be repositioned using a blunt instrument such as a mirror handle to remodel the bony socket.

The replanted tooth requires temporary stabilization by splinting. Recent studies have shown that long-term rigid splinting of replanted mature and auto transplanted immature teeth increases the risk of replacement root resorption (ankylosis). Accordingly, replanted teeth should only be splinted for a minimal amount of time (7-10 days) with a flexible wire or monofilament.[11]

Why store the avulsed tooth?

To preserve the vitality of the periodontal ligament is the ultimate requirement for successful healing of a replanted tooth. Protection of teeth from desiccation due to drying of the periodontal ligament tissue, by keeping it in storage media can improve the outcome of the treatment.

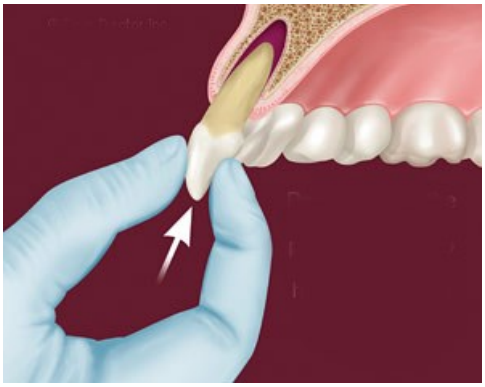

Fig 2: management of avulsed tooth

Storing the tooth can reduce the risk of tooth ankylosis. They could also prevent foreign bodies and bacterial invasion. Preservation of stem cells by maintaining the viability of the periodontal membrane could be an excellent outcome.

Qualities of a storage medium

- They should closely resemble the original socket environment.
- Adequate osmolality (cell pressure).
- Adequate pH.
- Nutritional metabolites.
- Ready accessibility and availability.
- Should be able to maintain PDL viability.
- Antioxidant property.
- Clonogenic capacity.
- No or minimal microbial contamination.

Storage materials

- Hanks Balanced Salt Solution(HBSS)
- Minimum essential medium(MEM)
- Saliva
- Bovine milk
- Propolis
- Viaspan

- Green tea
- Egg white
- Ice packs

Why coconut water??

Coconut water is biologically pure and sterile. It is rich in amino acids, minerals and vitamins. It is known to possess regenerative and antioxidant properties. Storage media having antioxidant properties can be more effective in maintaining the viability of PDL.[12- 14]

Advantages

- ❑ Coconut water can be used in raw form
- ❑ Ability to maintain periodontal cell viability for a longer time
- ❑ Natural products have easy availability
- ❑ Longer storage time
- ❑ Antioxidant property

Properties of coconut water as a storage media for tooth avulsion

1. Antioxidant

Antioxidants are basically chemicals that can prevent or slow cell damage. Storage media having antioxidant properties can be more effective in maintaining the viability of PDL. Interestingly, coconut water is abundant in antioxidants that clues it to be an excellent it its job.

2. Viability

Coconut water is comparable to HBSS and is more satisfactory than milk and saline for maintaining viability of PDL of avulsed tooth. They found that the total number of viable PDL cells was signifi cantly high when stored in coconut water as compared to propolis (50%), HBSS and milk.

Another study found the combination of coconut water with sodium bicarbonate to be more effective but some studies have also demonstrating contradicting results. Since the pH of coconut water is 4.1, it has harmful effects on cell metabolism until sufficiently neutralized.[15, 16]

It was also observed that Regular pasteurized milk and long-shelf life whole milk were found to have no significant difference in their storage efficacy when compared to coconut water.[17]

3. Cytotoxicity

When the cytotoxic effects of coconut water with whole milk, HBSS, tap water, using multiparametric cytotoxicity analysis employing 3T3 cells was assesed, coconut water and HBSS expressed least cytotoxicity.[18]

4. Storage

Coconut water can be used to store av ulsed tooth for a relatively longer period (45 minutes).Moura et al. claimedthat if the pH of coconut water is adjusted to7.0, then it can be used as storage media for upto 24 hou rs. This finding holds high relevance in clinical practice, where presence of life threatening conditions like complex fractures of jaw can delay the replantation of tooth.[18,19]

5. Biologically pure

Coconut water composition is quite similar to that of the intracellular fluid, which is a positive factor in the nutrition and

vitality of the cells[20] Coconut water is a sterile liquid that is readily accepted by the body, hence is believed to have been used as a substitute for blood plasma during the world wars. It is also being used as an intravenous rehydrating solution due to its high electrolyte content.

Within 15 minutes, HBSS is the most effective storage media.Between 15-120 minutes, HBSS is equivalent to coconut water.

We are abundantly blessed with coconuts. Considering the declining demand for coconuts in the country why not do a more elaborate research over the material and make it the best storage medium.

Future research

Standardized studies with similar methods are required to avoid diverging results and eliminate doubts over its use, as coconut water is a medium with easy access and good biological characteristics that Storage media for avulsed teeth could be promising for its indication.We require further expertise to venture out into researches to make coconut water a microbiological storage medium.

References

1. Nuvvula SK, Dedeepya P, Lakshmi KR. Knowledge regarding emergency management of avulsed teeth: A Survey of general dentists in Nellore, Andhra Pradesh. *J Indian Assoc Public Health Dent* 2011;17:560‑3.
2. Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F, et al. Guidelines for the management of traumatic dental injuries. II. Avulsion of permanent teeth. *Dent Traumatol* 2007;23:130‑6.
3. Gopikrishna V, Baweja PS, Venkateshbabu N, Thomas T, Kandaswamy D. Comparison of coconut water, propolis, HBSS, and milk on PDL cell survival. *J Endod* 2008; 34:587‑9.
4. Tulsi Sanghavi, Nimisha Shah, Vaishali Parekh, and Kiran Singbal. Evaluation and comparison of efficacy of three different storage media, coconut water, propolis, and oral rehydration solution, in maintaining the viability of periodontal ligament cells. *J Conserv Dent.* 2013; 16(1): 71–4.
5. Al-Nazhan S, Al-Nasser A. Viability of human periodontal ligament fibroblasts in tissue culture after exposure to different contact lens solutions. *J Contemp Dent Pract*. 2006;7:37–44
6. James F, Wesley MS. Evaluation of infant rehydration solutions; product evaluation. 2004. pp. 1–4. Available from:http://www.aicompanies.com/documents/file/InfantRehydrate.pdf .
7. Ozan F, Polat ZA, Er K, Ozan U, Değer O. Effect of propolis on survival of periodontal ligament cells: New storage media for avulsed tooth. *J Endod.* 2007;33: 570–3.
8. Halawany HS, Al Jazairy YH, Al Hussainan NS, Al Maflehi N, Jacob V, Abraham NB. Knowledge about tooth avulsion and its management among

dental assistants in Riyadh, Saudi Arabia. *BMC Oral Health* 2014;14:46.

9. Jyothi KN, Venugopal P, Nanda S, Shah MK. Knowledge and Attitude of medical doctors towards emergency management of avulsed tooth – A Cross sectional survey. *J Dent Sci Res* 2011;2:156-67.
10. Dali M, Naulaka D, Rajbanshi L. Knowledge, Attitude and practice in emergency management of avulsed tooth among medical doctors in Nobel Medical College, Biratnagar, Nepal: A cross sectional survey. *Int J Dent Health Sci* 2014;1:3-12.
11. Jessica Y. Lee DDS, MPH William F. Vann Jr. DMD, PhD. Management of avulsed permanent incisors: A decision analysis based on changing concepts. Asgeir Sigurdsson DDS.
12. Nwangwa EK, Aloamaka CP. Regenerative effects of coconut water and coconut milk on the pancreatic β-cells and cyto architecture in alloxan induced diabetic wistar albino rats. *Am J Trop Med Public Health* 2011;1:137-46.
13. Mantena SK, Jagadish, Badduri SR, Siripurapu KB, Unnikrishnan MK. In-vitro evaluation of antioxidant properties of Cocus nucifera Linn water. *Nahrung* 2003;47:126-31.
14. Buttke TM, Trope M. Effect of catalase supplementation in storage media for avulsed teeth. *Dent Traumatol* 2003; 19:103-8.
15. Omar SL, Devadathan A, Jacob J, Mathew J, Rex I. A comparative evaluation of post traumatic periodontal ligament cell viability using four different storage media- an in-vitro study. *Health Sci* 2013;2:1-9.
16. Moura CC, Soares PB, de Paula Reis MV, Fernandes Neto AJ, Zanetta Barbosa D, Soares CJ. Potential of coconut water and soy milk for use as storage media to preserve the viability of periodontal ligament cells: An in-vitro study. *Dent Traumatol* 2014;30: 22-6.
17. Silva EJ, Rollemberg CB, Cautinho-Filho TS, Krebs RL, Zaia AA. A multiparametric assay to compare the cytotoxicity of different storage media for avulsed tooth. *Braz J Oral Sci* 2013;12:90-4.
18. Ali SA, Al-Jundi S, Mhaidat N, Awawdeh L, Naffa R. Effect of coconut water concentration on survival of bench-dried periodontal ligament cells. *Int J Clin Pediatr Dent* 2011; 4:9-13.
19. Moreira-Neto JJS, Gondim JO, Raddi MSG, Pansani CA. Viability of human fibroblasts in coconut water as storage medium. *Intern Endod J* 2009;42: 827-30.
20. Pearson RM, Liewehr FR, West LA, Patton WR, McPherson JC, Runner RR. Human periodontal ligament cell viability in milk and milk substitutes. *J Endod* 2003; 29:184-86.

HOLLOW MAXILLARY COMPLETE DENTURE - A HOPE FOR RESORBED RIDGES

* Dr.Sylvana A.M, *Dr.Sujana U, **Dr. Deepa Shenoy

Abstract

Severely atrophic completely edentulous maxilla with increased inter ridge space poses a clinical challenge in prosthetic rehabilitation. This article presents a simple method for fabrication of a hollow maxillary complete denture.

Keywords: complete denture,light weight denture,inter ridge distance,residual ridge resorption

Corresponding author: Dr.Sylvana A.M

**Assistant Professor, **Reader, Dept. of Prosthodontics and Crown & Bridge, Sree Anjaneya Institute of Dental Sciences, Modakkallur P.O, Kozhikode, Kerala, India*

Introduction

Long term use of complete dentures by edentulous patients results in severe atrophy in one or both of the residual alveolar ridges, which presents difficulty in prosthetic rehabilitation. The conventional dentures given in such cases are heavy due to the excessive acrylic resin, and lead to compromised stability of the dentures. Historically, various alternative methods using a solid 3-dimentional spacer, including dental stone, cellophane wrapped asbestos, silicon putty, or modelling clay during laboratory processing for fabrication of hollow dentures were attempted.

This paper describes a technique for the fabrication of a lightweight hollow denture that can be used in selected patients with advanced atrophy of the maxilla.

The advantage being reduction in the weight of excessive acrylic resin that normally replaces the lost alveolar ridge in the inter-ridge space of denture wearers.

Technique

1. Primary impressions and final impressions were made in the conventional manner.
2. Jaw relation was recorded and try in procedure was done.
3. The mandibular waxed denture was fabricated in the normal conventional manner whereas the following changes were adapted during the fabrication of maxillary denture in order to make it hollow.
4. The waxed denture was invested in a flask.
5. The flask was heated for dewaxing procedure, opened, and the remaining wax was flushed out.(Fig 1a)
6. Once the flask was cooled, a 2 mm thickness of base plate wax was adapted to the tissue surface of the master cast as well as the tooth side of the flask. (Fig 1b)

7. Avoid the creation undercuts in the wax. An index was made on the wax of the soft tissue part and the dentulous part. The index will guide in the correct positioning of the two portions after processing.
8. The lower compartment of another similar flask was removed and placed on the counter portion of the original flask containing the teeth with wax adapted over them.
9. Dental plaster was vibrated on the wax adapted in the counter portion of the original flask. The flask was closed completely with the clamp.
10. Similarly the upper compartment of alternate flask was placed on the counter portion of the original flask containing master cast on which wax is adapted and flasked.(Fig 1c)
11. The wax was boiled out, cleaned.
12. Heat-cure, high-impact acrylic resin was then packed and processed.
13. The flasks were cooled and separated, and the flash was carefully removed. (Fig 1d)
14. Both halves of the original flask contain a processed acrylic resin shell. The two halves of the flask were fitted together and any acrylic resin that interfered with complete flask closure was removed.
15. A "rope" of doughy, heat-curing, high-impact acrylic resin approximately the diameter of a lead pencil was made. This acrylic resin rope was adapted around the border of the cured acrylic resin in the tooth side of the flask.
16. The new acrylic resin was moistened slightly with monomer. The flasks were closed, placed in a curing press, and processed with a long-curing cycle.
17. Cooled slowly and deflasked (cooling too quickly would cause more distortion than with a conventional denture).
18. The denture was finished and polished.
19. The denture was assessed by placing in a beaker full of water.(Fig 1e)

Summary

The technique for fabrication of the lightweight hollow maxillary denture is discussed in this report. The same technique can also be used for fabrication of a hollow denture in case of an atrophic mandibular alveolar ridges with a greater than usual inter occlusal distance. This is supposed to reduce the loading on the ridge by 25%.

When weight of a denture may be a contributing factor to the successful resolution of a patient's problem, the hollow denture should be considered. Thus, the M.M. De Van's Principle of preservation of whatever remains, an important aspect of Prosthodontics can be followed.

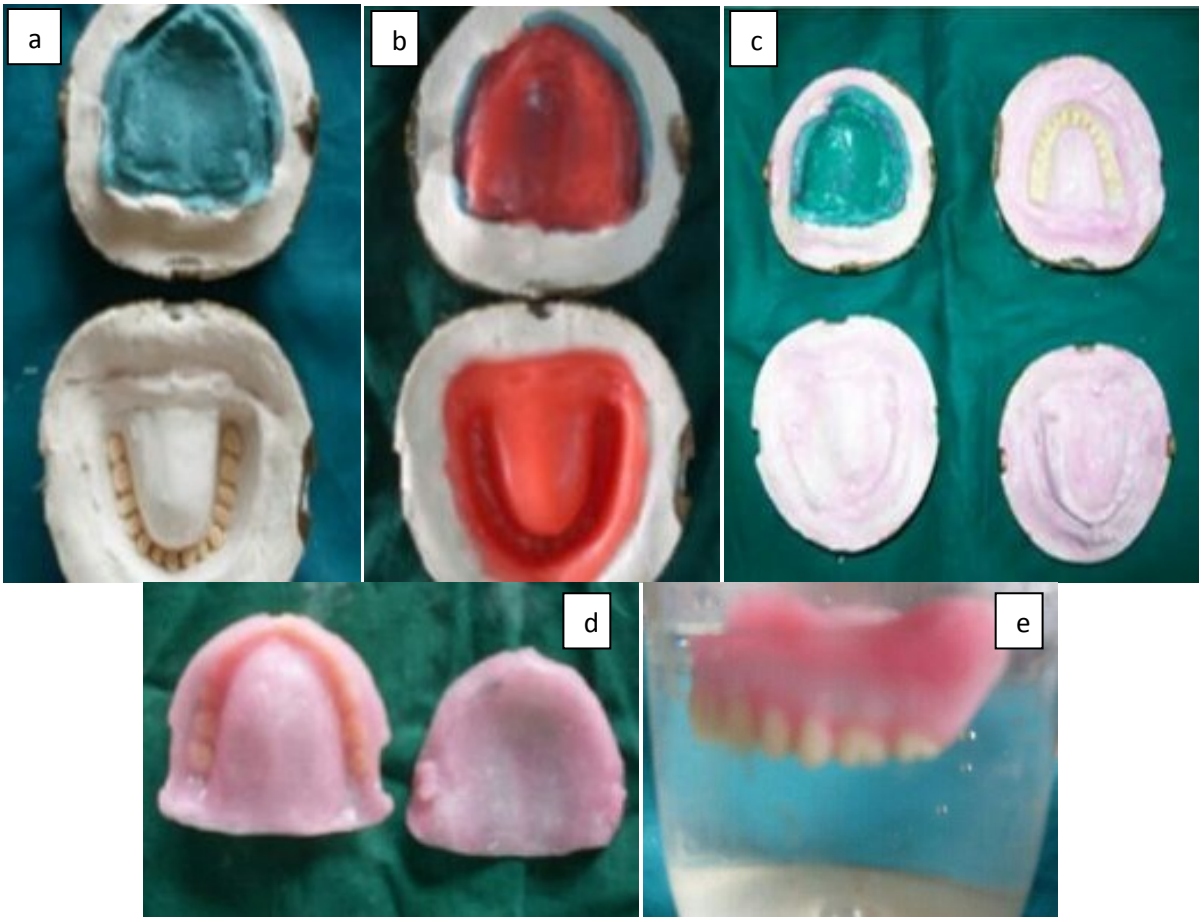

Fig 1: Technique of fabrication of hollow maxillary denture

Fig 1a: Flasking and dewaxing, 1b: Adapting wax for two separate layers, 1c:Flasking and dewaxing for two layers seperately, 1d: Fabricated soft tissue part and dentulous part, 1e: Final Prosthesis tested for buoyancy

References

1. O'Sullivan M, Hansen N, Cronin RJ, Cagna DR. The hollow maxillary complete denture: A modified technique. *J Prosthet Dent* 2004;91:591-4.

2. El Mahdy AS. Processing a hollow obturator. *J Prosthet Dent* 1969;22:682-6.

3. Brown KE. Fabrication of a hollow bulb obturator. *J Prosthet Dent* 1969;21:97-103.

4. Ackermann AJ. Prosthetic management of oral and facial defects followinf cancer surgery. *J Prosthet Dent* 1955;5:413-32.

5. Nidifier TJ. Hollow bulb obturator for acquired palatal openings. *J Prosthet Dent* 1957;7:413-32.

6. Rahn AO, Boucher LJ. *Maxillofacial prosthesis: principles and concepts.* St Louis: Elesvier; 1970: 95.

3 D BIOPRINTING: A REVIEW

*Dr. Swapna. C, **Dr. Amrutha. M. A, ***Dr. Pradeep Kumar. C,
*Dr. Sheejith. M, **** Dr. Ranjith. M

Abstract

3D printing is the process of creating a three-dimensional object, by adding successive layers of a material (usually plastics, metals, and other polymers) on top of each other. 3D printed prosthesis, orthodontic appliances, and implants are already in market. Recent advances have enabled 3D printing of biocompatible materials, cells, and supporting components into complex 3D functional living tissues. 3D bioprinting is being applied to regenerative medicine to address the need for tissues and organs suitable for transplantation. 3D bioprinting has already been used for the generation and transplantation of several tissues, including multilayered skin, bone, vascular grafts, tracheal splints, heart tissue and cartilaginous structures. Other applications include developing 3D bioprinted tissue models for research, drug discovery and toxicology. Bio-printed organs could potentially decrease transplant organ rejections and increase the availability of organs for critically ill patients. The ability to produce viable organs including tooth is still thought to be 10-15 years away, but functioning micro-organs have been produced.

Keywords: 3D bioprinting, Biomimicry, 3D bioprinters
Corresponding author: Dr. Amrutha. M.A

Professor,Post Graduate Student,***Professor & Head, ****Reader, Department of Prosthodontics, KMCT Dental College, Manassery, Kozhikode 673602, Kerala, India*

Introduction

Over the past few decades, printing technology has advanced from two-dimensional (2D) printing to an additive process in which successive layers of material are distributed to form 3D shapes.[1] The 3D printing revolution is about to transform our life. 3D printing, as described by Schubert et al.,is the process of creating a three-dimensional object, by adding successive layers of a material (usually plastics, metals and other polymers) on top of each other.

A 3D printer consists of one, or multiple material dispensers, which can move in three dimensions. It requires a control signal from software that can process 3D printing files. These convert a computer design into a slice-by-slice model to be printed. The production of 3D structures with complex geometries by printing is being applied both to enable rapid prototyping and manufacturing in industry and to the production of personalized consumer products in home such as bicycle parts, jewelry, and electrical components.[2]

Within dentistry, 3D printed prosthesis, orthodontic appliances, and implants have already been in the market for some years. These are created using 3D printing technology due to its ability to create completely new designs with minimal design-specific set up.

In 3D bioprinting, layer-by-layer precise positioning of biological materials, biochemicals and living cells, with spatial control of the placement of functional components, is used to fabricate 3D structures. There are several approaches to 3D bioprinting including biomimicry, autonomous self-assembly, and mini-tissue building blocks.

Researchers are developing these approaches to fabricate 3D functional living human constructs with biological and mechanical properties suitable for clinical restoration of tissue and organ function. One important challenge is to adapt technologies designed to print molten plastics and metals to the printing of sensitive, living biological materials. However, the central challenge is to reproduce the complex micro-architecture of extracellular matrix (ECM) components and multiple cell types in sufficient resolution to recapitulate biological function.[3]

3D bioprinting approaches

3D bioprinting is based on three central approaches: biomimicry, autonomous self assembly and mini-tissue building blocks.[3]

Biomimicry

Biologically inspired engineering has been applied to many technological problems including materials research, cell-culture methods, and nanotechnology. Its application to 3D bioprinting involves the manufacture of identical reproductions of the cellular and extracellular components of a tissue or organ. This can be achieved by reproducing specific cellular functional components, vascular tree, or manufacturing physiologically accurate biomaterial types and gradients. For this approach to succeed, the replication of biological tissues on the microscale is necessary.

Thus, an understanding of the microenvironment, including the specific arrangement of functional and supporting cell types, gradients of soluble or insoluble factors, composition of the ECM as well as the nature of the biological forces in the microenvironment is needed. The development of this knowledge base will be important to the success of this approach and can be drawn from basic research in fields of engineering, imaging, biomaterials, cell biology, biophysics and medicine.

Autonomous self-assembly

Another approach to replicating biological tissues is to use embryonic organ development as a guide. The early cellular components of a developing tissue produce their own ECM components, appropriate cell signaling and autonomous organization and patterning to yield the desired biological micro-architecture and function. A 'scaffold-free' version of this approach uses self-assembling cellular spheroids that undergo fusion and cellular organization to mimic developing tissues.

Autonomous self-assembly relies on the cell as the primary driver of histogenesis, directing the composition, localization, functional and structural

properties of the tissue. It requires an intimate knowledge of the developmental mechanisms of embryonic tissue genesis and organogenesis as well as the ability to manipulate the environment to drive embryonic mechanisms in bioprinted tissues.

Mini-tissues

The concept of mini-tissues is relevant to both of the above strategies for 3D bioprinting. Organs and tissues comprise smaller, functional building blocks or mini-tissues. These can be defined as the smallest structural and functional component of a tissue, such as a kidney nephron. Mini-tissues can be fabricated and assembled into the larger construct by rational design, self-assembly or a combination of both. There are two major strategies: (a) selfassembling cell spheres (similar to mini-tissues) are assembled into a macro-tissue using biologically inspired design and organization; [4,5] and (b) accurate, high-resolution reproductions of a tissue unit are designed and then allowed to self-assemble into a functional macrotissue. Examples of these approaches include the self-assembly of vascular building blocks to form branched vascular networks, [6,7] and the use of 3D bioprinting to accurately reproduce functional tissue units to create 'organs-on-a-chip', which are maintained and connected by a microfluidic network for use in the screening of drugs and vaccines, or as in *in vitro* models of disease. [8,9]

Combinations of the above strategies are likely to be required to print a complex 3D biological structure with multiple functional, structural and mechanical components and properties.

The main steps in the bioprinting process are imaging and design, choice of materials and cells, and printing of the tissue construct (Fig 1). The printed construct is then transplanted, in some cases after a period of *in vitro* maturation, or is reserved for *in vitro* analysis.

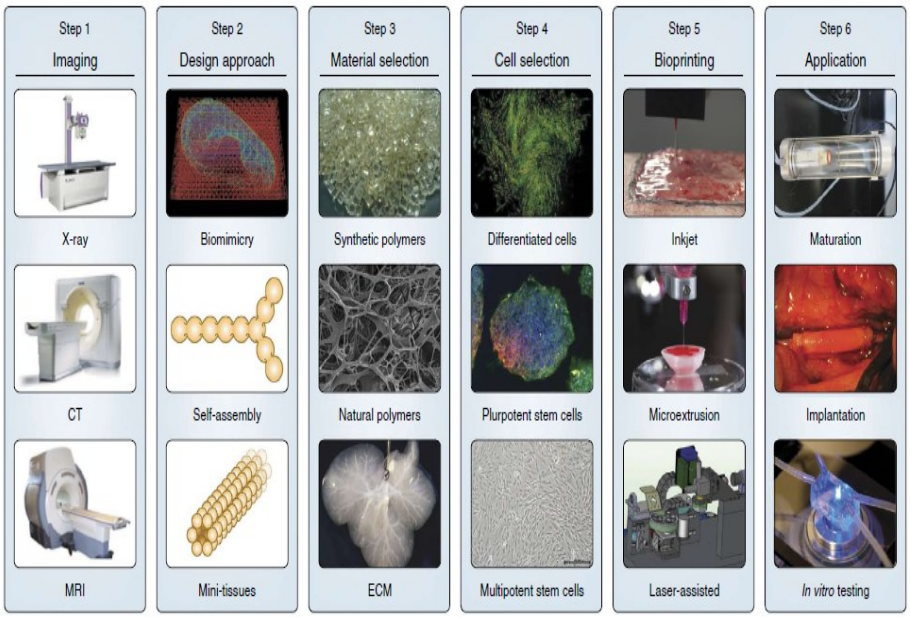

Fig1: A typical process for bioprinting 3D tissues

Imaging and digital design

An essential requirement for reproducing the complex, heterogeneous architecture of functional tissues and organs is a comprehensive understanding of the composition and organization of their components. Medical imaging technology is an indispensable tool used to function at the cellular, tissue, organ and organism levels. These technologies include most noninvasive imaging modalities, the most common being computed tomography (CT) and magnetic resonance imaging (MRI).

Computer-aided design and computer-aided manufacturing (CAD-CAM) tools and mathematical modeling are also used to collect and digitize the complex tomographic and architectural information for tissues. CT imaging, used for both diagnostics and interventional procedures, is based on the variable absorption of X-rays by different tissues. The X-ray source rotates around the object, and as the X-ray beam penetrates the body, sensors measure the transmitted beam intensity and angle, and record the data as a compilation of pixels that represent a small volume (voxel) of tissue. This imaging modality produces closely spaced axial slices of tissue architecture that, after surface rendering and stereolithographic editing, fully describe the volume of tissue.

A second approach, MRI, also can provide high spatial resolution in soft tissue, with the advantage of increased contrast resolution, which is useful for imaging soft tissues in close proximity to each other, without exposure to ionizing radiation. MRI uses nuclear magnetic resonance, a strong magnetic field causes a small fraction of nuclei in the tissue being imaged to align themselves with the magnetic field. [10] Changes to energy states of nuclei produce radiofrequency signals, which can be measured with receiver coils. The contrast of biological structures can be greatly increased with the use of contrast agents such as barium or iodine for CT scans and iron oxide, gadolinium or metalloproteins for MRI scans. These agents attenuate X-rays or enhance magnetic resonance signals that are commonly used to highlight structures, such as blood vessels, which otherwise would be difficult to delineate from their surroundings.

Once raw imaging data have been acquired from these imaging modalities, the data must be processed using tomographic reconstruction to produce 2D cross-sectional images. 3D anatomical representations can be produced for further analysis or modification. This process has been described as the transformation of 'analytical anatomy' into 'synthetic anatomy'. One method to generate computer-based 3D models of organ or tissue architectures is to use CAD-CAM and mathematical modeling techniques.[11] The 3D anatomical representation produces views of organ anatomy while retaining the image-voxel information that can be used for volume rendering, volumetric representation and 3D image representation. Reconstructed images or models can be viewed in multiple ways, including as contour stacks, as wire-frame models, shaded models or solid models with variable

lighting, transparency and reflectivity. If the aim is to produce an accurate reproduction of the imaged organ or tissue, 2D cross-sections or 3D representation can be used directly for bioprinting applications. Alternatively, a direct copy of a patients' own organ may not be desirable (due to disease or injury).

Tissue bioprinting strategies

The main technologies used for deposition and patterning of biological materials are inkjet, microextrusion, and laser assisted printing.

Inkjet bioprinting

Inkjet printers (also known as drop-on-demand printers) are the most commonly used type of printer for both nonbiological and biological applications. Controlled volumes of liquid are delivered to predefined locations. Inkjet printers use thermal or acoustic forces to eject drops of liquid onto a substrate, which can support or form part of the final construct.[12]

Microextrusion bioprinting

The most common and affordable nonbiological 3D printers use microextrusion. Microextrusion bioprinters usually consist of a temperature-controlled material-handling and dispensing system and stage, with one or both capable of movement along the *x*, *y* and *z* axes, a fiberoptic light source to illuminate the deposition area and/or for photoinitiator activation, a video camera for *x-y-z* command and control, and a piezoelectric humidifier. Microextrusion printers function by robotically controlled extrusion of a material, which is deposited onto a substrate by a microextrusion head. Microextrusion yields continuous beads of material.[13]

Laser-assisted bioprinting

Laser-assisted bioprinting (LAB) is based on the principles of laser-induced forward transfer. Initially developed to transfer metals, laser-induced forward transfer technology has been successfully applied to biological material, such as peptides, DNA and cells.[14]

Table 1: Comparison of printers

	Bioprinter type		
	Inkjet	Microextrusion	Laser assisted
Material viscosities	3.5–12 mPa/s	30 mPa/s to >6 x 10^7 mPa/s	1–300 mPa/s
Gelation methods	Chemical, photo-crosslinking	Chemical, photo-crosslinking, sheer thinning, temperature	Chemical, photo-crosslinking
Preparation time	Low	Low to medium	Medium to high
Print speed	Fast (1–10,000 droplets per second)	Slow (10–50 µm/s)	Medium-fast (200–1,600 mm/s)
Resolution or droplet size	<1 pl to >300 pl droplets, 50 µm wide	5 µm to millimeters wide	Microscale resolution
Cell viability	>85%	40–80%	>95%
Cell densities	Low, <10^6 cells/ml	High, cell spheroids	Medium, 10^8 cells/ml
Printer cost	Low	Medium	High

Materials and scaffolds

Materials currently used in the field of regenerative medicine for repair and regeneration are predominantly based on either naturally derived polymers (including alginate, gelatin, collagen, chitosan, fibrin and hyaluronic acid, often isolated from animal or human tissues), or synthetic molecules (polyethylene glycol; PEG).[15]

Conclusion

Organ printing, or computer-aided layer-by-layer assembly of biological tissues and organs, is currently feasible, fast-evolving and predicted to be a major technology in tissue engineering. Organ printing uses the principle of cellular self-assembly into tissues similar to the way embryonic-like tissues sort and fuse into functional forms dictated by the rules laid out in developmental biology. Replacement of diseased and lost human organs by bioprinted organs are soon going to be a reality.

References

1. Kruth JP. Material incress manufacturing by rapid prototyping techniques. *CIRP Annals-Manufacturing Technology*. 1991; 40: 603-14.
2. Malone E, Lipson H. Fab@ Home: the personal desktop fabricator kit. *Rapid Prototyping J.* 2007; 13: 245-55.
3. Murphy SV. 3D bioprinting of tissues and organs. *Nature Biotechnology.* 2014 Aug; 32(8): 773-85.
4. Mironov V,Visconti RP, Kasyanov V, Fargacs G, Drake CJ, Markwald RR. Organ printing: tissue spheroids as building blocks. *Biomaterials.* 2009; 30: 2164-74.
5. Kelm JM, Lorber V, Snedeker JG, Schmidt D, Broggini-Tenzer A, Weisstanner M. A novel concept for scaffold-free vessel tissue engineering: self assembly of microtissue building blocks. *J. Biotechnol.* 2010; 148: 46-55.
6. Kamei M, Saunders SB, Bayless KJ, Dye L, Davis GE, Weinstein BM. Endothelial tubes assemble from intracellular vacuoles in vivo. *Nature.* 2006; 442: p. 453-56.
7. Alajati A, Laib AM, Weber H, Boos AM, Bartol, Ikenberg K. Spheroid-based engineering of a human vasculature in mice. *Nat. Methods.* 2008; 5: p. 439-45.
8. Huh D, Matthews BD, Mammoto A, Montoya-Zavala M, Hsin HY, Ingber DE. Reconstituting organ-level lung functions on a chip. *Nature.* 2010; 328: 1662-68.
9. Sonntag F, Schilling N, Mader K, Gruchow M, Klotzbach U, Lindner G, Horland R. Design and prototyping of a chip-based multi-micro-organoid culture system for substance testing, predictive to human (substance) exposure. *J. Biotechnol.* 2010; 148: 70-75.

10. Pykett IL, JH Newhouse, FS Buonanno, TJ Brady, MK Goldman, JP Kistler, GM Pohost. Principles of nuclear magnetic resonance imaging. *Radiology*. 1982; 143:157-68.

11. Horn T, Harrysson O. Overview of current additive manufacturing technologies. *Sci. Prog.* 2012; 95: 255-82.

12. Xu T, Jian-Ming Zhu, Mohammed Z Albanna, James J Yoo, Anthony Atala. Complex heterogeneous tissue constructs containing multiple cell types prepared by inkjet printing technology. *Biomaterials.* 2013; 34:130-39.

13. Barron J, Wu P, Ladouceur H, Ringeisen B. Biological laser printing: a novel technique for creating heterogenous 3 dimensional cell patterns. *Biomed. Microdevices.* 2004; 6:139-47.

14. Guillotin Bk, Agnas Souquet, Sylvain Catros, Marts Duocastella, B. Pippenger. Laser assisted bioprinting of engineered tissue with high cell density and microscale organization. *Biomaterials*. 2010; 31: 7250-56.

15. Hutmacher D. Scaffolds in tissue engineering bone and cartilage. *Biomaterials.* 2000; 21: 2529-43.

IMPLANT STABILITY MEASURING DEVICES

*Dr. Lakshmi. B. L., **Dr.Pradeep Kumar. C,***Dr.Anisha Mandavia,
****Dr.Swapna.C, ****Dr. Sheejith.M, *****Dr.Ranjith.M

Abstract

Dental implant is an excellent option for prosthetic restoration that is associated with high success rates. Achieving and maintaining implant stability are the important prerequisites for the success of dental implants. Implant stability can be seen as a combination of mechanical stability, which is the result of compressed bone holding the implant tightly in place and biological stability, which is the result of new bone cells forming at the site of implant osseointegration. Mechanical stability is generally high, immediately after implant placement (primary stability). This is due to mechanical compression of the bone when the implant is placed, and it decreases with time. Biological stability, on the other hand, is non-existent immediately after placement. It becomes apparent only as new bone cells form at the implant site, and it increases with time (secondary stability).Therefore, it is of interest to develop and also evaluate assessment methods for different biomechanical properties of the bone/implant interface, both for experimental applications as well as clinical practice and for prognostic evaluation. The aim of this paper is to review different implant stability assessment methods and to assess its clinical relevance.

Keywords: implant stability, osseointegration,resonance frequency analysis

Corresponding author: Dr. Pradeep Kumar. C

Post Graduate Student,Professor & Head,***Senior Lecturer,****Professor,*****Reader, Department of Prosthodontics, KMCT Dental College, Manassery, Kozhikode 673602, Kerala, India*

Introduction

Successful osseointegration is a prerequisite for functional dental implants, and primary implant stability is a prerequisite for successful osseointegration. Implant stability is the absence of clinical mobility. Historically, the gold standard method used to evaluate the degree of osseointegration was microscopic or histologic analysis. However, due to the invasiveness of this method and related ethical issues, various other methods of analysis have been proposed like clinically checking for mobility with the help of blunt ended instruments, Radiographs, Cutting Torque Resistance, Reverse Torque, and Resonance Frequency Analysis (RFA).

Measuring implant stability supports making good decisions about when to load, allows advantageous protocol choice on a patient-to-patient basis, indicates situations in which it is best to unload, supports good communication and increased trust, and provides better case documentation.[1] In 1969, Brånemarket al. demonstrated that direct contact between bone and titanium implant surface was possible, defining osseointegration as “the direct, structural, and functional contact between live bone and the surface of a functionally loaded

implant." The first clinical report on dental implants, published a few years later, clarified that establishment and maintenance of osseointegration depend on the capacity of the tissues for healing, repair, and remodeling.

Schroeder et al. later defined this bone-implant union as a "functional ankylosis." The empirical nature of these initial formulations has now been recognized, and osseointegration is accepted as a histological term denoting direct bone apposition on the implant surface with no interposition of soft tissue. Clinical assessment is based on mechanical rather than histological criteria of stability, considering primary and secondary stability.

Primary stability mostly comes from mechanical engagement with cortical bone and the absence of mobility in the bone bed upon insertion of the implant, and depends on the quantity and quality of bone, surgical technique and implant design. Secondary stability depends on bone formation and remodeling at the implant-bone interface and is influenced by the implant surface and the wound healing time.

Degree of implant stability may also depend on the condition of surrounding tissues. It has been clinically demonstrated that implant stability plays a significant role in determining treatment outcome.[2] Implants show high success rates if certain preconditions are fulfilled. Because they determine the level of implant stability (primary and secondary), clinical parameters (including both patient and surgical parameters), and treatment protocol are important factors in determining treatment outcome.

At present, various diagnostic analysis have been suggested to check implant stability which include radiographs, the surgeon's perception, insertion torque (cutting torque analysis), seating torque, Reverse Torque Testing (RTT), percussion testing, impact hammer method, Pulsed Oscillation Waveform (POWF), implant mobility checker, Periotest, Resonance Frequency Analysis (RFA).[2] The purpose of this article is to review about the various methods to evaluate the stability of implant.

Factors that Influence Implant Stability[3]

They can be broadly divided as factors that influence the primary stability a, and factors that affect the secondary stability.

Factors affecting primary stability

1. Bone quality and quantity
2. Surgical technique, including the skill of the surgeon
3. Implant (geometry, length, diameter, surface characteristics)

Factors affecting secondary stability

1. Primary stability
2. Bone modelling and remodelling
3. Implant surface conditions

Various Methods to Measure Implant Stability

There are destructive and non destructive methods to measure implant stability.

Table 1:Destructive methods used to assess implant stability[4]

Method	Mode of action	Time of use of each method
Tensional Test	Earlier measured by detaching the implant plate from the supporting bone (*Kitsugi, et al. 1996*). Later modified by Bränemark – by applying the lateral load to the implant fixture (*Bränemark et al. 1998).* Fig:1	Not available – exhibited difficulties in execution.
Histomorphometric Analysis	Obtained by calculating the peri-implant bone quantity and bone-implant contact (BIC) from a dyed specimen of the implant and periimplant bone.	Assessed at pre, intra, and postsurgical time points.
Pull-out/Push-out Test	Investigates the healing capabilities atthe bone implant interface *(Brunski, et al.2000)*. It measures interfacial shear strength by applying load parallel to implant-bone interface. Fig:2, Fig:3	Assessed during the healing period. Applicable to only non-threaded implants. Technique sensitive.
Removal Torque Analysis	Implant is considered stable if the reverse or unscrewing torque was greater than 20Ncm *(Sullivan et al)*	At the time of abutment connection *(Sullivan, et al. 1996)*, implant surface in the process of osseointegration may fracture under the applied torque stress *(Ivanoff, et al. 1997)*

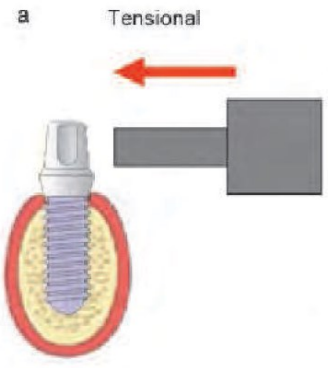

Fig:1 Tensional Test

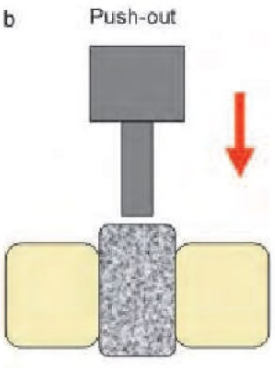

Fig:2 Pull out test

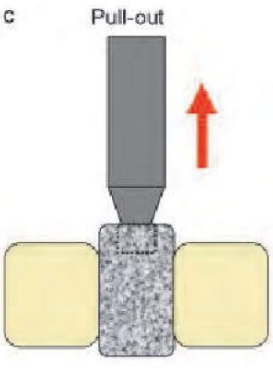

Fig:3 Push out test

Table 2:Non-destructive methods used to assess implant stability[4]

Method	Mode of action	Time of use of each method
Radiographic Analysis	Non-invasive method-bitewing view is used to measure crestal bone level. It has been reported that 1.5mm of radiographic bone loss can be expected in the first year of loading in a stable implant with 0.1mm of annual bone loss. *(Albrektsson et al)*	Can be performed at any stage of healing. Disadvantages include limitation in image resolution, distortion of images cannot make quantitative measurements about bone quality and density, cannot provide information about facial bone level, can perceive bone changes only after 30% bone loss occurs.
Insertion Torque Measurement	An increase in insertion torque greater than 30Ncm may signify an increase in primary stability, but maximum insertion torque is produced by the pressure of implant neck on the dense cortical bone of the alveolus.	Insertion torque values have been used to measure the bone quality in various parts of the jaw during implant placement *(O'Sullivan, et al. 2004)*. Higher insertion torque in cortical and cancellous bone- more than 50Ncm can lead to increase concentration of compressive stress- periimplant failure.
Cutting Torque Resistance Analysis (CRA)	Developed by *Johansson* and *Strid*, improved by *Friberg*. The amount of unit volume of bone removed by current fed electric motor is measured by controlling the hand pressure during drilling at low speed.	Determines areas of low density bone and quantifies bone hardness during implant osteotomy at the time of implant placement. CRA gives a more objective assessment of bone density than Lekholm and Zarb bone quality classification.
Reverse Torque Test	Proposed by *Roberts et al,* developed by *Johansson and Alberktsson*. It is used to assess the secondary stability of implant. Implant that rotate when reverse torque is applied indicates that bone-implant contact is destroyed. Fig:4	Verification of osseointegration after implant placement cannot quantify degree of osseointegration as threshold limits vary among patients, implant material, bone quality and quantity. The stress of the applied torque may in itself be responsible for the failure *(Sullivan et al. 1996)*. Does not measure lateral stability which is a useful indicator for successful treatment outcome.
Seating Torque	Like insertion torque, final seating torque gives idea about primary stability of implant when the implant reaches final apico-occlusal position.	Postsurgical implant placement.

Model analysis **1. Theoretical modal analysis** **2. Experimental Modal Analysis**	FEM(finite element analysis)- investigates vibrational characteristics of objects- to calculate stress and strain in various anticipated bone levels. It is dynamic analysis- measures natural characteristic frequency, mode and attenuation-via vibration testing.	Used in clinical studies and experiments. Used in non-clinical studies-in-vitro approach provides reliable measurement.
Percussion Test	Clinical judgement about stability is carried out by percussing the dental implant abutment with handle of dental instrument. A clear ringing crystal sound indicates successful osseointegration.	This is advised during surgical phase after placing the implant. It is subjective, could give inaccurate measurements due to high rigidity of implants. Lacks precision.
Impact Hammer Method	This is an improved version of percussion test. It involves tapping a tooth/implant with dental hammer at a rate of 4 times/sec with electromagnetically driven and electronically controlled tapping head.	Intra surgical and postsurgical.
Pulsed Oscillation Waveform (POWF)	Described by *Kaneko et al.* POWF is based on estimation of frequency and amplitude of the vibration of the implant induced by small pulsed force of 1kHz by lightly touching with 2 fine needles connected with piezoelectric elements.	In vitro and experimental studies. Sensitivity is low for assessment of implant stability.
Periotest (Siemens AG,Benshein, Germany)	Devised by *Dr. Schulte Teerlinck et al*.It is used to evaluate damping effect and stiffness of implant. An electronically driven and monitored rod is kept at approximately 20 degrees and and at a distance of 0.6-0.2mm (*I to et al 2008, Schulte 1988)*. Periotest value range from -8 (low mobility) to +50 (high mobility). Fig:5	Can measure the bone density at the time of implant placement and postsurgical placement of implant. Cannot measure mesiodistal mobility, position and angle of the rod affects the measured value, poor sensitivity.
RFA-Resonance Frequency Analysis (Non-destructive)	Suggested by *Meredith in 1998*.A transducer with 2 piezoceramic elements is tightened to implant or abutment screw. The transducer is screwed	At the time of implant placement. Provides baseline reading for future comparison and post-surgical placement of implant.

	directly to the implant body and shakes the implant at a constant input and amplitude, starting at a low frequency and increasing in pitch until the implant resonates. High frequency resonance indicates stronger bone-implant interface.	
MagneticTechnology RFA (Osstell™Mentor)	The transducer has a magnetic peg on top and is fixed to implant or abutment. On activation by magnetic resonance frequency probe the peg is activated, which vibrates and induces electric volt sampled by magnetic resonance frequency analyser. Values are expressed as (Implant Stability Quotient) ISQ of O to 100. Fig:6	At the time of implant placement. Provides baseline reading for future comparison and post-surgical placement of implant. This method is expensive and technique sensitiveas it requires respective transducer and magnetic peg, should maintain a distance of 1-3mm, angle of 90 degrees, and should be3mm above the soft tissue.
Implantest	Conventional impulse testing of an implant requires fastening an accelerometer with associated wires and connectors to the implant, striking it with a calibrated hammer, and then recording and interpreting the data. Implantest (Q Labs Inc., Providence, R.I.) incorporates all of the features of a conventional impulse test into a compact, portable, self-contained probe. Data can be gathered in seconds and is operator independent (independent of the direction or position of test application on the implant).	Complications may arise when attempting to test an implant with an attached multi fixture prosthesis, owing to their splinting effect.The dynamic signature of a multi fixture prosthesis is extremely complex owing to the supporting influence of all implants or natural teeth or a combination of these at the particular testing site.
Implomate	Developed by *Huang et al.* Utilizes impact force from a transducer to excite the resonance of implant instead of a sinusoidal wave. The received signal is transferred to acomputer for frequency spectrum analysis (2-20kHz) Higher frequency and sharp peak indicates stable implant while wider frequency and low peak indicates implant failure	At the time of implant placement. Provides baseline reading for future comparison andPost-surgical placement of implant. Few studies have been reported regarding the efficacy of this machine.

Fig:4 Reverse Torque Test

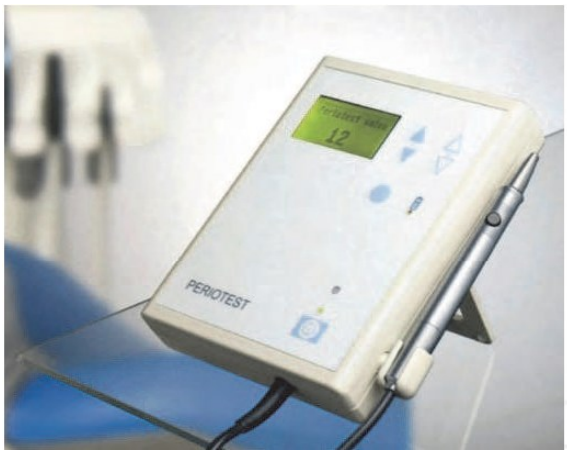

Fig:5 Periotest

Fig:6 Osstell Mentor Device

Discussion

In implant dentistry, the RFA technique has been adopted as an effective means to evaluate the relationship between implant stability and implant surrounding conditions such as osseointegration degree. In the implant-bone structural analysis, the results confirm the fact that the resonance frequency is significantly influenced by the implant surrounding conditions and that this sequential coupled method is effective to obtain the resonance frequency that reflect the property of the implant surrounding tissues and hence the osseointegration status. Previous studies have indicated that the clinical success of an implant depends largely on the biomechanical state of the implant-bone interface.[5,6]

Recently, RFA in combination with other destructive or non-destructive techniques, such as removal torque measurement, histological evaluation, radiography and CT has been applied to determine the dental implant biomechanical behaviours in-vivo or in-vitro tests. A number of observations have shown that the resonance frequency corresponds well to the measurements obtained by the techniques mentioned above because the bony modelling and remodelling on the implant-bone interfacial layer during healing process resulted in an increase instability.[7]

Presently, clinical application of RFA includes establishinga relationship between exposed implant length and resonance frequency or (Implant Stability Quotient) ISQ values; differential interarch and intra-arch ISQ values for implants in various location;prognostic criteria for long-term implant success; anddiagnostic criteria for implant stability.[3]

Many studies have indicated the presence of correlation between Periotest

and ISQ values.[4] Both Periotest and Osstell systems detected the change in implant stability in hard and in soft fixture interfaces, and this is demonstrated by the significant statistical difference between the direct contact and the soft interface groups. A significantly positive correlation was found between increased exposed implant lengths (EIL) and the PTV (periotest values), while strong negative correlation was found with Osstell™ system. The PTV decreases as the implant stability increases while the ISQ increases as the implant stability increases.[8] The RFA method, as a diagnostic tool, was not reliable in identifying mobile implants, however implant stability could be reliably determined for implants with an ISQ 47. All implants with an ISQi ≥ 49 osseointegrated when left to heal for 3 months. All implants with an ISQi ≥ 54 osseointegrated when immediately loaded.[9]

Mark Bischof et al conducted a study on the implant stability measurement of delayed and immediately loaded implants during healing. There was no statistically significant difference in the ISQi values of delayed and immediately loaded implants.[10] Pilar Valderrama et al conducted a clinical trial to evaluate the ability of the magnetic RFA device to detect changes in stability during early healing following implant placement and to determine whether the implant stability quotient (ISQ) values obtained correlated with those made with the electronic device. It was concluded that the changes in implant stability measured with newer magnetic device correlate well with those found with the electronic device. Both devices confirmed the initial decreases in implant stability that occur following placement and identified an increase in stability during the first 6 weeks of functional loading.[11]

Lars Sennerby et al reviewed the biological, biomechanical aspects and clinical implications of resonance frequency analysis used for measuring implant stability and concluded that RFA can supply clinically relevant information about the state of the implant–bone interface at any stage of the treatment or at follow-up examinations.[12] Mychelle et al conducted a study to analyze the influence of the design and surface morphology on the primary stability of dental implants. The insertion torque and resonance frequency analysis (RFA) were the parameters used to measure the primary stability of the implants. The result showed that the machined implants showed smaller insertion torques than treated implant surfaces. The maximum implant insertion torque depends on the implant geometry, thread form, and implant surface morphology. The placement of conical implants with treated surfaces required the highest insertion torque. There was no correlation between RFA and insertion torque implant.[13]

LinishVidyasagar et al conducted a study to evaluate the stability of implants using resonance frequency analysis (RFA) relative to length, diameter and arch location, at the time of implant placement and during second-stage surgery. The results showed implants at first-stage surgery to

have a mean stability of 66 ± 6.2 ISQ (range 52 to 79), and implants at the second stage to have a mean stability value of 65 ± 6.2 ISQ (range 51 to 79). Mandibular implants appear to reach higher stability values than maxillary implants at both first and second stage surgery.

A direct relationship was observed between implant stability and implant diameter, however not between implant stability and implant length.[14]

Majid Reza Mokhtari et al conducted a study to measure the stability of Astra Tech and ITI dental implants during the healing period and determine the factors that affect the ISQ. The result showed the means of ISQ for Astra Tech implant after 3 and 6 months were significantly greater than those for ITI implant. Statistical analysis showed higher ISQ values for mandible with Type I and Type II bone than maxilla and Type III and Type IV bone; implant diameter was significantly correlated to implant stability.[15]

Conclusion

Bone quality can affect implant stability and time of loading. For Type I and Type II bone implant success is higher than Type III and Type IV and they can be loaded faster. For poor quality bone we must use wider implants or highly textured ones.[15] Pictures from radiography are a common non-invasive method for studying stability of dental implants. One disadvantage with radiography is the difficulties to obtain reproducible pictures of high accuracy. Another method for dental stability measuring is to screw a small rod in the implant and measure resonance frequencies in the system. The resonance frequencies depend partly on the fixture and partly on stiffness in implant/bone interface. Among the various non-invasive implant stability methods resonance frequency analysis is more precise and accurate. RFA is determined by the changes in the interface stiffness, and it is affected in three aspects.

Firstly, bone-implant surface stiffness affects RFA and it increases through bone healing and remodelling. Secondly, the stiffness of bone itself, and bone density as well as the ratio of cortical and cancellous bone affects RFA. Finally, the stiffness of implant components can actsas a variable and it is affected by the interlocking structures, and the composing elements of the materials.[16] RFA can be used as measurement method for mini-implant stability.

In the future RFA might be used routinely to assessmini-implant stability throughout the course of treatment.[17] Osstell™ Mentor which works under the principle of resonance frequency analysis method for measuring the implant stability had proved to be more reliable compared to periotest system in measuring implant stability in hard and soft interfaces. Periotestmainly checks the mobility of implant as it works with the principle of impact hammer method. RFA is used extensively in clinical research as a parameter to monitor implant stability. RFA has high reproducibility and is more accurate than Periotest.[18]

References

1. Mistry G, Shetty O, Shetty S et al. Measuring implant stability: A review of different methods. *J Dent Implant* 2014; 4(2):165-9.
2. Digholkar S, Naga V, Madhav V. Methods to Measure Stability of Dental Implants. *J Dent Allied Sci* 2014;3(1):17-23.
3. Atsumi M, Park SH, Wang HL. Methods Used to Assess Implant Stability: Current Status. *Int J Oral Maxillofac Implants* 2007; 22:743-54.
4. Meenakshi S, Srividhya S, Raghunath N. Implant stability-A key determinant of implant integration. *TPDI* 2013; 4(1):1-8.
5. T Kaneko. Pulsed oscillation technique for assessing the mechanical state of the dental implant-bone interface. *Biomaterials* 1991; 21:555-60.
6. Elias JJ, Brunski J, Skarton H. A dynamic modal testing technique for noninvasive assessment of bone-dental implant interfaces. *Int J Oral Maxillofac Implants* 1996; 11:728-34.
7. Deng B, Keson BC, Liu GR. A new numerical approach for evaluation of dental implant stability using electromagnetic impulse. *Int Chin J Dent* 2008; 8:1-9.
8. Al-Jetaily S, Al- Farraj A, Al-Dosari. Assessment of Osstell and Periotest systems in measuring dental implant stability (in vitro study). *The Saudi Dent J* 2011; 23:17-21.
9. Nedir R, Bischof M, Szmukler-Moncler S. Predicting osseointegration by means of implant primary stability-A resonance-frequency analysis study with delayed and immediately loaded ITI SLA implants. *Clin. Oral Impl. Res* 2004; 15:520-8.
10. Bischof M, Nedir R, Moncler S et al. Implant stability measurement of delayed and immediately loaded implants during healing. A clinical resonance-frequency analysis study with sandblasted-and-etched ITI implants. *Clin. Oral Impl. Res* 2004; 15:529-39.
11. Valderrama P, Thomas W, Oates et al. Evaluation of Two Different Resonance Frequency Devices to Detect Implant Stability: A Clinical Trial. *J Periodontol* 2007; 78:262-72.
12. Meredith, Sennerby L,Neil. Implant stability measurements using resonance frequency analysis: biological and biomechanical aspects and clinical implications. *Periodontology 2000* 2008; 47:51-6.
13. Santos MVD, Elias CN. The Effects of Superficial Roughness and Design on the Primary Stability of Dental Implants. *Clin Implant Dent and Related Research* 2011; 13(3):215-23.
14. Vidyasagar L, Salms G,Apse P. Dental Implant Stability at Stage I and II

Surgery as Measured Using Resonance Frequency Analysis. Stomatologija, *Baltic Dental and Maxillofacial Journal* 2004; 6(3):61-72.

15. Mokhtari MR, Sargolsaie MRN. Resonance Frequency Analysis of Clinical Stability of Astra Tech and ITI Implant Systems. J Periodontol Implant Dent 2010; 2(2):66-9.

16. Park JC, Lee JW, Kim SM. Implant Stability - Measuring Devices and Randomized Clinical Trial for ISQ Value Change Pattern Measured from Two Different Directions by Magnetic RFA. Implant Dentistry - A Rapidly Evolving Practice. *http://www.intechopen.com*

17. Nienkemper M, Wilmes B, Panayotidis A, Pauls A, Golubovic V, Schwarz F. Measurement of mini-implant stability using resonance frequency analysis. *Angle Orthodontist* 2013; 83(2):230-38.

18. Zix J, Hug S, Liechti K, Stern RM. Measurement of implant stability by Resonance frequency analysis and damping capacity assessment: Comparison of both techniques in a clinical trial. *Int J Oral Maxillofac Implants* 2008; 23:525-30.

FIBROLIPOMA ON LOWER LIP:A RARE ENTITY

*Dr. Hiba Ummer, *Dr. Indu Sundaram, *Dr. Faiz Aboobacker.
**Dr. Rajeesh Muhammed P K, **Dr Mayeesh Radhakrishna, ***Dr. Swapna Honwad.

Abstract
Lipomas are common benign mesenchymal tumor arising from mature adipocytes. Oral lipomas are rare and fibrolipoma is an even rarer histological variant. A review of literature showed only 33 cases of fibrolipoma reported in the oral cavity. This paper intends to report a histopathologically diagnosed case of fibrolipoma in a 62 year old male who presented with a swelling on lower lip.

Keywords: Lipoma, Fibrolipoma, Fibroblast
Corresponding author: Dr. Faiz Aboobacker

** Post Graduate Student,**Reader,***Senior Lecturer, Department of Oral Pathology & Microbiology, KMCT Dental College, Manassery, Kozhikode 673602, Kerala, India*

Introduction

Lipomas are common benign mesenchymal tumor arising from mature adipocytes. Oral lipomas are usually rare and the reported rate is 1 in 5000 cases. Fibrolipoma is an uncommon histological variant and only few cases have been reported.[1] The common site of occurrence of oral lipoma is buccal mucosa.

This paper reports a case of 62 year old male with a swelling on left lower lip which is a rare entity with respect to the site of occurrence.

Case report

A 62 year old male reported with a chief complaint of swelling on the left lower lip since 2 years. The lesion was painless and on clinical examination, an ovoid swelling of size 2.5 x 2 cm was found on the inner aspect of left side of the lower lip. It was 0.5 cm away from the vermillion zone of the lip. The mucosa over the swelling was normal. The borders were well defined and the surface was smooth. (Fig 1)

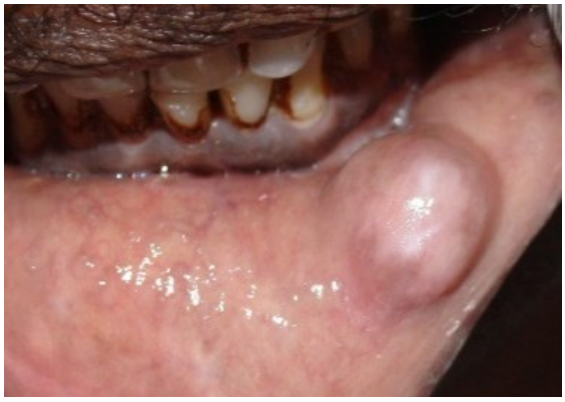

Fig1: Clinical photograph showing swelling in left lower lip

All the findings of inspection were confirmed on palpation. It was firm in consistency, with smooth surface and well-defined borders. The lesion was non tender and was not associated with bleeding. It was not fixed to the underlying tissues. A

provisional diagnosis of mucocele was given and surgical excision was done. Gross examination showed a roughly ovoid shaped mass measuring 2 x 1.8 x 1.8 cm in size, creamish white in color, soft in consistency with nodular growth noticed in some areas. The cut surface showed a jelly like material. (Fig 2& 3)

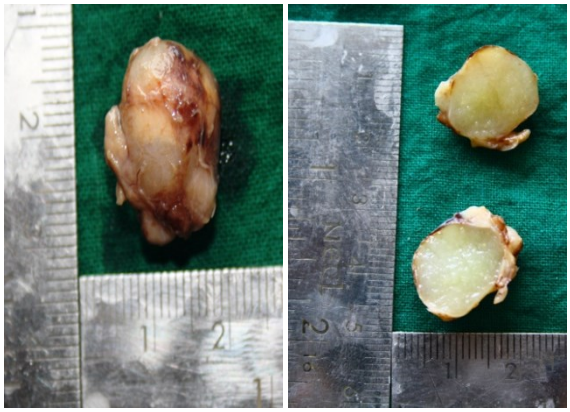

Fig 2&3: Gross specimen and the cut section showing jelly like surface

Histopathological examination revealed a well circumscribed lesion with a thin fibrous capsule.

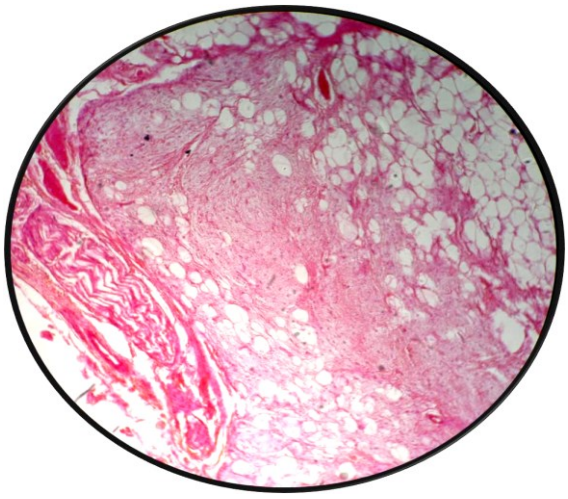

Fig 4: Histopathological picture shows mature fat cells embedded in dense collagen fibers

Mature fat cells were seen embedded in a dense collagenous stroma with proliferating fibroblasts. These findings were consistent with the final diagnosis of fibrolipoma. (Fig 4)

Discussion

Lipoma - best known as universal or ubiquitious tumor, due to its wide distribution in the human body. It is a benign mesenchymal neoplasm composed of mature adipocytes and are derived from mature fat cells.[1] About 20% of lipoma occurs in the head and neck region. However, oral lipoma comprise of only 1% to 4% of cases and presents as painless, well-circumscribed, slow-growing sub mucosal mass or superficial lesion.[2]

Usually slow growing and rarely recurs after surgical treatment. Hence, the prognosis of this benign tumor is considered good. Oral lipoma can occur in various anatomic sites including the major salivary glands, buccal mucosa, lip, tongue, palate, vestibule, and floor of mouth.[3] The first description of oral lipoma was given by Roux in 1848 in a review of alveolar mass; he referred it as a “yellow epulis”.[4]

The etiology of intraoral lipoma remains unclear, but the suggested pathogenic mechanisms include the “hypertrophy theory” which states that obesity and inadvertent growth of adipose tissue may contribute to formation of these oral lesions. This theory is less convincing in explaining those lesions occurring in areas devoid of pre-existing adipose tissue.[5]

Another theory known as "metaplasia theory" suggests that lipomatous development occurs due to aberrant differentiation of *in situ* mesenchymal cells into lipoblast, since fatty tissue can be derived from mutable connective tissue cells almost anywhere in the body. J. J. Lin and F. Lin suggested that these benign entities are congenital lesions arising from embryonic multipotential cells that remain subclinically dormant until they differentiate into fat cells under hormonal influence during adolescence.

However, in some cases, trauma and chronic irritation may trigger the proliferation of soft tissue and play a role in the development of a Lipoma.[5] It may also arise by preadipocyte differentiation and proliferation mediated by cytokine following soft tissue damage.[6] Despite the histological similarity to normal adipose tissue, lipomas have distinctive clonal chromosomal abnormalities like translocations involving 12q 13-15, locus interstitial deletions of 13q, and rearrangement involving 8q 11-13 locus 2.[7]

Conclusion

Fibrolipoma is a microscopic variant of lipoma characterized by a significant fibrous component intermixed with lobules of fat cells. Consistency of this lesion varies from soft to firm, depending on the quantity and distribution of fibrous tissue and depth of tumor.[8] Fibrolipoma has been thought to be congenital, caused by endocrine imbalances, the product of a degenerated fibromatous tumor, or to arise from the maturation of lipoblastomatosis which is a an infiltrative type of benign neoplasm with lobules of immature fat cells separated by connective tissue septa and areas of loose myxoid matrix. Further maturation of both adipose and fibrous tissue results in mature strands of collagen separating fat cells into lobules. Fibrolipoma has been reported to be more frequently occurring in buccal mucosa and vestibule and shows a slight predominance in females.[1] In the present case lesion occurred in lower lip in a male patient which attributes to the rarity of the present case.

Fibrolipoma represents a distinct rare histopathological entity with an asymptomatic clinical course and only few cases are documented so far. The proliferative activity of fibrolipoma is greater than the other variants. Confirmative diagnosis is possible only by histopathological examination. Identification of such unique and rare histopathological variants is essential for the better understanding of pathogenesis of such lesions which can be helpful for apt and successful treatment.

References

1. Rao GS, Chatra L, Shenai P. Intra-oral lipoma- a rare entity. *IJARS.* 2013;2(2):1-3 .
2. Manjunatha BS, Pateel GS, Shah V. Oral fibrolipoma-a rare histological entity: report of 3 cases and review of literature. *J Dent (Tehran).* 2010;7(4):226-31.

3. Furlong MA, Fanburg-Smith JC, Childers EL. Lipoma of the oral and maxillofacial region: Site and sub-classification of 125 cases. *OOOOE*. 2004 Oct 31; 98(4):441-50.

4. KumaraswamySV ,NanjappaMadan, Keerthi , Singh Shakti; Lipomas of oral cavity: case reports with review of literature. *J Maxillofac Oral Surg* 8(4):394–97.

5. Chavan S, Ingle Y, Deshmukh R, Kulkarni VV. Fibrolipoma-A Rare Intraoral Tumor: A Case Report. *Journal of Dental and Allied Sciences*. 2013 Jul 1;2(2):83.

6. Pereira T, Shetty S, Sapdhare S, Tamgadge A. Oral fibrolipoma: A rare histological variant. *IJDR*. 2014 Sep 1;25(5):672.

7. Gujjari SK, Shah M, Hegde U, Doddawad VG. Fibrolipoma: Report of two intraoral cases. *J Clin Diagn Res*. 2012;6:524-6.

8. Khubchandani M, Thosar NR, Bahadure RN, Baliga MS, Gaikwad RN. Fibrolipoma of buccal mucosa. *Contemporary Clinical Dentistry*. 2012 Apr;3(Suppl1):S112.

AWARDS & ACHIEVEMENTS

Dr. Faiz Aboobacker &
Dr.Indu Sundaram T S

Final year Post Graduate Students, Department of Oral Pathology & Microbiology secured first prize in quiz contest at the Fourth National Rapid Review Programme held at Sri Ramachandra University, Porur, Chennai, on February 3rd 2016.

Oral & Maxillofacial Surgeon's Day celebrations

The Department of Oral and Maxillofacial Surgery, KMCT Dental College, along with the Trauma care unit of KMCT Medical College conducted a trauma awareness rally at Kozhikode Beach for the general public. The rally was flagged off by Mr. Purushan Kadalundi, MLA. A screening camp was also conducted the same day. Dr. Manoj Kumar KP addressed the gathering.