The Journal of

ABOUT THE JOURNAL

The Journal of Prosthetic rehabilitation is a peer reviewed open access e-journal published on behalf of Indian Prosthodontic Society, Nagpur Branch. Articles on Complete Denture Prosthodontics, Removable Partial Denture Prosthodontics, Fixed Partial Denture Prosthodontics, Implantology, Maxillofacial Prosthodontics, Occlusion, Aesthetics and Materials used in Prosthodontics will be published in this journal. Journal will be published in January and June of every year.

ADDRESSES

EDITORIAL OFFICE

DR. RAJLAKSHMI BANERJEE
Aesthetica Multispeciality Dental Clinic And Orthodontic Centre,
78, Rachana Classic Building, Abhyankar Nagar,
Nagpur- 440010.
Phone : +91 9890324934

PUBLISHED BY

INDIAN PROSTHODONTICS SOCIETY
Nagpur Branch

DESIGNED BY

Mallhari Udyog
Nagpur

OFFICE BEARERS OF INDIAN PROSTHODONTIC SOCIETY

IPS HEAD OFFICE BEARERS

Dr. Ravindra Savadi President	**Dr. Kashinath K. R.** Immediate Past President	**Dr. J. R. Patel** President Elect
Dr. Manesh Lahori 1st Vice-President	**Dr. Ramesh A. S.** 2nd Vice-President	**Dr. Rupesh P. L.** Secretary
Dr. Jangala Hari Joint Secretary	**Dr. George P. John** Treasurer	**Dr. N. Gopi Chander** Editor

IPS NAGPUR BRANCH

Dr. Usha Radke Founder President	**Dr. Neelam Pande** President	**Dr. Pravin Sundarkar** President Elect
Dr. B.K. Motwani Immediate Past President	**Dr. Saee Deshmukh** Secretary	**Dr. Tushar Mowade** Treasurer
	Dr. Rajlakshmi Banerjee Editor	

EC MEMBERS

Dr. Krishnakumar Lahoti	**Dr. Deepti Lambade**	**Dr. Neha Garg**
Dr. Yogesh Ingole	**Dr. Parag Bhoyar**	**Dr. Gaurav Jaiswal**

he Journal of
PROSTHETIC REHABILITATION

EDITORIAL BOARD

FROM THE EDITOR'S DESK

DR. RAJLAKSHMI BANERJEE

It gives me immense pleasure to come up with the 2nd issue of the IPS Nagpur branch, **'The Journal of Prosthetic Rehabilitation'**. The Journal as always remains committed to providing a platform for the postgraduate students and faculty to publish their work and aims to cover all spheres in the subject of Prosthodontics. This issue is also special as we are gearing up for the 48th IPS National first ever Virtual conference in the history of Indian Prosthodontic society and look forward to cooperation from all of you. We are also coming up with a webinar series from the 3rd to 17th of August as a kickstart of our conference preparations. Kindly join us in the enriching scientific experience.

Minimally Invasive Esthetic Options & Procedures in Prosthodontics

PROFESSOR (DR.) J. R. PATEL

- Dr. J. R. Patel did BDS in 1981 and MDS in 1983 from Govt. Dental College & Hospital, Ahmedabad.
- He has been into academics and education since 38 years.
- He started his academic carrier as a Lecturer/Readerfrom Govt. DentalCollege in 1982.
- He was a Professor & Head at Shri Balaji Dental College, Chennai.
- He has worked as Principal, Faculty Dean, Professor & Head, PG Guide & PhD Guide at K. M. Shah Dental College & Hospital, Vadodara.
- He was a Vice Chancellor of Sumandeep Vidyapeeth.
- Presently he is a Principal & Faculty DeanofNarsinhbhai Patel Dental College & Hospital.
- He is also a Faculty Dean of Nootan College of Nursing & Nootan Physiotherapy College of Sankalchand Patel University, Gujarat.
- There are about 65 publications in national & International indexed Journals to his credit.
- He has authored chapters in threetextbooks on Prosthodontics & Dental Materials.
- He is a President of Indian Prosthodontic Society Head Office.
- He is a President-Elect of Indian Dental Association, Gujarat State Branch.
- He was a President of IPS Gujarat State Branch, IDA Ahmedabad Branch & Govt. Dental College & Hospital Ahmedabad Alumni Association.
- He was organizing chairman of 41st IPS Conference2013, 2nd International Conference of Evidenced Based Education 2015 in Sumandeep Vidyapeeth deemed to be university, 47th IDA Gujarat State Annual conference 2017, 21st IPS National PG Convention 2019, 4th International Digital Conference 2019& many state level and University/College level conferences.
- He was a guest speaker & keynote speaker at IPS PG convention and conferences and many branches of Indian Dental Association of Gujarat State.
- He has conducted many hands-on and workshop & preconference courses at IPS & IDA conferences & conventions.

Minimally invasive treatment options have become increasingly feasible in Prosthodontics, due to the introduction of the adhesive technique in combination with restorative materials featuring translucent properties similar to those of natural teeth.Because of this, conservative treatments those are able to modify the shape, size, and color of the teeth and provide the result, which the patient expects, should always be the first therapeutic option.Various conservative options to preserve the available tooth structure are mentioned here.

1. Bleaching procedure: The lightening of the color of a tooth through the application of a chemical agent to oxidize the organic pigmentation in the tooth is referred as bleaching. It is classified as Nonvital bleaching procedures & Vital bleaching procedures.
2. Microabrasion: It involves the physical removal of tooth structure.In this procedure 11% HCL + Silicone carbide particles are used.It can remove discoloration upto 0.2-0.3 mm.
3. Macroabrasion:An alternative technique to microabrasion for removal of localized, superficial white spots and other surface stains or defects is called macroabrasion.It is done with 12-fluted composite finishing bur in a high speed handpiece with adequate water spray.
4. LaminateVeneers: A veneer is a layer of tooth-colored material that is applied to a tooth to restore localized or generalized defects and intrinsic discolorations.Common indications for veneers are tooth malformation, discoloured teeth, abraded teeth and faulty restorations.Mainly it is classified as Partial veneers & Full veneers. According to mode of fabrication classified as direct veneers and indirect veneers.Over the years there have been various advancements in laminates and veneers in dentistry. The recent advancements are:

   a) Stacked/Feldspathic Teeth Veneers: These veneers contain many stacks of porcelain giving rise to multiple layers in the veneer. of these feldspar veneers is that they are not strong due to their low mechanical properties as the flexural strength is from 60-70 MPA. The feldspars contain fluoroapatite crystals improving the optical appearance of the tooth.It has a polychromatic appearance and high translucency, hence closely resembles the natural tooth.

   b) Thick Monochromatic Teeth Veneers: These are usually thicker than the normal veneers, hence contributing to its strength and durability. They are present in one colour and can be customised according to the patient's preference.

   c) Lithium disilicate veneers: They are the most widely used true glass ceramics. It is versatile and is stronger than other porcelain veneers. It has a high flexural strength and available in a variety of shades. It has high resistance to thermal shock thus managing the problem between two similar materials. It is used for teeth which require minimal reshaping.

   d) Minimally Invasive Veneers or No-prep Veneers:These veneers are ultrathin having a thickness similar to contact lenses of about 0.3-0.5 mm and hence get are called "contact lenses of teeth". They consist of lumineers, durathin veneers and vivaneers.

   Lumineers: They are exceptionally thin veneers (0.3mm) made of a special cerinate porcelain. They can be easily placed with minimal invasion and pain. They have high strength and resilience despite being exceptionally thin.

   Durathin Veneers: These veneers are exceptionally thin and are about 0.2 mm whereas the traditional veneers are usually about 0.5 mm thick. These veneers have gained popularity due to its good esthetic effects as it gives a natural translucency to the teeth closely resembling natural teeth.

   Vivaneers: These are extra tough veneers with a thickness of about 0.3 mm and hence need a minimal thickness of about 0.3 mm.They are manufactured in Glidewell laboratories.

   e)MAC veneers (Microadvanced Cosmetic Division veneers): They are pressed ceramic

veneers. They are manufactured in Microdental laboratories. They have high strength and are denser than other veneers. They are a bit thicker when compared to other veneers which ensure that these veneers can firmly adhere to the tooth surface and are not displaced from the teeth.

f) Da Vinci veneers: They are high quality, ultra thin veneers. These porcelain veneers are hand crafted and are of tooth colored ceramics. They have fluorescent porcelain that enhances the aesthetic quality and the strength of the veneer. They have the ability to resist stains.

g) Zirconia veneers: Zirconia is a polycrystalline ceramic which is acid resistant with no amorphous silica which does not react to traditional glass etching treatments. Zirconia veneers have excellent aesthetics. It is a versatile material. They are high strength materials having fluxural strength of 1000 MPa.

5. Resin bonded fixed dental prosthesis:It is a prosthesis that is luted to tooth structure, primarily enamel, which has been etched to provide mechanical retention for resin cement.

l Evolution of resin bonded Fixed partial dentures

a) Bonded pontic

b) Cast perforated resin retained FPD's (Rochettebridge) Use of ring like retainers, with funnel shaped perforations through them to enhance resin retention.

c) Etched cast resin retained FPD's (Maryland bridge): Bridge retention has been enhanced by the development of resin cements which bond chemically to both the tooth surface and the etched metal alloy. It provides micro mechanical retention.

d) Macroscopic mechanical retention resin retained FPD's (Virginia bridge)

- Salt crystals (150 to 250 μm) were incorporated into wax and removed in solution leaving cubic retentive pits
- Produces roughness on the inner surface of the retainer
- This was a time saving method and more retention is achieved compared to the technique of etching

e) Cast mesh FPD's

f) Chemical bonding resin retained FPD's

g) Fiber reinforced composite resin FPD's

- Fiber-reinforced composite restorations are resin-based restorations containing fibers aimed at enhancing their physical properties.

6. Everstick crown & Bridges:

- With GC everstick C&B we can prepare composite bridges reinforced with fiber in one single visit, using a reversible and minimally invasive technique.
- Mainly indicated in hybrid bridges, temporary bridges, immediate bridges, surface retained bridges.

Evaluation of various components affecting dento-facial esthetics in young Indian population- *A cross-sectional* Study

Varunraj Jadhav, Tushar Mowade, Priya Gupta, Saee Deshpande

Introduction: Smile is a person's ability to express a range of emotions with the structure and movement of the teeth and lips, can often determine how well a person can function in society.[1] The search for beauty can be traced to the earliest civilizations; both the Phoenicians (app 800 BC) and Etruscians (app 900 BC) carefully carved animal tusks to stimulate the shape, form and hue of natural teeth. The ideal goal of prosthetic dentistry is to restore occlusion, esthetics, phonetics, form, function appearance and overall health of patient.[2] A balanced symmetrical smile is considered essential in facial esthetics as it influences facial expression, general physical appearance and the expression of emotions. Many researchers have evaluated parameters affecting pleasant smile in patients. Relationship of age, sex, race and lip length on exposure of maxillary teeth was first evaluated by Brundo GC etal.[3] Heartwell et al evaluated correlations between lip length and teeth exposure and reported that vertical position of the central incisor primarily determined by their relationship with lip in repose regardless of age and sex.[4] Frush JP et al stated that smiling line helped to determine vertical position of the maxillary teeth in complete denture, as well as central incisors were longer than other maxillary teeth. The golden proportion (1.618 : 1.0) is a mathematically constant ratio that defines the dimensions between larger and a smaller length.[5] This specific relation is unique, perfect, ideal, and desirable. It has been used from studying beauty to design esthetic restorations.[6-7]

Mahshid M, et al evaluated Golden proportion assessment between maxillary and mandibular teeth in esthetic smiles.[8-9] However these studies have been done on Western population . There is lack of evidence regarding these parameters in Indian population. Hence this study has been planned to evaluate naturally occurring esthetic parameters in young Indian population and how they can be co-related between different sexes and age groups.

Materials and methods: This study was carried out in VSPM Dental College, Nagpur. One-hundred (100) participants (50 men, 50 women) were included in this study. The mean age of the participants was 20-29 years.

- **Inclusion/exclusion criteria:**

  The inclusion criteria were no missing maxillary and mandibular anterior teeth, no gingival and periodontal conditions or therapy that would undermine a healthy tissue-to-tooth relationship; no interdental spacing or crowding, no anterior restoration, and no history of orthodontic treatment. Patients of both sexes from young age group 20-29 years. All patients having Class I molar occlusion. Exclusion criteria eliminated subjects with evidence of gingival alteration or dental irregularities; apparent loss of tooth structure due to attrition, fracture, caries, or restorations; obvious problems that could disfigure or otherwise affect the face and dentition; and history of trauma, congenital, or acquired defects in the head and neck region, loss or prosthetic replacement of anterior teeth, or a history of maxillofacial surgery. Completely edentulous or partially edentulous patients

Measurements: Measurements were performed with the subjects seated in a dental chair with the head and back in an upright position. For golden proportion evaluation, the widths of the teeth were measured at the mesio-distal contact points of teeth. Anterior teeth width was measured from distal contact point of 13 to distal contact point of 23 in maxilla and distal contact point of 33 to distal contact point of 43 in mandibular teeth using flexible ruler (Fig. 1). Each measurement was made thrice by the same operator

and the repetitive value was used for accuracy and calibration of results. The golden proportion for each subject was assessed by multiplying the width of the larger component by 62% and compared the width of the smaller component for proportion to be analyzed. The width of central incisor was multiplied by 62% and compared with the width of the adjacent lateral incisor (Fig: 2). Similarly the width of the lateral incisor, canine and the maxillary and mandibular teeth were evaluated for golden proportion. Smile line is esthetic display of teeth when person smiles.It is imaginary line along incisal edges of the maxillary anterior teeth which mimics curvature of superior border of lower lip. It basically exposure of the midfacial cervical margin of the clinical crown relative to vermillion border of upper lip. Open smiles were divided into three categories. High smile (Reveals the total cervicoincisal length of the maxillary anterior teeth and a contiguous band of gingiva (Fig. 3, A). Average smile (Reveals 75% to 100% of the maxillary anterior teeth and the interproximal gingiva only (Fig. 3, B). low smile (Displays less than 75% of the anterior teeth (Fig. 3, C). Upper lip length was measured with the help of millimetre flexible ruler from subnasal to most inferior portion of upper lip. Shade of tooth was evaluated using Vitapan shade tab(fig 4) in northern

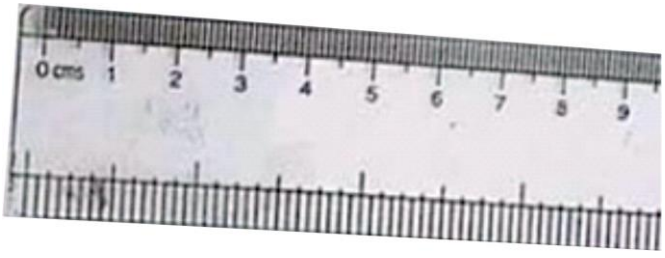


Figure 1: Flexible ruler

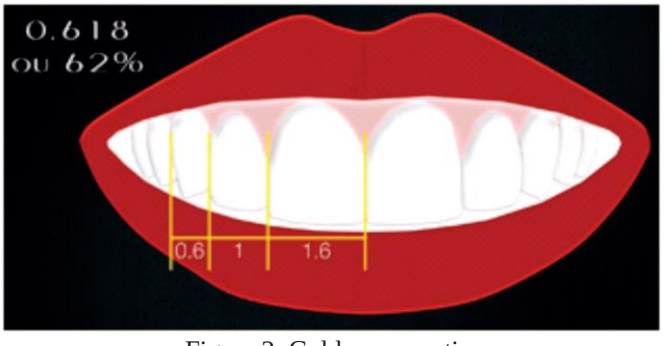


Figure 2: Golden proportion

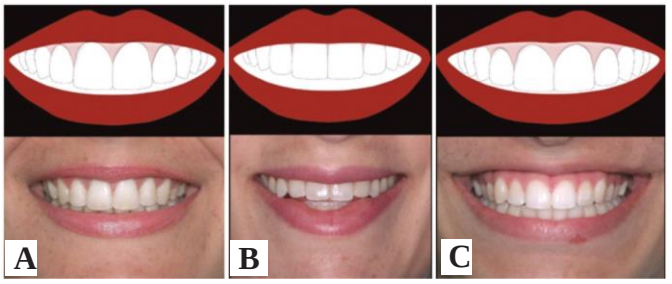


Figure 3: Three general and photographs illustrating types of smiles.A: high smile; B: average smile and C: low smile.

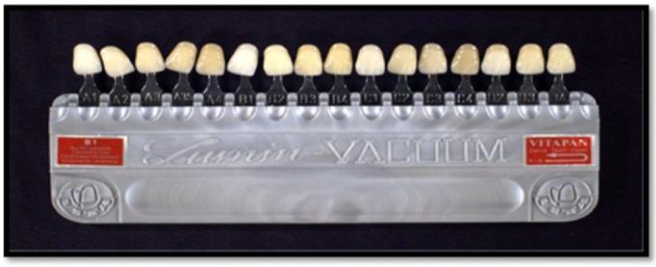


Figure 4: Vitapan Shade Guide for shade measurement

day light.

Statistical analyses: Statistical Package for Social Sciences, Version 10 (SPSS-V10) software was used for the analyses of data. Spearman's (rho) was used to find correlation between smile line and upper lip. Chi square analysis was done to find the corelation between various ratios of golden proportion, smile line, shade and upper lip length during smiling amongst different sexes. An independent t-test was used to compare mean measured values between genders ($p \leq 0.05$). Descriptive analysis was done by setting alpha error at 5% and p value less than 0.05 was considered statistically significant.

Results: Frequency and percentage of golden proportion ratio between different sexes during a maximum smile are shown in Table 1.

The data revealed no statistical significance in the ratio of golden proportions based on gender. The data obtained from this study is summarized in Table 1. There is no golden proportion exist in between the population. The ratio of 1.2 and 1.3 were more common than 1.618 which is observed in 39% of the samples and 35% of individuas. Ratio of 1.5 and 1.6 was observed in 2 % and 3% . No major differences in proportion existed between different sexes and symmetry of teeth.

Correlation of shade of tooth and sex: The results indicated that the most common shade for the maxillary and mandibular central incisors for males and females in the age group of 20–29 years using the three shade guides Vitapan are A2 and A1. Females had more tendency for brighter A1 shade compared to little darker and yellower A2, A3 and A3.5 shades found in males.

Correlation of smile line and sex: Age and sex distribution of the participants in relation to the display of gingiva during a maximum smile are shown in Table 3. The age of the participants ranged between 20 -29 years. The data shows 36% of male and 29% of female had average smile line and 6% of male and 12% of female have high smile line.

Correlation of upper lip length during smiling and sex: Upper lip length in males:- range (16-20mm) 39 individuals; followed by (21-25mm) 8 individuals. Upper lip length in females:- range (10-15mm) 5 female individuals followed by(16-20 mm) in 44 individuals(Table 4) .

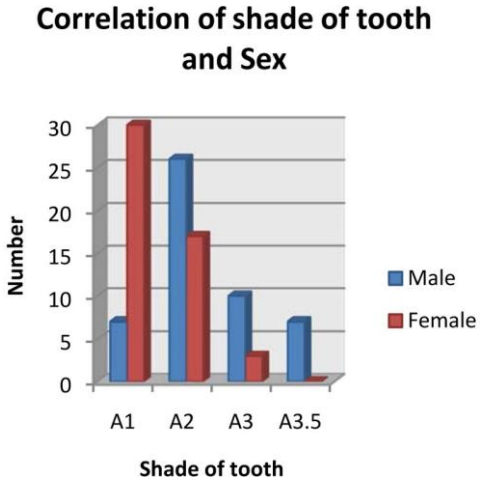
Correlation between smile line and upper lip length during smiling: Out of 17 individuals who showed low smile line, mean upper lip length during smiling was found 19.52±1.62 mm. Out of 65 individuals who showed average smile line, mean upper lip length during smiling was found 18.09±1.49 mm. Out of 18 individuals who showed high smile line, mean upper lip length during smiling was found 16.05±1.62 mm. (Table 5)

Ratio	Males	Females	Total
1.1	3	4	7
1.2	22	17	39
1.3	17	18	35
1.4	6	8	14
1.5	1	1	2
1.6	1	2	3
Total	50	50	100
Chi2 –value	2.3128		
p-value	0.804, NS		

Table 1: Golden proportion ratio between different sexes

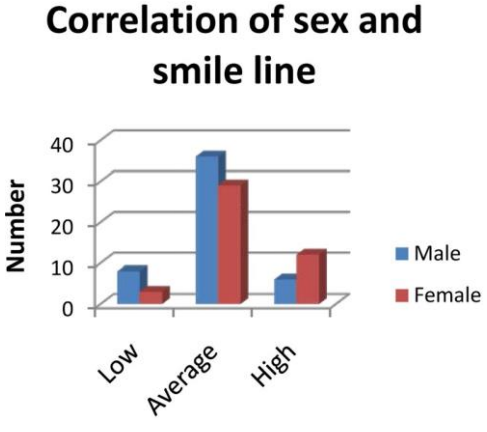
Shade of tooth	Male	Female
A1	7	30
A2	26	17
A3	10	3
A3.5	7	0
Total	50	50
Chi2 – value	26.9502	
p-value	<0.0001, Highly Significant	

Table2: Correlation of shade of tooth and sex



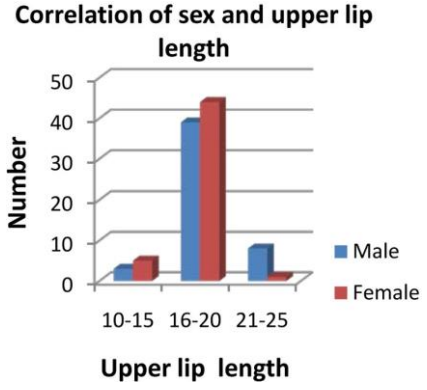
Smile line	Male	Female
Low	8	9
Average	36	29
High	6	12
Total	50	50
Chi2 – value	2.8127	
p-value	0.245, NS	

Table 3 shows : correlation of smile line and sex



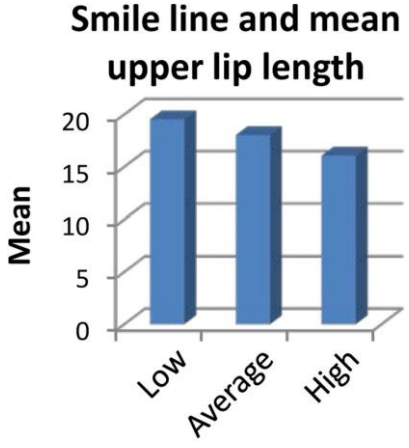
Upper lip length(mm)	Male	Female
10-15	3	5
16-20	39	44
21-25	8	1
Total	50	50
Chi2 – value	6.2456	
p-value	0.044,Significant	

Table 4: Correlation of upper lip length during smiling and sex



Smile line	Number	Mean upper lip length (mm)	Range
Low	17	19.52 ± 1.62	17-22
Average	65	18.01 ± 1.49	15-22
High	18	16.05 ± 1.62	13-19
Total	100		
Spearman's (rho)	- 0.5410		
p- value	<0.0001, highly significant		

Table 5: Correlation between smile line and upper lip length during smiling



DISCUSSION: The golden proportion (1.618 : 1.0) describes the ratio between the dimensions of a larger and a smaller length. Various researchers have opined for and against the use of this mathematic proportions in dentistry. Levin observed the golden proportion between the width of central incisor, lateral incisor and the canine.[6] Golden proportion assessment between maxillary and mandibular teeth on Indian population was done by Chander NG et al. in year 2012.The clinical tooth width measurements were recorded with the digital vernier calipers on 576 patients of both sexes in the age group of 21-30 years. Flexible ruler was used to determine the width of maxillary and mandibular anterior teeth on the patients by the same operator. They said that golden proportion was not found between the width of the right central and lateral incisors in 53% of women and 47% of men. Also, The golden proportion is an inappropriate method to relate the successive widths of the maxillary anterior teeth in Indian population.[5] From the results obtained and within the limitations of the study the following were appraised. Ethnic differences should be considered for esthetics and proportion studies especially with Indian population which varies with cultural diversity. The golden proportion was not found between maxillary and mandibular anterior teeth in majority of Indian population and the ratio of 1.2 and 1.3 is seen in 39% and 35% respectively. There were no major changes seen in the proportions between sexes and symmetry of teeth in Indian population.

Rodrigues S et al evaluated Shade Differences Between Natural Anterior Teeth in Different Age Groups and Gender Using Commercially a vailable Shade Guides in year 2012 and concluded that the most common shade for maxillary and mandibular incisors in the younger age group is A2/2R1.5/140 and A1/1M2/120 for the males and females using Vita Lumin, Vita 3D Master and Chromascop shade guides respectively. Although the incidence of males with darker teeth as compared to females was higher. They said that there is no statistical significant correlation between shade differences in both the sexes.[10] In present study, for male individuals, A2

shade - 26 individuals, A3 shade - 10 individuals and A3.5 shade - 7 individuals. For females, A1 shade - 30 individuals, A2 shade - 17 individuals and A3.5 shade - not found.

Tjan A et al in 1984 investiagated some esthetic factors in a smile. A survey of the characteristics of an open smile was conducted with 454 full-face photographs of randomly selected dental and dental hygiene students. Findings show that an average smile exhibits approximately the full length of the maxillary anterior teeth, has the incisal curve of the teeth parallel to the inner curvature of the lower lip.11 In males, average smile line - 36 individuals and high smile line - 6 individuals. In females average smile line - 29 individuals and high smile line - 12 individuals.

Vig r et al done a survey that correlates measurements of upper lip type, sex, race, and age of dentulous patients with the amount of exposure of the maxillary and mandibular anterior teeth with the lips gently parted and in the resting position. Perhaps the most interesting finding was the gradual reduction in the amount of maxillary central incisor exposure with an increase in age, accompanied by a gradual increase in the mandibular tooth exposure.[12] In our study upper lip length in males range (16-20mm) 39 individuals; followed by (21-25mm) 8 individuals. Upper lip length in female range (10-15mm) 5 female individuals followed by (16-20 mm) in 44 individuals. Also, out of 17 individuals who showed low smile line, mean upper lip length during smiling was found 19.52±1.62 mm. Out of 65 individuals who showed average smile line, mean upper lip length during smiling was found 18.09±1.49 mm. Out of 18 individuals who showed high smile line, mean upper lip length during smiling was found 16.05±1.62 mm.

Conclusion: Within the limitations of this study, the following conclusions were drawn:

1 Golden proportion between the widths of maxillary anteriors was not observed in majority of population. No major differences in proportion existed between different sexes and symmetry of teeth.

2 For shade of the tooth, females had more tendency for brighter A1 shade compared to little darker and yellower A2, A3 and A3.5 shades found in males.

3 For smile line, females have more tendency for display of maxillary anterior teeth due to high smile line compared to males.

4 For lip length during smiling, females have tendency for shorter lip length's compared to more prominent and longer lip length's in males.

5 Correlation between smile line and upper lip length during smiling, smile line is inversely proportional to mean upper lip length during smiling.

References:

1 Pini N.B, Gribel B.Z. Analysis of the golden proportion and width/height ratios of maxillary anterior dentition in patients with lateral agenesis. Journal of Esthetic and Restorative Dentistry 2012;24:402-414

2 Hochman M.N, Tarnow D.P.Maxillary anterior papilla display during smiling:A clinical study of the interdental smile line.The International Journal of Periodontics and Restorative Dentistry 2012;32:373-383

3 Patel J.R,Sethuraman R. Acomparative evaluation of effect of upper lip length ,age,sex on amount of exposure of maxillary anterior teeth.The Journal of Contemporary Dental Practice.2011;12:24-29

4 Heartwell CM, Rahn AO,Syllabus of complete dentures (3rd).Philadelphia 1974;3:313-322

5 Chander NG, Vaikunth V K, Rangarajan V . Golden proportion assessment between maxillary and mandibular teeth on Indian population J Adv Prosthodont 2012;4:72

6 Levin EI. Dental esthetics and the golden proportion. J Prosthet Dent 1978;40:244-52.

7 Snow SR. Esthetic smile analysis of maxillary anterior tooth width: the golden percentage. J Esthet Dent 1999;11:177-84.

8 Mahshid M, Khoshvaghti A, Varshosaz M, Vallaei N. Evaluation of "golden proportion" in

individuals with an esthetic smile. J Esthet Restor Dent 2004;16:185-92.

9 Bhuvaneshwaran M. Principles of smile design. Journal of Conservative Dentistry 2010;13:225-232

10 Rodrigues s, Shetty R. An Evaluation of Shade Differences Between Natural Anterior Teeth in Different Age Groups and Gender Using Commercially Available Shade Guides. J Indian Prosthodont Soc2012;12:4:222–230

11 Tjan A, Miller G et al. Some esthetic factors in a smile. J Prosthet Dent 1984;51:24-28

12 Vig R.G,Brundo G.C. The kinetics of anterior tooth display.The Journal of Prosthetic Dentistry 1978;39:502-504

Socket preservation– A Review

Dr. Suyog Vikas Bahiramwar[1], Dr. Tushar Mowade[2], Dr. Usha Radke[3], Dr.NeelamPande[4], Dr. Rajlakshmi Banerjee[5]

1 Junior Resident- I, Department of Prosthodontics, VSPM, DCRC
2 Reader, Department of Prosthodontics, VSPM, DCRC
3 Dean & HOD, Department of Prosthodontics, VSPM, DCRC
4 Professor, Department of Prosthodontics, VSPM, DCRC
5 Reader, Department of Prosthodontics, VSPM, DCRC

Abstract

Following extraction of the teeth, the remaining socket heals from the apex toward the crest. When nothing is placed into the socket at the time of tooth removal, the infiltration of soft tissue at the crest often results in facial and crestal bone loss. Many literatures consider socket preservation as a necessity for further aesthetic considerations in the pre-prosthetic and corrective procedures of the alveolar ridge upon and post extraction. Routine bone grafting of alveolar sockets after the extraction of teeth has been a controversial subject which relates to a multitude of factors recently reported in the literature. Prior to the introduction of various bone grafting materials and membranes, the socket historically was allowed to heal by secondary intention. This method of wound closure has been the main course of post-operative management of the socket.

Introduction: Although bone loss around implants is reported as a complication when it progresses uncontrolled, resorption does not always lead to implant loss, but may be the result of biomechanical adaptation to stress.[1] Advantages of immediate implant placement include alveolar ridge preservation, reduction in marginal bone loss after extraction, and a short treatment time, all of which imply an overall benefit to the patient. Immediate implant placement in fresh extraction sockets provides predictable anatomic, functional, and aesthetic outcomes.[2]

Factors to consider for immediate implants into extraction sites are thickness of socket walls, thickness of gingival drape, optimal position of the implant, and patient factors such as hygiene and smoking cessation. The art of treatment should be done is a clinical challenge because inevitably postextraction bone loss is indeterminate.[3]

Socket preservation

Tooth Extraction Technique: The massive atrophy of the alveolar processes of the jawbones after tooth extraction, which until now has been regarded as unavoidable, represents a major problem both in prosthodontics and implantology. This atrophy occurs unevenly. Atraumatic extraction methods that are popularly advocated can at most reduce this atrophy, but cannot prevent it. The initial incision can be made with a microsurgical blade to minimize elevation of the gingival tissues. The blade incises the gingival fibers and begins separation of the periodontal ligament. The periodontal ligament can then be further separated from the root with the use of a periotome, avoiding the buccal plate 4-5

Flap Design: The extraction of a tooth results in a decrease in support of the papillae and some loss of papillae height. The loss of papillae height is increased with the elevation of buccal and lingual flaps [35]. In areas of esthetic concern, consideration should be given to extracting the tooth and augmenting the socket without elevating a flap or the use of a mini-flap on the buccal preserving the papillae.

Postoperative Management: The most important step in the post operative management of augmented extraction sockets is the placement and shaping of the temporary tooth that is placed over the extraction area. If the socket is augmented and an immediate

implant is not placed, a removable ovate pontic can be placed immediately. The pontic form can be altered during the healing period with light-cured resin to optimize the pressure on the healing tissues and direct the gingival form. The loss of papillae height from extraction can be largely restored with the use of removable or fixed provisional appliances.[6]

Barrier Membranes: The first barrier membrane used for extraction socket augmentation was expanded polytetrafluoroethylene (pTFE), which required primary closure and a second surgical procedure.[7,8] This technique is still used for large augmentations of deficient edentulous ridges. The key characteristics of an ideal barrier membrane are biocompatibility, suitable occlusive (barrier) qualities and durability upon exposure. A membrane that can be exposed eliminates the need for primary closure.[9]

The graft material must be protected from the epithelial advance. This is the primary principle behind guided bone regeneration and guided tissue regeneration (GBR and GTR, respectively). The theory of GTR and GBR is centered on the migration of pluripotent and osteogenic cells from the periosteum and adjacent alveolar bone to the defect site while at the same time excluding epithelial cells and fibroblasts from infiltrating and potentially disrupting new bone formation.[10-12]

Bone Grafting Materials: The materials commonly used are autogenous bone, anorganic bovine bone, freeze-dried bone allograft, and beta tricalcium phosphate (bTCP), which all are osseoconductive, as well as demineralized freeze-dried bone allograft DFDBA, which is osseoinductive.[13]

Healing Pattern of Socket-Alveolus: Acting as a physical matrix, the coagulum directs the movement of cells, including mesenchymal cells, as well as growth factors. Neutrophils and later macrophages enter the wound site and digest bacteria and tissue debris to sterilize the wound. They release growth factors and cytokines that will induce and amplify the migration of mesenchymal cells and their synthetic activity within the coagulum.[14]

Within a few days, the blood clot begins to break down (fibrinolysis). The proliferation of mesenchymal cells leads to gradual replacement of the coagulum by granulation tissue (2 - 4 days).[15]

By the end of 1 week, a vascular network is formed and by 2 weeks the marginal portion of the extraction socket is covered with young connective tissue rich in vessels and inflammatory cells.[16]

By 4-6 weeks, most parts of the alveolus are filled with woven bone, while the soft tissue becomes keratinized. At 4-6 months, the mineral tissue within the original socket is reinforced with layers of lamellar bone that is deposited on the previously formed woven bone. 8-10 Although bone deposition in the socket will continue for several months, it will not reach the coronal bone level of the neighboring teeth.[5]

The Effect of Hard-Tissue Preservation: Changes in the Vertical Height of the Alveolar Ridge can be done with the help of surgical and non surgical procedures. Changes in the Width of the Alveolar Ridge is defined by Width of Bone Loss.

Discussion: A number of studies were conducted to evaluate whether alveolar ridge resorption following tooth extraction could be reduced by application of socket preservation grafting materials into the socket right after extraction.

Robert Horowitz et al. conducted a study to Evaluate the Alveolar Ridge Preservation with a B-Tricalcium Phosphate Socket Graft. After 6 months, the sites preserved with grafting material demonstrated excellent preservation of buccolingual alveolar ridge Width. There was a significantly better maintenance of alveolar ridge dimension than the placement of an immediate dental implant with no grafting. Socket grafted extraction sites exhibited a decreased amount of bone loss as compared to non-grafted sites. There was evidence of vital bone ingrowth into grafted extraction sites.[17]

Serino G et al did a study on Ridge preservation following tooth extraction using a polylactide and polyglycolide sponge as space filler. Loss of alveolar bone height following tooth extraction was

lower in the sockets where a grafting material was inserted as comparedto what was observed where natural healing by clot was allowed. Grafted sockets had healed with less bone resorption especially at mid buccal portion, where the buccal plate of the socket was often found to be partially or completely destroyed by tooth pathology. After 6 months, bone samples were harvested and there was new bone formed that was mineralized, mature and well-structured.[18]

Barone A et al studied Xenograft versus extraction alone for ridge preservation after tooth removal. Extraction-alone group had significantly greater height and width reduction compared to ridge-preservation group. Some implants placed in extraction-alone group showed a buccal dehiscence that required guided bone regeneration procedures after implant insertion. There was significantly higher trabecular bone percentages and total mineralized tissue in ridge-preservation group.[19]

Conclusion: Socket preservation maintain the height and width of the remaining viable alveolar ridge post extraction. This can be achieved through adequate flap design whenever needed, atraumatic extraction, adequate selection of grafting material and the membrane barrier. Socket preservation is comparatively new technique but effective in the bone preservation. With the help of this without doing any additional procedures the residual bone can be used to its advantage, but newer studies with more data are required to complete this procedure.

References:

1 Kitamura E, Stegaroiu R, Nomura S, Miyakawa O. Biomechanical aspects of marginal bone resorption around osseointegrated implants: considerations based on a three□dimensional finite element analysis. Clinical oral implants research. 2004 Aug;15(4):401-12.

2 Ramalingam S, Al-Hindi M, Al-Eid RA, Nooh N. Clinical evaluation of implant survival based on size and site of placement: A retrospective study of immediate implants at single rooted teeth sites. The Saudi dental journal. 2015 Apr 1;27(2):105-11.

3 Jensen OT. Dental extraction, immediate placement of dental implants, and immediate function. Oral and Maxillofacial Surgery Clinics. 2015 May 1;27(2):273-82.

4 Ten Heggeler JM, Slot DE, Van der Weijden GA. Effect of socket preservation therapies following tooth extraction in non-molar regions in humans: a systematic review. Clinical oral implants research. 2011 Aug;22(8):779-88.

5 Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. International Journal of Periodontics & Restorative Dentistry. 2003 Aug 1;23(4).

6 Douglass G. Socket Preservation Techniques. *Inside Dentistry* 2.8 (2006).

7 Buser D, Dula K, Belser U, Hirt HP, Berthold H. Localized ridge augmentation using guided bone regeneration. I. Surgical procedure in the maxilla. International Journal of Periodontics & Restorative Dentistry. 1993 Feb 1;13(1).

8 Dahlin C, Andersson L, Linde A. Bone augmentation at fenestrated implants by an osteopromotive membrane technique. A controlled clinical study. Clinical Oral Implants Research. 1991 Oct;2(4):159-65.

9 Kirkland G, Greenwell H, Drisko C, Wittwer JW, Yancey J, Rebitski G. Hard tissue ridge augmentation using a resorbable membrane and a particulate graft without complete flap closure. International Journal of Periodontics & Restorative Dentistry. 2000 Aug 1;20(4).

10 Jahangiri L, Devlin H, Ting K, Nishimura I. Current perspectives in residual ridge remodeling and its clinical implications: a review. The Journal of prosthetic dentistry. 1998 Aug 1;80(2):224-37.

11 Amler MH. The time sequence of tissue regeneration in human extraction wounds. Oral Surgery, Oral Medicine, Oral Pathology. 1969 Mar 1;27(3):309-18.

12 Winkler S. Implant site development and

alveolar bone resorption patterns. Journal of Oral Implantology. 2002 Oct;28(5):226-9.

13 Boyan BD., et al. "Use of growth factors to modify osteoinductivity of demineralized bone allografts: lessons for tissue engineering of bone". Dental Clinics of North America 50.2 (2006): 217-228.

14 Lin WL, McCulloch CA, Cho MI. Differentiation of periodontal ligament fibroblasts into osteoblasts during socket healing after tooth extraction in the rat. The Anatomical Record. 1994 Dec;240(4):492-506.

15 Araujo MG, Berglundh T, Lindhe J. On the dynamics of periodontal tissue formation in degree III furcation defects: an experimental study in dogs. Journal of clinical periodontology. 1997 Oct;24(10):738-46.

16 Cardaropoli G, Araujo M, Lindhe J. Dynamics of bone tissue formation in tooth extraction sites: an experimental study in dogs. Journal of clinical periodontology. 2003 Sep;30(9):809-18.

17 Horowitz RA, Mazor Z, Miller RJ, Krauser J, Prasad HS, Rohrer MD. Clinical evaluation alveolar ridge preservation with a beta-tricalcium phosphate socket graft. Compend Contin Educ Dent. 2009 Jan 1;30(9):588-90.

18 Serino G, Biancu S, Iezzi G, Piattelli A. Ridge preservation following tooth extraction using a polylactide and polyglycolide sponge as space filler: a clinical and histological study in humans. Clinical oral implants research. 2003 Oct;14(5):651-8.

19 Barone A, Aldini NN, Fini M, Giardino R, Guirado JL, Covani U. Xenograft versus extraction alone for ridge preservation after tooth removal: a clinical and histomorphometric study. Journal of periodontology. 2008 Aug 1;79(8):1370-7.

PARADIGM SHIFT IN IMPLANT DENTISTRY

Dr. Y. Satya Sai Sruthi[1], Dr. B. Lakshmana Rao[2], Dr. Satyanarayana S V Tammineedi[3], Dr. P.S.H.L. Parvathi[4], Dr. V. Chakradhar[5]

1 Postgraduate student, Department of prosthodontics, Lenora institute of dental sciences
2 Professor & Head, Department of prosthodontics, Lenora institute of dental sciences
3 Reader, Department of prosthodontics, Lenora institute of dental sciences
4 Postgraduate student, Department of prosthodontics, Lenora institute of dental sciences
5 Postgraduate student, Department of prosthodontics, Lenora institute of dental sciences

ABSTRACT: In this modern era implants have out classed and out matched fixed and removable modalities of rehabilitating edentulousness. this has been chiefly due to advancements in material science, improved knowledge of the bone-implant interface dynamics and surgical techniques. these in turn have made possible predictable outcomes for this mode of treatment. However, there are still many issues that need to be addressed. For example, even while osseointegration has been the bedrock of implantology the ankylosed nature of the interface does present significant problems in certain clinical situations. Similarly, the nature of the bone and anatomic proximity of the sinus in the posterior maxilla does present issues while navigating this region. Last but not the least has been the not so successful methods to conserve bone loss during osteotomy for implant bed preparations which can compromise primary stability. this article is an attempt to highlight the various strategies adopted to overcome these hurdles and which have resulted in a paradigm shift in the way implantology will be practiced in the future. A paradigm shift means a fundamental change in approach or underlying assumptions.

KEY WORDS: Osseointegration, implant, Socket shield, osseo-densification, dynamic implant valve approach, liga-plants.

Introduction: implant anchored rehabilitation is the new norm for the management of edentulousness in any form. This has been the outcome of the synergistic efforts by both clinicians and engineers. Challenged by clinicians for improved materials, and designs for implant bodies biomedical engineers have responded wonderfully by providing them with better and improved materials and designs. The bedrock on which implantology rests is the phenomenon of osseointegration. a term coined by the pioneer Brånemark and defined by him. Later Albrektsson a close associate of Brånemark enunciated six parameters for successful implant therapy and they are 1. the implant material, 2. implant surface, 3. implant design, 4. host factors, 5. implant surgical technique and 6. biomechanical factors which play a leading role in achieving osseointegration.[1] Of the six, three he said are within the control of the profession. They are implant surface, implant design, and surgical technique. Through this paper we would like to review the recent advances in pertaining to the implant surface, design and surgical technique.

Paradigm shift in surgical technique: OSSEODENSIFICATION: Primary stability has been an important factor in assessment of success of an implant and it is influenced by the shape and design of the implant, quality and quantity of the bone, the surgical technique and skills of the surgeon, whilst its maintenance is depended on the loading conditions, the presence of parafunctional habits, and the healing capacity of the host.[2,3]

To increase the primary stability of an implant placed in low density bone procedures opted are:[3]

Omitting bone tapping,

Bi-cortical fixation,

Under-preparation,

Stepped osteotomy,

Condensation.

To overcome the disadvantages of these procedures the reinvented procedure is OSSEO-DENSIFICATION.[2,3] An optimized surgical protocol must satisfy two conditions: provide an implant bed that will help achieve primary stability and two, minimize bone to the maximum. While the first can be achieved relatively easily the second was proving to be an intractable problem. Today with the advent of the concept of osseodensification a solution to this last problem is also at hand.

Principle of Ossodensification[2,3,4]: In direct contradistinction to the conventional mode of osteotomy where the drill actively churns out bone by actively 'cutting it', the osseodensification technique condenses the bone even while drilling it. This results in almost zero loss of bone. Even while providing primary stability. This condensation is achieved by using special burs called Versah burs. These have flutes which when turned counterclockwise at 800 to 1500 rpm condenses bone rather than cutting it and condenses the bone and compacts the autologous bone graft in the osteotomy site. Truly a paradigm shift in the way osteotomy is performed.

Rationale of Osseo-densification procedure[2,3,4]:

1 This process is the densification of the bone that will be in immediate contact to the implant results in higher degrees of primary stability due to physical interlocking between the bone and the device.

2 faster new bone growth formation due to osteoblasts nucleating on instrumented bone that is in close proximity with the implant.

The bur technology was developed by Huwais S, when rotated in clockwise direction it has the cutting action on the bone, when in anti-clockwise direction it has non-cutting action and densifies the bone (FIG1). The osteotomy preparation has to be done by **Bouncing-Pumping Motion** (FIG 2).[4,5,6]

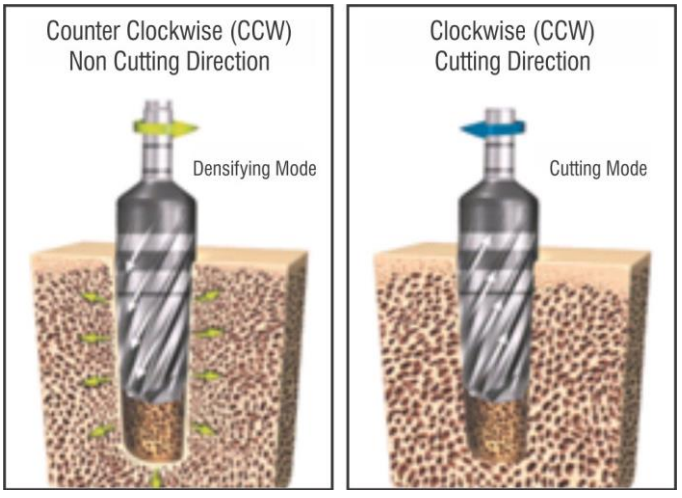


Figure 1: Bur technology: clockwise and anti-clockwise rotation

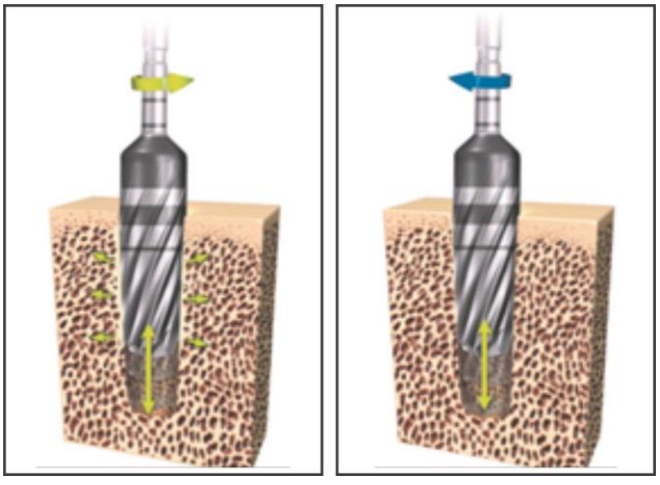


Figure 2: Bouncing and pumping motion

FIG 2: Bouncing and pumping motion

Indications[2]:

1 when bone quality is SOFT.

2 when width of available bone is LESS THAN 3MM (lateral ridge expansion),

3 when posterior maxillary height is LESS THAN 7MM (maxillary sinus elevation),

4 when density of bone is LOW.

Pardigm shift in implant surface: Liga plants[7,8,9,10]: Implant is expected to replace the missing natural tooth both in structure and function. The fixture of the implant replaces the root portion of the tooth only partly in both structure and function. The main difference between a natural tooth and implant is presence of periodontal ligament (PDL) in natural

tooth which helps in vertical movement of the tooth and acts as shock absorber. Due to lack of PDL in the implant may lead to failures in the clinical scenarios like tooth and implant supported fixed restorations and even a single tooth replacement because of the difference present vertical movement there will be increased occlusal highpoint and interferences on the implant crown than on the natural tooth leading to crestal bone loss. To overcome such problems, Ligaplants were developed recreating the natural tooth anatomy. Liga plant by literal meaning it is implant with periodontal ligament (FIG 3).

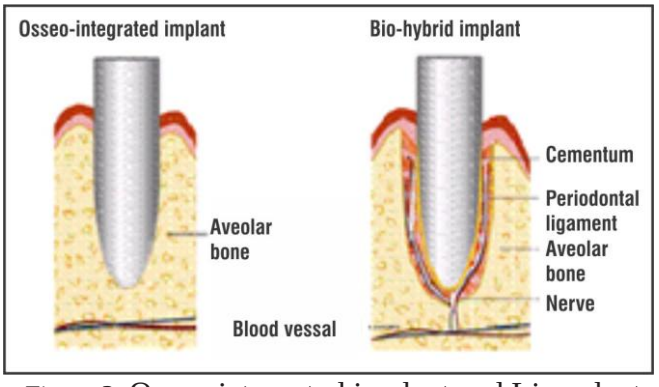


Figure 3: Osseo-integrated implant and Liga plant

Properties of Liga Plants [7,8]:

1 PDL cells distribute forces, elicited during masticatory function and other contact movements to the alveolar process via the alveolar bone proper.

2 It gives the tooth some movement in the socket by acting as a shock absorber.

3 Proprioception is also provided by Liga plants.

4 It also homes vital cells such as osteoblasts, osteoclasts, fibroblasts, cementoblasts, and most importantly undifferentiated stem cells which are osteoconductive in nature.

Procedure of obtaining Ligaplants[10]:

1 Temperature responsive culture dishes preparation

2 Cell culture and cells

3 PDL cells culturing in a bioreactor

1) Temperature responsive culture dishes preparation: On-to polystyrene culture dishes, N-isopropylacrylamide monomer in 2-propanaol solution was spread. Then these dishes were subjected to electron beam irradiation with an Area Beam Electron Processing System. The dishes were then rinsed with cold water to remove ungrafted monomer and then sterilized with ethylene oxide.

2) Cell culture and cells: From an extracted tooth human periodontal ligament cells were isolated. From the middle third of the root periodontal tissue was scraped with a scalpel blade after extraction. The harvested tissue was placed into culture dishes containing = Dulbecco's modified Eagle's minimal essential medium, supplemented with 10% fetal bovine serum and 100 units/ml of penicillin-streptomycin. Then in a humidified atmosphere of 5% CO□ at 37°C for 48 hours those outgrowth cells were cultured to allow attachment of the cells to the dishes. The debris were eliminated by washing the dishes and the medium has to be changed three times per week. Human periodontal ligament cells were placed on temperature-responsive culture dishes (35mm in diameter) at a cell density of 1x10 □and cultured at 37°C supplemented with 50mg/mL ascorbic acid 2-phosphate,10nM dexamethasone and 10nM ßglycerophosphate that function as an osteo-differentiation medium to harvest the cell sheet.

3) PDL cells culturing in a bioreactor: A hydroxyapatite (HAP) coated titanium pin, was placed in a hollow plastic cylinder leaving a gap of 3mm around the pin. Through the gap culture medium was continuously pumped. Single cells suspension, obtained from human, was seeded first into plastic vessels under a flow of growth medium for 18 days.

Advantages[9,10]:

- It can **decrease** problems faced by implants such as **gingival recession and bone defects** of the missing tooth site.
- It **mimics natural tooth**.
- It **induces bone formation**.
- Despite the initial fitting being loose in order to spare PDL cell cushion, Liga plants **firmly**

integrates without interlocking and without direct bone contact.

Disadvantages [9, 10]:

- The main disadvantage with the Liga plants is primary stability cannot be assessed.

Paradigm shift in implant design: Diva Implant[11]: When patients present with advanced ridge resorption, it could complicate the procedure of implant surgery. This problem is magnified in the posterior maxilla where ridge resorption and sinus pneumatization, compounded with a poor quality of bone, are often encountered. The procedure of choice to restore this anatomic deficiency is maxillary sinus floor elevation.

There are many procedures available in the literature on sinus lift. Some of them are:[11]

1. Transcrestal Approach (tSFE)
2. Lateral Window Approach (LatW)
3. Piezoelectric Surgery (PS)
4. Balloon elevation technique
5. Hydraulic Sinus Lift Technique (HySiLift)
6. Osteotome Technique (OstSFE)
7. Nasal suction technique

Most of the sinus lift procedures performed by the surgeons are cumbersome and carried the high risk of possible complications including infection, bleeding, etc., DIVA, a new sinus elevation technology, delivers an innovative solution of restoration that enables sinus lift implants to be carried our using a simple, relatively short procedure, with significantly lower risk of complications and patient discomfort.

Diva implant[12,13,14]**:** The Titanium-Aluminum-Vanadium implant (Ti-6Al4V ELI) has an internal sealing screw that serve for endoscopic direct observation and as a drug delivery system via its channel.

Unique qualities of DIVA[11]**:**

- **Use of implant itself** to elevate the sinus membrane without risk of perforation
- Its configuration allowing **injection of bone substitute directly** through the implant
- **Absolute sealing** of the implant against oral flora

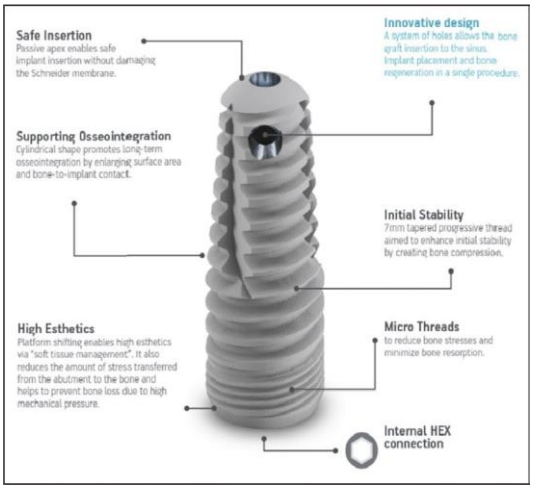


Figure 4: DIVA implant

Figure 5: Initial and final valve screws of DIVA implant

DIVA IMPLANT KIT[11]**:**

A. DIVA Implant (FIG 4)

B. Internal Screw Driver (optional)

C. Syringe

D. IV Cannula

E. Synthetic Bone Paste (TCP in hyaluronic acid)

F. DIVA osteotome

STEP BY STEP PROCEDURE[11, 12, 13, 14]**:** Step by step procedure of the DIVA implant placement is explained in the Figure 6

1. Initial drill
2. Use of osteotome
3. Insertion of diva implant

4. Long screw valve removal (Figure 5)
5. Attach saline syringe cannula
6. Racheting by 1mm
7. Attachment of bone graft material syringe
8. Placement of second screw valve (Figure 5)

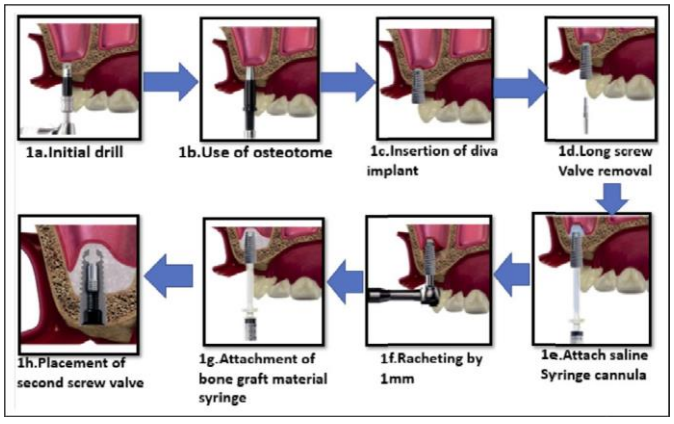


Figure 6: Step by step procedure of DIVA implant placement

The new approach permits[11]:

-- a closed sinus lifting procedure via the implant itself,

-- drug delivery via the implant port,

-- intraosseous feedback via the same port,

-- augmentation procedures via the implant, and

-- endoscopic control over the implant and the surrounding bone during the entire period of the usage of the implant.

Conclusion: The world wide acceptance of implant-based rehabilitation for edentulousness is chiefly due to the predictable outcome it offers. However, there still remains many unaddressed issues. one such being the placement to restoration time lag. Yet another has been the presence of an ankylosed bone-implant interface rather than a natural suspensory natured interface. Yet another issue has been the often difficult and complicated techniques to manage the posterior maxilla where anatomic conditions like a lowered maxillary sinus can and does pose difficulties. The worldwide demand of the implants, has opened up the scope of the advancements. Current research and observations evoked a change of paradigm during the past decade: instead of focusing mainly on topographical features, surface roughness, the new paradigm includes now the change in the technique used, type of implants being used with topographical modifications. New technologies, based on the three-dimensional evaluation of patients for dental implants have opened new avenues to clinicians for accurate and predictable diagnosis, planning, and treatment in a multidisciplinary patient-based approach. The clinicians have to thoroughly check for select material and choose particular technique accordingly.

References:

1 Albrektsson T, Brånemark PI, Hansson HA, Lindström J. Osseointegrated titanium implants. Requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. Acta Orthop Scand 1981; 52:155-70.

2 Huwais S, Meyer E. Osseodensification: A novel approach in implant osteotomy preparation to increase primary stability, bone mineral density and bone to implant contact. Int J Oral Maxillofac Implants 2016; 32:27-36.

3 Meyer EG, Huwais S. Osseodensification is a Novel Implant Preparation Technique that IncreasesImplantPrimaryStabilitybyCompaction and Auto-Grafting Bone. San Francisco, CA: American Academy of Periodontology; 2014.

4 Huwais S. Inventor; Fluted osteotome and surgical method for use. US Patent Application US2013/0004918; 3 January, 2013.

5 Huwais S. Autografting Osteotome. WO2014/077920. Geneva, Switzerland: World Intellectual Property Organization Publication; 2014.

6 Huwais S. Enhancing implant stability with osseodensification: A two year follow up. Implant Pract 2015; 8:28-34.

7 Bharathi D, Siji JT, Srinivasan, Senthil KS. Ligaplants- A review. Annals of dental speciality 2017; 5(2): 71-3.

8 Nair ST, Sreedevi KG, Beevi R, Janam P. Ligaplants- a therapeutic modality on the horizon. JSPIK 2015; 8(3): 101-4.

9 Arunachalam LT, Sudhakar U, Merugu S, Janarthanan AS. Tissue-engineered periodontal ligament on implants : Hype or hope ? J Dent Implant 2012;2: 115-6.

10 Jibi J, Rao BL, Sruthi YSS, Pratyusha T, Chitra C. A Novel Approach in Implant Dentistry – LIGAPLANTS. Int J Sci Res (IJSR). 2019;8(3): 43-5.

11 Sruthi YSS, Rao BL, Jibi J, Pallavi C. Neoteric sinus elevation: a smart lift - DIVA implants. Paripex Ind J Res. 2019; 8(3): 1-3.

12 Nahlieli O, Casap N, Moshonov J, Zagury A, Michali E, Samuni Y. A novel dental implant system with an internal port for endoscopic closed sinus augmentation: a feasibility study in pigs. Int J Oral Maxillofac Implants 2013; 28(6): 556-561.

13 Nahlieli O. Dynamic implant valve approach for dental implant procedures. Chine J Dent Res 2014; 17(1): 15-21.

14 Nahlieli O, Zagury A, Michaeli E, Bruck N, Nahlieli DD, Casap N. Four- years' experience with dynamic implants with internal port for minimally invasive sinus elevation. Quintessence Int 2016; 47(8): 669-675.

Neutral Zone Technique for Severely Resorbed Mandibular Ridge: Case series

Shruti Potdukhe[1], Janani Iyer[2], Jyoti Nadgere[3]

Abstract: Neutral zone technique is one of the method of management of severely resorbed mandibular ridge cases. Various materials can be used to record the neutral zone. Balanced occlusion is one of the parameter used to aid in the stabilization of the lower denture. In this case series we will discuss about different materials such as low fusing impression compound and tissue conditioner used to record the neutral zone with different form of occlusion.

Keywords: Neutral zone, severely resorbed mandibular ridge, Balanced occlusion, Low Fusing Impression compound, Tissue Conditioner

Introduction: The goal of dentistry is for patients to keep all of their teeth throughout their lives in health and comfort. If the teeth are lost despite all efforts to save them, a restoration should be made in such a manner as to function efficiently and comfortably in harmony with the muscles of the stomatognathic system and the temporomandibular joints[1]. The stable position of the teeth represents equilibrium of all the forces acting on them. If that position of equilibrium namely the neutral zone, is not found, the resulting dentition will not last long and will not be esthetically pleasing and the patients use of functional efficiency, maximum length of use and pleasing esthetics will not have been met[2]. To understand the stable position of teeth, the concept of neutral zone is important. The neutral zone concept in complete denture was proposed by Sir E. Wilfred Fish in 1931[3]. Neutral zone is defined as potential space between lips and cheeks on one side, and tongue on other side, that area or position where forces between the tongue and lips or cheeks are equal[1]. Neutral zone approach to complete denture is to locate the area in edentulous space where the teeth should be positioned in such a way that the forces exerted by muscles will stabilize the denture[4]. Neutral zone technique is the most effective way for patients who have unstable and unretentive dentures.

Occlusion is also one of the important factor affecting stability of denture. To minimize dislodging forces the occlusion can be balanced throughout the functional range of movement of the patient[5].

In this article two cases of severely resorbed mandibular ridge rehabilitated by complete denture using two different materials for recording neutral zone technique with balanced occlusion and centric occlusion are presented.

Case 1: A 60 year old female patient reported to the department of prosthodontics with the chief complaint of difficulty in mastication due to all missing teeth in upper and lower arch since 6 years. Extraoral examination showed ovoid facial form, concave and sunken profile. The lip length was average (figure 1). Intraoral examination showed favourable maxillary residual ridge and severely resorbed mandibular ridge (Figure 2). Thus it was decided to fabricate lower complete denture utilizing neutral zone impression technique.

Figure 1: Extra oral picture

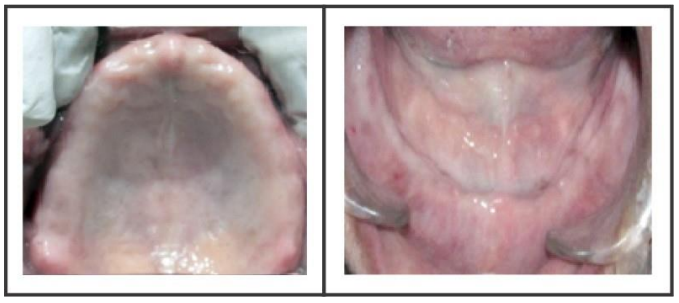


Figure 2: Intra oral picture

Primary impression: A primary impression for maxillary ridge and mandibular ridge was made with impression compound (Y-Dent) in a metal stock tray (Figure 3). The primary impression was poured with dental plaster (Dent kaldent). On primary cast, custom tray was fabricated.

Final Impression: The sectional border moulding was done for maxillary arch with low fusing impression compound (DPI-Pinnacle). All green technique was used to record the borders of mandibular arch6. Final impression was made with Zinc oxide eugenol impression paste (DPI-Impression Paste) (Fig 4). Final cast was poured in dental stone (Dent kaldent).

Figure 3: Primary impression

Figure 4: Final impression

Jaw relation: Two sets of autopolymerising denture base were fabricated. On one set wax rims were fabricated. Horizontal and Centric jaw relation was recorded. Facebow record was made to orient maxillary cast on articulator (Hanau). The Mandibular cast is mounted using the centric relation record.

Recording neutral zone: On articulator three acrylic pillars one in center, two in molar region were made on second set of mandibular denture base to maxillary denture base to maintain the vertical dimension. Wires were adapted in between the pillars for reinforcement (Figure 5). Low fusing impression compound was manipulated and adapted on mandibular denture base[7]. With whole assembly placed in mouth patient was asked to purse lips, count from 60 to 70, smile, grin, pronounce the vowels, swallow, slightly protrude the tongue and lick the lips until the material has set. A wash impression with zinc oxide eugenol paste (DPI-Impression Paste) was made to record the Neutral zone (Figure 6). On articulator, dental plaster index was made in three sections right buccal, left buccal, lingual around neutral zone impression (Figure 7).

Figure 5: Adaptation of wires between acrylic pillars

Figure 6: Recording Neutral Zone with low fusing impression compound and Zinc oxide Eugenol Wash on recorded neutral zone

Teeth arrangement: Molten wax was poured in neutral zone space. Mandibular occlusal rim height was adjusted according to previously recorded jaw relation. Semi-anatomic crossed-linked acrylic denture teeth for both anterior and posterior region were selected. These teeth were selected as they don't put more pressure on ridge thereby prevents underlying bone resorption and allows easy reshaping for occlusal adjustments. Mandibular anterior and posterior teeth were arranged according to plaster index (Figure 8). Complete teeth arrangement was done so as to provide multiple bilateral posterior contacts in centric relation. A protrusive interocclusal record was made to set the condylar guidance on the articulator (Figure 9). Anterior try-in was done and anterior guidance was set. Programming of articulator was done as lateral condylar guidance of 15º; horizontal condylar guidance of 25º and anterior guidance of 5º for balanced occlusion.

Figure 7: Plaster index of recorded neutral zone

Figure 8: Mandibular Teeth Arrangement within Plaster Index


Figure 9: Protrusive Bite Record for Balnced Occlusion

Try-in: Trial Dentures were evaluated to verify Centric relation, occlusal vertical dimension and Balanced occlusion.

Denture Insertion: Dentures were fabricated, inserted and evaluated (Figure10)

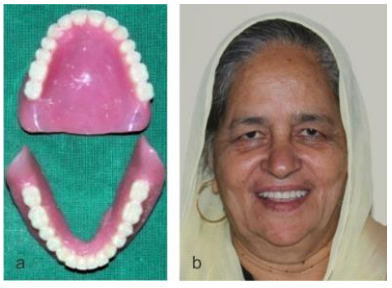


Figure10: a) Final Dentures b) Post Operative Extra Oral view

CASE 2: A 65 year old female patient reported to the department of prosthodontics with the chief complaint of loose lower denture since 1 year. Extraoral examination showed tapered facial form and concave profile and medium lip line (figure 11). Intraoral examination showed adequate maxillary residual ridge and severely resorbed mandibular ridge (Figure 12). All the steps followed were same. Neutral zone was recorded using tissue conditioner8 (D- soft) (Figure 13). Dentures were fabricated, inserted and evaluated (Figure 14).


Figure 11: Extraoral Picture


Figure 12: Intraoral Picture

Figure 14: Recording Neutral Zone with Tissue Conditioner

Figure 15: Final Dentures

Discussion: The ability of a denture to be firm, steady or constant, to resist displacement by functional stresses and not to be subjected to change of position when forces are applied defines stability. With severe resorption the muscular attachment comes nearer to the residual ridge affecting stability of mandibular denture more than maxillary denture[9]. To overcome the problem of unstable denture, the neutral zone concept was introduced. Neutral zone is the space where the forces between the tongue and cheeks or lips are equal or neutralized[9]. It is used as a guide to develop physiologic contour for polished surfaces of the mandibular denture and for determining physiologically appropriate facio-lingual tooth position. The neutral zone technique is used to achieve retention and stability in atrophic mandibular ridges[10].

Various materials have been used to record the neutral zone such as waxes, impression plaster, impression compound, tissue conditioners and polyether. The material should be reasonably slow setting to permit the oral musculature to shape it to the appropriate contour and dimensions. Adel A.M. et al in 2019 conducted study to determine relationship between the crest of the alveolar ridge and neutral zone and to compare its location recorded by low fusing impression compound and tissue conditioner. They concluded that no significant difference was noted in the positions of neutral zone recorded in relation to the alveolar ridge crest[10].

In this case series two commonly available materials namely, low fusing impression compound with zinc oxide eugenol paste wash and tissue conditioner were used to record the neutral zone. Low fusing impression compound is a thermoplastic material with low viscosity allowing ease in manipulation of oral musculature, better flow and good accuracy. Tissue conditioners are viscoelastic material they have long working time, good flow, longer durability and don't resist forces exerted by the surrounding tissues. Thus most accurate neutral zone position which is close to crest of ridge was recorded by using the above two materials.

Occlusion is one of the factors for enhancing the principles of denture. Balanced occlusion helps in directing the forces of mastication to aid in the balance and stabilization of the functioning mandibular denture. Thus, denture fabricated by neutral zone impression technique and balanced occlusion aids in retention and stabilization of the denture rather than dislodging the denture during function, as well as reduced food lodgement, good esthetics due to facial support, proper positioning of the posterior teeth allowing sufficient tongue space. Clinicians must identify and record the neuromuscular dynamics of the oral tissues and this should be applied in the construction of the definitive prosthesis[3].

Conclusion: The coordination of complete dentures with neuromuscular function is the foundation of successful stable dentures. Neutral zone impression technique and type of occlusion are one of the factors aiding in stabilization and retention of the mandibular denture in severely resorbed ridge cases.

References:

1 Srivastava V, Gupta NK, Tandan A, Kaira LS, Chopra D. The neutral zone: Concept and technique. J Orofac Res. 2012 Jan;2(1):42-7.

2 Jacobson TE, Krol AJ. A contemporary review of the factors involved in complete denture retention, stability, and support. Part I: retention. The Journal of prosthetic dentistry.1983 Jan 1;49(1):5-15.

3 Chaturvedi S, Abdelmonem AM, Haralur S, Suleman G, Majeed MI, Alfarsi MA. An In Vivo Study to Compare Location of Neutral Zone Recorded with Two Materials. The journal of contemporary dental practice. 2019 Feb;20(2):239-46.

4 J Beresin VE, Schiesser FJ. The neutral zone in complete dentures. Journal

of Prosthetic Dentistry. 2006 Feb 1;95(2):93-100.

5 Kurth LE. Balanced occlusion. Journal of Prosthetic Dentistry. 1954 Mar 1;4 (2):150-67.

6 Daniel S, Daniel AY, Kurian N. A modified physiologic impression technique for atrophic mandibular ridges. CHRISMED Journal of Health and Research. 2017 Jul 1;4(3):204.

7 Agrawal KK, Singh SV, Vero N, Alvi HA, Chand P, Singh K, Goel P. Novel registration technique to register neutral zone. Journal of Oral biology and craniofacial Research. 2012 Sep 1;2(3):198-202.

8 Kursoglu P, Ari N, Calikkocaoglu S. Using tissue conditioner material in neutral zone technique. New York State Dental Journal. 2007;73(1):40

9 Hansson S, Halldin A. Alveolar ridge resorption after tooth extraction: A consequence of a fundamental principle of bone physiology. Journal of dental biomechanics. 2012;3.

10 Yeh YL, Pan YH, Chen YY. Neutral zone approach to denture fabrication for a severe mandibular ridge resorption patient: Systematic review and modern technique. Journal of dental sciences. 2013 Dec 1;8(4):432-8.

A systematic approach in Prosthetic rehabilitation of Hemi-mandibulectomy: A case report

Dr Hemangi kalambe[1], Dr Aparna Barabde[2], Dr Pravin Sundarkar[3], Dr Sumit Dhope[4], Dr Bhushan Wankhede[5]

*Corresponding author: Dr Hemangi kalambe

1 Post Graduate student

2 Professor, guide and HOD

3 Professor

4 Senior Lecturer

5 Reader,

* Specialist Prosthodontist, Post Graduate student,

All Department of Prosthodontics, VYWS Dental college and Hospital, Amravati

Abstract: Surgical resection of the mandible due to presence of benign or malignant tumour is the most common. Depending upon the location and extent of the tumour in the mandible, various surgical treatment modalities like marginal, segmental, hemi, subtotal, or total mandibulectomy can be performed. The restoration of normal function and esthetics is often challenging in the prosthetic rehabilitation of patients with hemi-mandibulectomy defects due to unstable occlusion and mandibular deviation. Besides, there is difficulty in swallowing and impaired speech. This case report describes the systematic prosthodontic management of a patient that has undergone hemi-mandibulectomy with a provisional training Appliance i.e., flange prosthesis followed by an interim and definitive cast partial denture prosthesis.

Introduction: The mandible, located inferiorly in the facial skeleton, is the largest and strongest bone of the face. It forms the lower jaw and acts as a receptacle for the lower teeth. It also articulates on either side with the temporal bone, forming the temporomandibular joint. It is a significant structure in lower third of face constituting to function and esthetics. It is a single bone that creates peripheral boundaries of the floor of the mouth, facial form (lower third), speech, swallowing, mastication and respiration[1]. One of the most challenging and demanding maxillofacial endeavours is the construction of functional dentures for a patient who has undergone a mandibular resection. Segmental resection of the mandible results in physiological and esthetic problems, of which the most significant difficulty encountered is mandibular deviation toward the defective side. Mandibular deviation due to unilateral mandibular discontinuity defects caused by surgery or trauma results in lack of occlusion and altered maxillomandibular relationships for optimum mastication and appearance. In the present case, marginal hemi-mandibulectomy was done, so the amount of deviation was much less[2]. Furthermore, the deviation of the mandible towards the resected side was due to scar contracture only. Prosthodontic intervention is usually recommended in the initial healing period of reconstructed mandible to prevent the rotation of the mandibular occlusal plane inferiorly and extrusion of the maxillary teeth and improve the masticatory efficiency. Literature shows techniques to correct mandibular deviation that can vary from intermaxillary fixation with elastics, palatal or mandibular guiding flange anchored on natural teeth or the dental flange. The guiding flange is probably the simplest and most useful in maintaining position of the remaining jaw. Cantor and Curtis provided a hemi-mandibulectomy classification for edentulous patients that can also be applied in partially edentulous arches[4]. In patients where reconstruction is not done after resection of the mandible, scar tissue formation occurs over a period of time that stiffens the tissues and worsens prosthetic rehabilitation, leading to compromised treatment planning. The present case report describes the prosthodontic management of Hemi-mandibulectomy with cast partial denture with a guiding flange because there was occlusal deviation observed due scar tissue.

Case report: 38year old male reported to department of Prosthodontics with the chief complain of difficulty in eating due to deviation of jaw and missing teeth in right side and wants replacement of missing teeth.

The patient gave history of malignancy involving right buccal mucosa and mandibular alveolus and thus right side marginal hemi-mandibulectomy was performed 1.5 year back. Extra oral examination revealed facial symmetry but a slight deviated lower third of face towards the resected side, optimum mouth opening. The patient could manually guide himself into occlusion (Figure 1). On Intraoral examination it revealed right mandibular defect distal to right first premolar and surgical stiff scar seen on resected side; 45–47 teeth were missing. Mandibular arches were partially edentulous, representing Kennedy's Class II (Figure 2). The ridges were not prominent, covered only by stiff scar soft tissue without sufficient height and width for support. Orthopantomogram revealed the absence of the mandible alveolar bone with thin marginal bone intact distal to the mandibular right first premolar on the resected side (Figure 3).

Figure 1: A 26-year-old patient with right hemi-mandibulectomy

Figure:2,3,4-Intraoral scar tissue, deviated mandible towards resected side, OPG showing right mandibular alveolus resection

The case was diagnosed as Cantor and Curtis Class I mandibular defect. Treatment plan was decided and mandibular guide flange prosthesis was given as there was a little occlusal deviation. The application of endosseous implants in combination with bone graft for jaw reconstruction has allowed for improved result and could have been the ideal treatment but due to patient financial constraint only a definitive prosthesis of mandibular cast partial denture was designed to replace the missing teeth. The patient was recalled over a period of 1 year. Primary impression of both the maxillary and the mandibular arch was made with irreversible hydrocolloid (Zermack Hyrogum Alginate). Cast was poured with Type III dental stone. A maxillomandibular record was made by manually assisting the mandible into the centric occlusion. The maxillary and mandibular cast was mounted on a 3-point articulator (figure 4). The prosthesis was fabricated on the non-defect (left) side. The design included the guidance flange on the buccal side and the supporting flange on the lingual side. The retention was provided by the interdental clasp, engaging the canines and the molars (Figure 5). The guide flange extended superiorly and diagonally on the buccal surface of the molars and the premolars, allowing the normal horizontal and vertical overlap of the maxillary teeth (Figure 6). The guide flange was sufficiently blocked out, so that it would not traumatize the left maxillary teeth and the gingiva when the patient closed his mouth. Care should be taken to preserve the buccal-surface indentations of the opposing maxillary teeth which were guiding the mandible in a final definite closing point during mastication. The flange height was adjusted in such a way that it guided the mandible from large opening position (in practical limits of the height of the buccal vestibule) to the maximum intercuspation in a smooth and unhindered path. The prosthesis was delivered and post-insertion instructions were given (Figure 7).

Figure 5 : Guiding flange appliance with retentive clasp

Figure 6 : Guiding flange appliance with retentive clasp

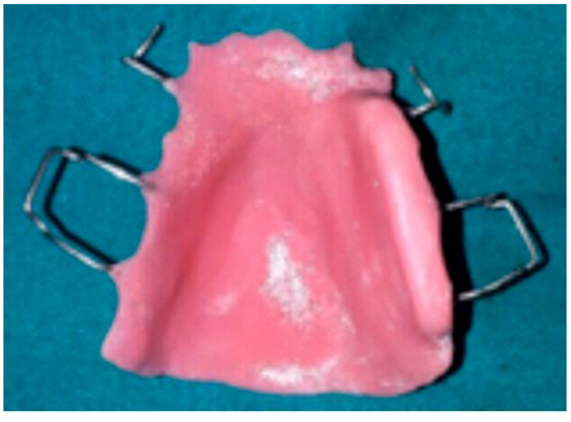


Figure 7 : Guiding flange appliance with retentive clasp

After a training period of 4 months normal occlusion was achieved with deviation and definitive cast partial denture prosthesis was planned (Figure 8).

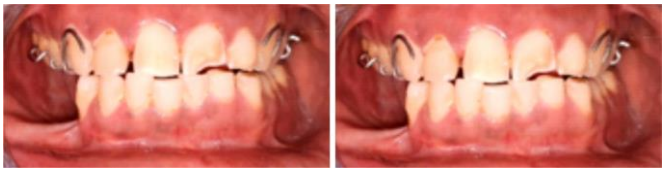


Figure 8: Normal occlusion achieved

For the definitive prosthesis surveying was done (Figure 9). Cast partial denture designing and mock rest seats were prepared on the cast. As it was a distal extension case as stress breaker RPI(mesial rest, distal proximal plate, I bar) was planned but due to the surgical scar tissue present on defect side no buccal vestibule was available for I bar, so the modification of RPI was applied i.e., RPA clasp system(Mesial rest , distal proximal plate and Akers clasp). On the second appointment rest seats were prepared on 36, 37, 33, and 44 in the patient's mouth Secondary impression was made with elastomeric impression material using a custom acrylic tray (Figure 10) and final cast was poured. Wax pattern fabrication was made on the final cast (Figure 11). The wax pattern was further invested and dewaxing was done and the cast partial denture framework was casted in cobalt chromium metal. Metal framework try in was carried out and functional impression was made with recording the jaw relation (Figure12,13). Altered cast was fabricated. Patient's facebow orientation was transferred to semi-adjustable articulator and teeth arrangement was carried out. (Figure14,15).

Figure 9, 10, 11: Surveying, final impression, wax pattern

Figure 12, 13: Metal try-in (RPA clasp assembly), jaw relation record, functional impression made

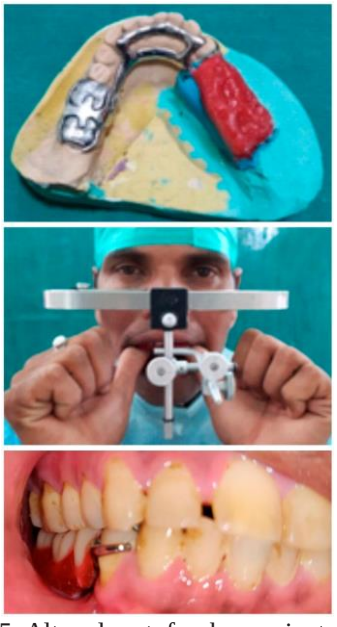


Figure 14,15: Altered cast, facebow orientation, try-in

The metal framework with the cast was further acrylized with heat cure denture base material (Trevalon Heat Cure Denture Base) so that the tissue supporting area of the prosthesis is in heat cure acrylic base material (Figure 16,17). The acrylized prosthesis was further finished and polished and inserted in the patient's mouth. The deviation of the mandible reduced by guide flange is now maintained by the cast partial denture.

Figure 16: Intra oral post-operative photographs

Figure 17: Pre-operative and post-operative photographs

Discussion: The success in rehabilitating a patient with hemi-mandibulectomy depends upon the nature and extent of surgical defect, treatment plan, type of prosthesis, and patient co-operation. The earlier the mandibular guidance therapy is initiated in the course of treatment, the more successful is the patient's definitive occlusal relationship (Desjardins, 1979 and Sahin, 2005)[5]. This article describes functional rehabilitation of hemi-mandibulectomy patient who has undergone resection with reconstruction graft and plate. Guide flange prosthesis (GFP) is a mandibular conventional prosthesis designed for the patient who is able to achieve an appropriate mediolateral position of the mandible but is unable

to repeat this position consistently for adequate mastication (Patil, 2011 and Desjardins, 1979)[6]. It helps to prevent deviation of the mandible, improve masticatory function and esthetics and to re-establish an acceptable occlusal relationship so that the patient can adequately control opening and closing mandibular movements. During the initial healing period following mandibular resection early prosthodontics intervention by mandibular guide flange and maxillary stabilization prosthesis serve the purpose of reducing mandibular deviation. The tissue in the surgical region is scarred, uneven, without support of the bone, and movable in various degrees. These features make the area unsuitable to be covered by an appliance or to receive loading. The frontal plane rotation occurs due to loss of proprioceptive sense of occlusion, which leads to uncoordinated and less precise movement of the mandible. In addition, due to attachment loss of muscles of mastication on the surgical side, there is significant rotation of the mandible upon forceful closure[7]. The guide flange can be used for a period of 4 months until the patient experienced considerable decrease in deviation (improvement was observed after 4 weeks of insertion). Definitive treatment of these patients takes at least a year from the date of surgery as definitive treatment requires complete healing and no recurrence of cancer. Till then the acrylic GF prosthesis can be used as a training device for mandibular movements and to avoid further compilations[3].

Conclusions: The success of hemi-mandibulectomy rehabilitation depends on the nature of surgical defect, patient's cooperation and prosthetic management with early physiotherapy program. The presence of teeth in both the arches creates a better proprioceptive sense and the prosthesis which re-educates the mandibular muscles to re-establish an acceptable occlusal relationship will control the opening and closing of the mandibular movements adequately and repeatedly[8].

References:

1 Dr Sounder Raj. K., Dr Vishwanath et al. Prosthodontic rehabilitation of hemi-mandibulectomy with cast partial denture. International Journal of Current Research, Vol. 11, Issue, 02, pp.1383-1386, February, 2019

2 Ritu Sharma, Akanksha Sharma, Bhanu Pratap Verma et al. Twin-Occlusion Prosthesis: A Glimmer of Hope for Hemi-mandibulectomy Patient. Indian Journal of Dental Sciences; Volume 11: Issue 1: January-March 2019

3 Deenadayalan Lingeshwar, Rajendran Appadurai, Ujjayanthi Sswedheni et al. Prosthodontic management of hemi-mandibulectomy Patients to restore form and function - A case series. World J Clin Cases 2017 October 16; 5(10): 384-389

4 Shweta Choudhary, Supratim Ram1, Ajit Kumar[2]. Prosthetic Management of a Hemi-Mandibulectomy Patient. Indian Journal ofDental Sciences: Volume 10 :Issue 2:April-June 2018

5 Raipure PE, Prasad P. Rehabilitation of a Hemi-mandibulectomy Patient with Interim Prosthesis. Int J Dent Med Res 2014;1(4):83-86.

6 Ashlesha Subhash Marathe, Prasad Shankarrao Kshirsagar1. A systematic approach in rehabilitation of Hemi-mandibulectomy: A case report. The Journal of Indian Prosthodontic Society:Apr-Jun 2016:Vol 16:Issue 2.

7 Pravinkumar Gajanan Patil, Smita Pravinkumar Patil.Guideflangeprosthesisforearlymanagement of Reconstructed hemi-mandibulectomy: a case report. J Adv. Prosthodont. 2011; 3:172-6

8 Nair SJ, Aparna IN, Dhanasekar B, Prabhu N. Prosthetic rehabilitation of Hemi-mandibulectomy defect with removable partial Denture prosthesis using an attachment-retained Guiding flange. Contemp. Clin Dent 2018; 9:120-2.

9 Pathak S et al. Occlusal guiding flange prosthesis for management of hemi-mandibulectomy- a case report. J Dent Specialities.2015;3(2):192-194

10 Marathe AS, Kshirsagar PS et al. A systematic approach in Rehabilitation of hemi-mandibulectomy: A case report. J Indian Prosthodont. Soc 2016 ;16:208-12.

11 Agarwal S, Praveen G, Agarwal SK, Sharma.S et al. Twin occlusion: A solution to rehabilitate hemi-mandibulectomy patient-a case Report. J Indian Prosthodont Soc 2011;11:254-7.

Smile Designing : A Literature Review

Dr Sumeet Jalan[1], Dr Usha Radke[2], Dr Neelam Pande[3], Dr Rajlakshmi Banerjee[4], Dr Richa Sahai[5]

Abstract: In modern times, we are living in an esthetically governed society. Often the difference between success and failure lies in the facial expression affecting both our personal & professional lives. Scottish physiologist Charles bell (1774-1842) was quoted as remarking that the thought is to the word that the feeling is to the facial expression. He pointed out in 1806 that a smile could convey a thousand different meanings, yet it is the most easily recognized expression. And because the mouth is one of the focal points of the face , it should come as no surprise that the smile plays a major role in how we perceive ourselves, as well as in the impressions we make on the people around us. The article presents a review on smile designing and its future implications.

Introduction: The smile is dependent on the musculature and the presence of the teeth. An attractive or pleasing smile clearly enhances the acceptance of the individual in the society where he belongs and the character of the smile influences to the great extent the attractiveness and the personality of the individual. But every person is not fortunate enough to have a beautiful smile.[1] The answer to the above problem is the esthetic dentistry which has developed leaps and bounds with the latest technologies and materials. A Prosthodontist is probably the best person to identify the qualities of an ideal smile. Further he can also change the quality of smile with the recently available innovative techniques and the state of art restorative materials and to plan restorations in harmony with the existing smile within acceptable limits.

Litrature review:

Classification of smile (Solomon E.G.R.)[2]

1) Depending on the nature of labial mucous membrane
   a) papilla smile
   b) Gingival smile
   c) Mucosa smile
2) Dependent on the lip component
   a) Straight smile
   b) Convex smile
   c) Concave smile

Defination: Glossary of Prosthodontic terms. January 1999.

Esthetics

1. Pertaining to the study of beauty and the sense of beautiful. Descriptive of a specific creation that results from such study; objectifies beauty and attractiveness and elicit pleasure.
2. Pertaining to sensation. Esthetic reshaping Modification of the surfaces of teeth to improve appearance Esthetics (adj. 1798)

The branch of philosophy dealing with beauty. In dentistry, the theory and philosophy that deal with beauty and beautiful, esp. with respect to the appearance of a dental restorations, as achieved through it's form and or color. Those subjective and objective elements and principles underlying the beauty and attractiveness of an object, design or principle.

Dental Esthetics The application of the principles of esthetics to the natural or artificial teeth and restorations. (GPT 1999)

Esthetic Dentistry can be defined as the art and science of dentistry applied to create or enhance beauty of an individual within functional and physiological limits.[3]

Cosmetic dentistry is application of the principles of esthetics and certain illusionary principles, performed to signify or enhance beauty of an individual to suit the role he has to play in his day-to-day life or otherwise.

Smile designing is a process whereby the complete oral hard and soft tissues are studied and evaluated and certain changes are brought about which will have a positive influence on the overall esthetics of the face. These changes are governed by the principles of esthetic dentistry. Hence, a good smile design would naturally and effortlessly blend with the rest of the face to provide an esthetic and functional complex "A well designed smile is a product of consolidated efforts accomplished by accurate diagnosis, methodical treatment planning, use of advanced materials and contemporary techniques rendered by the skilled dentist". Physical attributes of the elements of the dento-facial composition.[4]

The artistic parameters to be considered for essential beauty and those which are subtly present in natural beauty form the fundamental principles of esthetics. Understanding these artistic parameters of beauty and co-relating them to the dento-facial complex will enable the dentist to appropriately scale esthetics in any dento-facial composition. Composition means the act of combining elements or parts to form a whole. There are various physical attributes of the elements of a composition that impart the esthetic value. The various physical attributes of the elements of a composition are:

Unity or oneness: "It gives different parts of the composition the effect of a whole". Unity can either be static, when repeated shapes or designs are seen as in inanimate things, like the composition of crystals; or dynamic and changing as in living beings. Unity between different parts of the face, and teeth is essential to give the effect of oneness or wholeness to the dento-facial composition.

Proportion: To be able to give a certain mathematical representation of beauty for numerically expressing the relationship of the various units that combine to make a composition, the term proportion is used. The relationship of the various units which are different from each other in a composition but are associated with each other through a certain repetitive mathematical factor is the repeated ratio. The proportion between the various elements of a harmonious composition, in which the cohesive and segregate forces are equally balanced and which has its various units in an esthetically appealing respective proportion to each other is the golden proportion.

Dominance: It exists when a strong centralized structure is surrounded by well-demarcated, characterized structures. In a dento-facial composition it creates immaculate unity leading to a harmonious composition. The absence of dominance makes the composition weak. Color, shape and size are the factors which can control dominance.

Balance: It is achieved when there is an exact equilibrium between the forces present on either side of the fulcrum in a composition. In dentistry, this implies the balance of the elements in relation to the midline. If any elements are imbalance on one side then, to create a visual balance either these elements are moved towards the midline or are counter-balanced with opposite elements to regain the balance. In balance the weight of the elements far away from the fulcrum grows in importance.

Visual tension is the tension brought about by the presence of certain elements that cause an imbalance in the given composition. If the presence of these factors is closer to the fulcrum, the effect of the tension into the fulcrum, the effective the tension induced is more magnified as against their presence further from the fulcrum. A distally inclined lateral incisor on one side is compensated by a more mesial inclination of the first premolar on the opposite side to reduce the effective visual tension. These variations are naturally found in dentitions explaining the reason why sometimes irregularities in inclinations still produce pleasant smiles.

The inter-pupillary line helps to evaluate the orientation of the incisal plane, the gingival margins and the maxilla. An imaginary horizontal line

through the incisal plane and the gingival margins should be visibly parallel to the inter-pupillary line. This helps to diagnose any asymmetry in the tooth position or gingival location. When an imaginary line is drawn across the gingival margins, it may not be parallel to the inter-pupillary line indicating a certain degree of canting of the maxilla.[5]

Vertical references: The facial midline serves to evaluate the location and axis of the dental midline and the medio-lateral discrepancies in tooth position. The inter-pupillary line and the facial midline emphasize the „T" effect in a pleasing face. The dental midline, if perpendicular to the inter-pupillary line and coinciding with the bridge of the nose and the philtrum, produces an attractive orientation of the smile. Axial inclination is the direction of the anterior teeth in relation to the central midline and becomes progressively more pronounced from the central incisor to the canine. There is a definite mesial inclination to all the anterior teeth related to the midline. The axes of the premolars and the first molar on either side also show mesial inclination in relation to the midline.

The perception of tooth inclination can be viewed from the frontal aspect around the central vertical midline, which acts like a fulcrum around which axial inclination of teeth on either side exhibit a phenomenon of balance of lines Natural smiles show a deviation from this standard axial inclination. Deviations in axial inclination cause a visual tension when beyond the point of equilibrium.[6]

Sagittal references: Soft tissue analysis at a standardized position helps in studying the profile of an individual. The contours of the upper and lower lip support are determined by the position of the anterior teeth and can be used as a guide for the placement of teeth when planning restorations. The lip protrusion, the amount of prominence of chin, recession or prominence of the nose and its degree, all help in profile analysis for diagnosis and treatment planning.

The E-line or esthetic line is an imaginary line connecting the tip of the nose to the most prominent portion of the chin on the profile, ideally the upper lip is 1-2 mm behind and the lower lip 2-3mm behind the E-line. Any change in the position of the E-line indicates the abnormality in the upper or lower lip position. The main support of the upper lip is contributed by the gingival two thirds of the maxillary central incisors rather than the incisal one third According to study by Fradeani, the lip support is a better guide of tooth position than incisal edge position.[7]

The relationship of the maxillary incisal edges to the lower lip is a guide for the placement of the incisal edge position and length. The pronunciation of the „F" and „V" consonants helps determine the position of the incisal edges. On pronouncing „F" and „V" the incisal edges should make a definite contact at the inner vermilion border of the lower lip Thus the position of the incisal third of the maxillary central incisor can be determined.

Phonetic references: Phonetics plays a part in determining maxillary central incisor design and position. „F" and „V" sounds are used to determine the tilt of the incisal third of the maxillary central incisors and their length. The „M" sound is used to achieve relaxed rest position and repeated at slow intervals can help evaluate the incisal display at rest position „S" or „Z" sounds determine the vertical dimension of speech. Its pronunciation makes the maxillary and the mandibular anterior teeth come in near contact and determine the anterior speaking space The amount of posterior speaking space varies with the amount of mandibular protrusion necessary to bring the anterior teeth in near contact for the „S" sound.

Smile elements: The extent of the smile is outlined by the curvature of the upper and lower lip and the position of the angle of the mouth, and it determines the degree of exposure, both in the anterior and posterior teeth, gingiva as well as the width of the buccal corridor. Smiles can be classified as passive, active (moderate) and laugh. In a passive smile the lips are parted slightly away from the rest position expressing content, passion, desire, surprise, etc. In

an active smile the lips move to a significant extent away from the rest position displaying more teeth and even gums, expressing joy, welcome, happiness, etc. Laugh is an instant fluctuation from an active smile position where the facial muscles instantly act leading to maximum exposure of the teeth and gums. Humorous and funny situations usually lead to such an expression.

Lip and lip lines: The length, the curvature and the shape of the lips significantly influence the amount of tooth exposure during rest and in function. A prominent tooth display is associated with a youthful smile and most patients would like to seek the benefit of the same. Some researchers demonstrated that the average maxillary incisor display with the lips at rest is 1.91mm in men and 3.40 mm in Women Patient"s with short upper lips and younger patients generally display more maxillary tooth structure which may be up to 3.65mm.

Upper lip line helps to evaluate the length of the maxillary incisor exposed at rest and during smile and the vertical position of the gingival margins during smile. The upper lip line can be classified as low, medium or high depending upon the amount of tooth or gingival display that is available at rest of during a moderate smile. The gingival margins may be displayed in high lip line cases. The most apical position of the gingiva over the facial aspect of the maxillary central incisor and canine is slightly distal to the long axis of the tooth while in the maxillary lateral incisor it is at the long axis of the tooth. This is called the gingival zenith. Whenever a patient displays the gingival margins easily on smiling or speaking, a definite pattern of the gingival display can be recorded. This pattern can be either esthetic or unaesthetic. A smile can be termed "toothy" if more than 6mm of incisal display is seen at rest position or "gummy" if more than 3mm of gingival tissues are displayed in moderate smile).[8]

Lower lip line helps to evaluate the buccolingual position of the incisal edge of the maxillary incisors and the curvature of the incisal plane.

Smile line: It is an imaginary line passing through the incisal edges of the upper anterior teeth. The smile line usually coincides or runs parallel to the inner vermilion border of the lower lip. In a youthful smile the incisal edges of the central incisors and canines are aligned on a convexity and are linger than the lateral incisors, incisal embrasures gradually deepen from central incisor to the canine, giving the appearance of the wings of a gull. Thus the incisal plane is said to have a gull-wing appearance when the incisal edges of the central incisors and canines are aligned on a convexity the incisal plane is convex. Reduced incisal embrasures and leveling of the gull-wing effect as in a straight smile line is associated with aging.

Negative space: Negative space is a dark space appearing between the jaws and the mouth opening either at the corner of the mouth of around the buccal aspect of the posterior teeth during active smile and laugh. The lateral negative space exists between the labial surface of maxillary teeth and the corner of the mouth while the buccal negative spaces appear in the buccal vestibule on either side of the buccal aspect of posterior teeth. Obliteration of these essential spaces by dental elements like bulky canines, wide arches or over-contoured restorations can lead to an unattractive smile. Excessive negative space seen in cases of missing premolars or palatally placed posteriors and a constricted arch also appear unaesthetic.[9]

Progressive abating in a dental composition: When similar structures are aligned in an arch form one after the other, they appear to progressively abate in size from the nearest to the farthest. This gives an illusion of depth. The essential requirement of the front to back progression in dental composition is the alignment of the contour of the labial and surface at the incisal third, middle third and the gingival third of successive teeth in the arch. The incisal mesio-buccal inclines should be well aligned to give a smooth progression from tooth to tooth. The buccal and lateral negative space progressively reduces the illumination on teeth to enhance the front to back abating effect. The presence of poorly shaped

teeth, differences in axial inclinations, tooth length discrepancies, discolorations, gingival disharmonies etc. can lead to a visual tension resulting in a disruption of the front to back progression.

Proportion: When mathematics is applied to the study of ideal tooth form, a numerical relationship is established within a single tooth form (ideal proportion) and also between a series of teeth in the arch (relative proportion). The position of the tooth in the arch, the relationship between the width, the length and the face of the tooth can also be numerically established in relation with certain anatomic landmarks.

Golden Proportion is expressed in numerical form and applied by classical mathematicians such as Euclid and Pythagoras in pursuit of universal divine harmony and balance. It has been applied to a lot of ancient Greek and Egyptian architecture and may be expressed as the ratio 1.618:1. If the ratio is applied to the smile made up of the central, lateral incisor and the mesial half of the canine, it shows that the central incisor is 62% wider than the lateral incisor which in turn is 62% wider than the visible portion of the canine which is the mesial half, when viewed from the front. Application of sizing the central incisors from certain facial measurements is known as the 1 to 16 theory, whereby the height of an ideal maxillary central incisor from the incisal edge to the gingival crest is 1/16th of the distance from the inferior border of the chin to the inter papillary line. The same tooth width can be measured from the mesial to distal contact areas and is 1/16th of the distance measured from either zygomatic prominence through an imaginary facial midline.

Pleasing Smile is a naturally attractive smile that evokes a feeling of beauty or harmony and complements the personality of the bearer is termed as a pleasing smile. The natural pleasing smile may not necessarily comply with all rules of symmetry or golden proportion or may not exhibit perfect balance without irregularity of shape. However, the composition is esthetically appealing with unity within its various elements.

The distinguishing characteristics observed in people with pleasant smile dominance that can be used as a guideline for creating the same are:[10]

The maxillary central incisors exhibit a strong presence by their size and form reflecting the personality of the individual.

The maxillary lateral incisors and the canines complement the cement incisor in terms of proper shape and form.

Although numerically all proportions of the anterior teeth do not follow the rule of golden proportion, the teeth are so placed that they appear in suitable proportions with each other.

Smile recurring ratios are observed in the teeth from the central incisor to the premolar.

Well co-ordinated movements of the lips with the other peri-oral musculature and corresponding harmonious facial expressions, contribute to the pleasant face during smile.

The complexion and texture on the face contrast with the lip color, gingival and the teeth leading to a distinct demarcation between the oral and the facial frame.

Perceptual Aspects–The art of illusion: Illusion is an imagination where a perception of an object is created. The art of creating illusions consists of changing perception, to cause an object to appear different from what it actually is. Teeth can be made to appear smaller, larger, wider, narrower, shorter, longer, younger, older, masculine or feminine. One is subjected to light the most fundamental objects exhibits two dimensions, that is, length and width. True natural light is multi-directional and on striking the surface of the object, also reveals texture and shadows, this adds the third life like dimension of depth. Illusion works on two basic principles which are the principle of illumination and the principle of light. The most important of these is the perception that light approaches and dark recedes. This is termed as the "Principle of Illumination". The second artistic predilection of great importance in dentistry is the use of horizontal and vertical lines and ridges.

Horizontal lines make the object appear wider and vertical lines make the object appear longer. This is termed as the "Principle of Line". The artistic predilection exhibited in the principle of illumination can be maintained to change the size, shape and the overall form of the tooth through illusions.

Cosmetic contouring is the reshaping of natural teeth to make them esthetically pleasing. In natural dentitions, variations seen in tooth shape and size sometimes violate the acceptable width to length ratios as well as the golden proportion. Minor adjustments in contours to change the perception of these proportions increase the esthetic acceptability to a great extent. It is indicated for giving a pleasing appearance to fractured, chipped, extruded, malformed or over lapped teeth. The procedure is contra indicated in hypersensitive teeth, teeth with thin or defective enamel formation or large pulp chambers.[11]

Total Smile Analysis: It is a cumulative inference analysis, drawn by interpreting and integrating various analysis like a visual, space, profile and computer analysis after performing the preliminary analysis. Now-a-days manufacturers promote digital radiography system and video camera in one unit i.e. single hand piece which will be convenient for use.

CAD/CAM: With CAD/CAM (Computer assisted design / Computer assisted manufacture) technology we can design veneers and crowns to enhance smile while the patient waits. The so called "mock- up" of a planned cosmetic treatment also has been shown to be quite useful. It also allows clinician to visualize the desired results and solve potential problems before providing treatment to the patient.

Source of support: Nil

Conflict of Interest: None

Referances:

1 Goldstein R. Esthetics in Dentistry. Vol 1: Principles, Communication, Treatment Methods, edt 2. Ontario: BC Decker, 1998.

2 Solomon EGR: Esthetic consideration of smile. J of IPS 10, 1999, 4, 41-47.

3 Morley J. The role of cosmetic dentistry in restoring a youthful smile: JADA 1999, 1166-72.

4 Gurel G, Bichacho N. Permanent diagnostic provisional restorations for predictable results when redesigning smiles. Pract Proced Aesthet Dent 18, 2006, 281-6.

5 Chiche GJ, Pinault A. Esthetics of Anterior Fixed Prosthodontics. Chicago: Quintessence, 1996.

6 Magne P, Belser U. Bonded Porcelain Restorations in the Anterior Dentition: A Biomimetic Approach. Chicago: Quintessence, 2002.

7 Fradeani M. Esthetic Rehabilitation in Fixed Prosthodontics. Vol 1: Esthetic Analysis: A Systematic Approach to Prosthetic Treatment. Chicago: Quintessence, 2004.

8 Spear M. The maxillary central incisor edge: A key to esthetic and functional treatment planning. Compend Contin Educ Dent 20, 1999, 512-6.

9 Sohomura T. Use of an ultra-high speed laser scanner for constructing three dimensional shapes and occlusion. JPD 84, 2000, 345-52

10 Singer B. Principles of esthetics. Curr Opin Cosmet Dent 10, 1994, 6-11.

11 Messing M. Smile architecture: beyond smile design. Dent Today 14, 1995, 76-9.

ROLE OF NANOMATERIALS IN PROSTHODONTICS : A REVIEW

Dr Rupali Patel[1], Dr Trupti M. Dahane[2], Dr S. R. Godbole[3], Dr Seema Sathe[4]

1 P.G. Students, Dept of prosthodontics, 2 Associate Professor, Dept of prosthodontics, 3 Professor, Dept of prosthodontics, 4 Professor, Dept of prosthodontics, Sharad Pawar Dental College

Introduction: 'Nano' simply means One Billionth/10^{-9}/0.000000001.[1] Nanotechnology is engineering at the atomic and molecular scale. Materials fabricated at nanoscale demonstrate superior properties as compared to what they exhibit on a macroscale, facilitating exclusive applications. For example, opaque substances become transparent such as copper; inert materials become catalysts (e.g. platinum); stable materials turn combustible (e.g. aluminum); solids turn into liquids at room temperature (e.g. gold); insulators become conductors (e.g. silicon).[2]

The evolution for nanotechnology dates to around late 19th century. The term 'nanotechnology' was conceived and popularized by Prof. Kerie E Drexler in 1977.[3] The potential benefit includes its ability to exploit the atomic and molecular properties of materials and to foster newer materials with better properties.

The growth of nanotechnology and scope of its application has revolutionized the medical field progressing to emergence of "Nanomedicine" that is - applications of nanotechnology for treatment, diagnosis, monitoring and control of biological systems.

Similarly, development of "nanodentistry" will make the maintenance of near-perfect oral health conceivableusing nanomaterials biotechnology including tissue engineering and nanorobotics.

New treatment modalities have been suggested in literature, such as remineralization, tooth hypersensitivity, orthodontic nanorobots, dental cosmetics, local anesthesia, photosensitiserscarriers, impression materials, nanoencapsulation, nanoneedles, bone replacement materials and dentifrices etc.

Prominent developments are the nanocomposites, bonding agents, emerging of link between biomolecules and nanotechnology through the generation of biomaterials.

Nanorobots being suspended in liquid and able to swim about, devices would be able to reach surfaces beyond reach of toothbrush bristles or the fibers of floss. As short-lifetime medical nanodevices, they could be built to last only a few minutes in the body before falling apart into materials of the sort found in foods (such as fiber). With this sort of daily dental care from an early age, tooth decay and periodontal disease can be prevented.[4]

The regeneration of hard and soft tissues around a solid implant, or development of new tissues to replace implanted biodegradable material will provide new vistas in the field of tissue regeneration.

The article reviews the concept of nanomaterials and its application in the Prosthodontics.

Concept of nanomaterials: Materials reduced to the nanoscale can suddenly show very different properties compared to what they exhibit on a macroscale, enabling unique applications.

The unique properties of the nanomaterial includes[5]–

Small size effect,

Quantum size effect

Quantum tunnelling effect

Surface effect

The small size effect[5] is the minimum amount of energy that is required for interactions between nanoparticles (interactions like dissolution, melting, boiling, bonding, molecular reactions). This effect

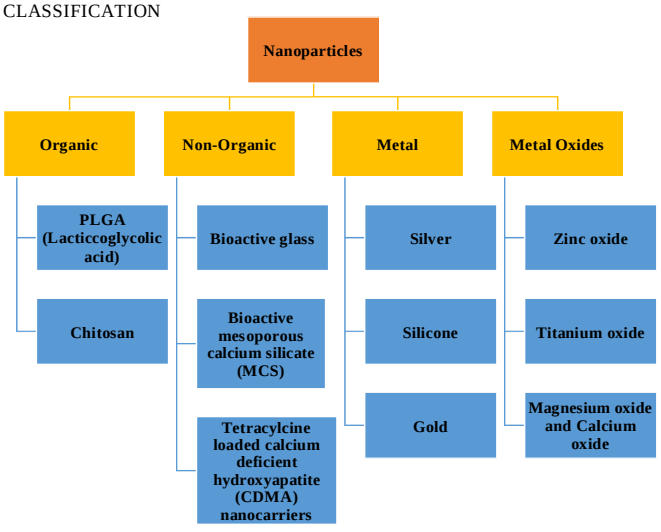
can be of particular use in the dental materials to improve flexure strength as unlike the usual sized particle they do not resist the shear strength rather get accommodated to it.

Also, the extensive aggregation prevents the material from developing discontinuity that is the Quantum size effect.

The Quantum tunnelling effect is that when a nanoparticle is made to pass through a thin barrier (eg - a cell membrane) it would not require much energy as it passes through the area of least resistance (the membrane in this case), this phenomenon explains the antimicrobial activity by membrane disintegration.

The surface effect can be explained by the fact that nanoparticles have multiple surfaces which leads to more area for interactions (precisely the high surface energy).

CLASSIFICATION



Nanomaterials in prosthodontics:

1 Nanometals

- Framework for Removal Partial Denture

Cobalt-chromium alloy or cobalt-chromium-molybdenum alloy and titanium alloys are most frequently used for fabricating metal stents of partial denture framework.

The cobalt chromium binary alloy is developed into cobalt chromium-tungsten alloy and later into cobalt chromium molybdenum alloy. It displays superior mechanical properties and corrosion resistance as compared to stainless steel or gold alloy[4,5].

- Modification of Titanium surface (Implant)

Though titanium has superior properties like specific strength, high corrosion resistance, good biological security and elastic modulus, biological integration is the most crucial element for perennial success of implants.

Therefore, use of titanium nanoparticle was experimented by Dorkhan et al in his study. He altered the surface of titanium implant by anodic oxidation into nanoscales with 50 nm range pores. It was noted that similar level of adherence of soft-tissue cells i.e keratinocytes and fibroblasts amongst altered and unaltered implant surfaces. While, attachment of oral streptococci was significantly lower on the nanostructured surface.[6]

Anodization is a simple and less expensive process to promote osteoblastic adhesion according to the various studies. This was demonstrated by Yao et al (2015) in his study to create nano-surface on titanium and Ti6Al4V implant by anodization. It was observed that the anodized surface had higher roughness at nanoscale dimensions than the un-anodized Ti-based surfaces. Thus, enhancing osteoblastic adhesion on the anodized metal substrates.[7]

Nanoceramics: Routinely used alumina ceramics though have superior mechanical properties but one of its major drawback is that it is more likely to crack.

Zirconia ceramics have significantly overcome the shortcomings of alumina ceramics but they lack toughness.

'Nanoceramic' refers to the ceramic material with nanoscale dimensions in the microstructures phase.[8] Ceramic is essentially a kind of brittle material; however, nanoceramic shows good toughness and ductility, this is due to the arrangement of atoms in nanoceramics interface.

Series of studies were conducted with regards to toughness and strength of nanoceramics like, Wang et al (2006) in his experiment, compared addition of 20% of Nano ZrO_2 to a composite of AL_2O_3

and conventional ZrO_2 in terms of toughness. Nanoceramic yielded better results.[5]

Li et al (2011) through his study revealed the hardness of traditional ZrO_2 was 1500 while that of nano ZrO_2 is 1750.9

V. Raj et al (2014) compared the micro hardness and toughness of Conventional TiO_2 Ceramics Vs Nano TiO_2 Ceramics. Nano TiO_2 exhibited 13000kN/m2 micro hardness and superior hardness while conventional TiO_2 ceramics had value less than 2000kN/M2.[2]

In general, the advantages of nanoceramics that could be summarized are:

Super plasticity.

Superior mechanical properties

Nanoresins: PolyMethylMethacrylate [PMMA] has good mechanical properties such as high hardness, rigidity, biological compatibility, aesthetics, and easy processing characteristics.

The major drawbacks include instability of color, poor wear resistance, volumetric shrinkage, oral mucosa irritation, and discoloration.

Low fatigue strength, low abrasion resistance and microbial adhesion are the other disadvantages of PMMA.

Fusion of PMMA and nanoparticles display an array of superior properties. Nanoparticles like Tio_2, ZrO_2, CNT have been used to enhance PMMA material.[2,5] Hua et al (2013) performed a study in which the saturation of reinforcing effect was studied for conventional PMMa and TiO_2 reinforced PMMA. Results were:

A Nano particle with aspect ratio larger than 30 could nearly make the reinforcing effect reach saturation.

Saturation at 3% volume increase is equivalent to 6% volume increase of glass fibre.

Cooper et al(2002) showed that addition of small amount of CNT will significantly improve the impact strength of PMMA. Hong et al (2003) added methcryloxypropyltrimethoxysilane (MPS) modified silica nanoparticles to PMMA which increased the tensile strength and tensile modulus.[6]

Mudhaffar (2012) evaluated the effect of addition of different percentage of modified ZrO_2 to heat activated PMMA. He concluded that significant results were obtained at 3% and 5% nanofillers in terms ofabrasion resistance, tensile and fatigue strength.[4,5,8]

In the quest of exploring the antimicrobial properties of nanoparticles, Yoshida et al(1999) demonstrated that a resin composite mixed with silver nanoparticles had a long-term inhibitory effect against S. mutans.[1]

Laura et al(2011) prepared the PMMA composites along with addition of TiO_2 and Fe_3O_2 nanoparticles, for simultaneously coloring and/or improving the antimicrobial properties. The study concluded that PMMA containing nanoparticles demonstrated lower rate of Candida albicans (C. albicans) cell adhesion and a lower porosity, compared to standard PMMA.[9]

Nanomaterials in Maxillofacial materials: Meran et al (2017) : conducted an in-vitro study to check the efficacy of silver nanoparticles against C.albicans by coating it on silicone, the study was carried out of human fibroblasts.[6] He found that when fibroblasts grown on silver coatings were challenged with C. albicans, the Ag NP coating was effective at preventing fungal growth as measured by ethanol production by the yeast, and without damaging the fibroblasts.

Shakir DA et al (2018) evaluated the effects of adding titanium oxide (TiO_2) nanofillers on the tear strength, tensile strength, elongation percentage, and hardness of room-temperature-vulcanized (RTV) VST50F and high temperature- vulcanized (HTV) Cosmesil M511 maxillofacial silicone elastomers. The findings of the study were:

The addition of 0.25 wt% and 0.2 wt% TiO_2 nanofiller into VST50F and Cosmesil M511 elastomers, respectively, resulted in a statistically significant increase in the mean values of tear strength, tensile strength, elongation percentage, and hardness of the materials.[12]

Summary:

Category	Nanomaterial Used	Property Improved
Nano metals	Deposition of nanostructure Ti on the surface of pure titanium, Ti6 Al4 V and CoCrMo surfaces	Lower adhesion of oral streptococci on the nanostructured surfaces than on the pure titanium, increased adhesion to osteoblasts
	TiN, ZrO_2/Al_2O_3, Si_3N_4/TiO_2, and ZrO_2/SiO_2	Increases wear resistance
Nano Ceramics	ZrO_2	Increases the hardness and toughness of the ceramic
	Zirconia-Silica sol-gel nano addition	Higher hardness
	Hot presses Alumina-CNT	Improved tribological and mechanical properties
Nano Resin	TiO_2 reinforced PMMA	Increases the saturation per unit area in polymers
	TiO_2 and Fe_3O_2	Increased Anti-fungal property against C.Albicans
	Ag-PMMS nanoparticles	Improved anti-microbial properties

Fate of expansion of prosthodontics technology is interlinked with the progress of materials science. Nanomaterials have been the forerunner in basic scientific innovation and clinical technological advancement of prosthodontics. Incorporation of nanoparticles enhance many mechanical properties of various dental materials applied in the field of Prosthodontics.

Referances:

1 Feynman RP. There's Plenty of Room at the Bottom. :13.

2 Bhardwaj A, Bhardwaj A, Misuriya A, Maroli S, Manjula S, Singh AK. Nanotechnology in dentistry : Present and future. J Int Oral Health. :6.

3 Freitas RA, Assoc JAD. The following resources related to this article are available online at jada. ada.org (this information is current as of January 7, 2011): :8.

4 Bumiller M. Nanotechnology, Nanoparticles and Nanononsense. 2007;61.

5 Wang W, Liao S, Zhu Y, Liu M, Zhao Q, Fu Y. Recent Applications of Nanomaterials in Prosthodontics. J Nanomater. 2015;2015:1–11.

6 Miao X, Wang D, Xu L, Wang J, Zeng D, Lin S, et al. The response of human osteoblasts, epithelial cells, fibroblasts, macrophages and oral bacteria to nanostructured titanium surfaces: a systematic study. Int J Nanomedicine. 2017 Feb; Volume 12:1415–30.

7 Manipal College of Dental Sciences, Mangalore, Y Pai U, Mundathaje M, Mallya L. Applications of nanotechnology in dentistry. J Int Med Dent. 2016 Jan 7;2(3):186–203.

8 Das A, Nasim I. Nanotechnology in dentistry: A review. :3.

9 Le X, Poinern GEJ, Ali N, Berry CM, Fawcett D. Engineering a Biocompatible Scaffold with Either Micrometre or Nanometre Scale Surface Topography for Promoting Protein Adsorption and Cellular Response. Int J Biomater. 2013;2013:1-16.

10 Bedoya et al chapter 4 Adverse local and systemic effect of nanoparticles released from oral and cranio-maxillofacial implants, Nanostructured Biomaterials for Cranio-Maxillofacial and Oral Applications. Elsevier.

11 Meran, Z, Besinis, A, De Peralta, T, Handy, RD 2017. Antifungal Properties and Biocompatibility of Silver Nanoparticle Coatings on Silicone Maxillofacial Prostheses In Vitro. J Biomed Mater Res Part B 2015:00B:000–000.

12 Shakir DA, Abdul-Ameer FM.Effect of nano-titanium oxide addition on some mechanical properties of silicone elastomers for maxillofacial prostheses. J Taibah Univ Med Sc 2018;13(3):281e290.

Virtual articulator a future to be ……

Dr. Jyoti sharma[1], Dr. Jayesh Shinde[2], Dr. Rajlakshmi Banerjee[3], Dr.Tushar Mowade[4], Dr.Usha Radke[5]

Abstract: Dentistry is linked strongly to the use of computer technology in the future. The virtual articulator is one such application in prosthetic and restorative dentistry based on virtual reality. The use of computer aided design (CAD) systems and reverse engineering tools permit the introduction of kinematic analysis in virtual design process simulation of real patient data, allow analysis with regard to static and dynamic occlusion .With the advent of digitalization, dentistry has become easier, accurate and time saving. This article reviews the evolution of virtual articulators, working of virtual articulators, advantages and limitations of virtual articulators, and a brief note on haptic based touch enabled virtual articulator.

Introduction: Many Research work, innovative and technological advancements introduced in the field of dentistry has been recently quoted in a decade. Computer technology seems to form the future of dentistry. Virtual reality (VR) is one such technology that have a strong impact on research, development, and industrial production.

The Virtual articulator can be defined as a software tool for improved clinical outcome based on virtual reality technology. Virtual Reality technologies in dentistry will be used to provide better education and training by simulating complex contexts and enhancing procedures that are traditionally limited, such as work with mechanical articulator.

Innovative research has also invaded the field of prosthodontics with several articulator designs which are used for fabrication of restorations compatible with stomatognathic system. The transition from numerous mechanical articulator designs to recently developed virtual articulators is a major breakthrough in the development of the articulator design. There are several articulators available in market today, some are very complex and some are very simple in their use and adjustments, which one to be used depends on preference of dentists.[1]

Evolution of digital articulators:

Szentpetery's virtual articulator:

In 1999 it was introduced. A fully adjustable 3D virtual dental articulator that can reproduce various movements of the mechanical articulator, including the curved Bennett angle movements, making it more versatile than mechanical articulator. But as it is a mathematical approach, it behaves as an average value articulator and it is not possible to easily obtain the individualized movement paths of each patient.

Virtual articulator of Kordass and Gaertner:

Introduced in 2000 and aims at precise registration of mandibular movement with the help of jaw motion analyzer. This system requires digital representation of the jaws as input data generates an animation of the jaw movement and delivers a dynamic and tailored visualization of the collision points. If a device for the registering of the patient specific jaw movements is available as for e.g. the Zebras jaw motion analyzer, the recorded jaw motion can be integrated in to animation. Jaw motion analyzer is a device used for the acquisition of the Mandibular movements.

Virtual articulator based on mechanical dental articulator:

It was introduced by the University of the Basque Country in 2009. The project was focused on

developing a different virtual articulator based on mechanical dental articulator. The implementation of this articulator enables the user to select which setting parameters are to be registered and transferred to the patient, and therefore compare the differences between the virtual articulator and the mechanical articulator for better simulation of the most adequate articulator. Problems or the limitation of the previous approaches to develop virtual dental articulator were considered in this project. The main advantage of this approach is that the user can choose the most suitable articulator for the simulation.[2]

Importance of virtual articulator: The Digital articulator has a goal to improve the design of dental prosthesis, adding kinematic analysis to the design process. Commonly used semi adjustable articulators, however have major limitations. The mechanical articulators follow border structure of mechanical joint and cannot represent the effects of resilience of the soft tissue or the time dependent muscle guided movement pattern of mastication. In addition to this, it cannot represent the real dynamic condition of the occlusion in mouth. Often problems regarding the technical procedures and dental materials hamper the accuracy of reproduction mainly by:

1 The deformation of registration material (E.g. Wax, which is susceptible to heat)

2 Repositioning the cast into bite impression without leaving any space.

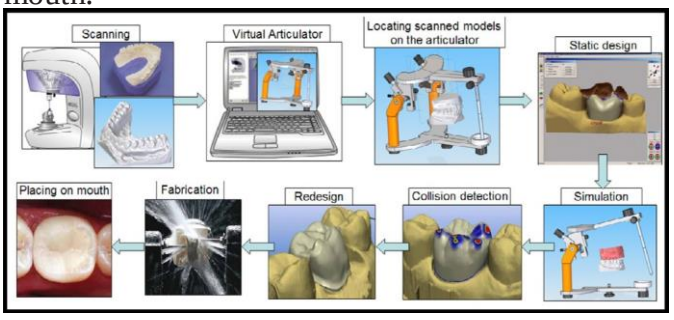
3 The use of rigid and expanded plaster material.

4 Maintenance of the mechanical articulator.

Because of these problems, the reproduction of dynamic, excessive contact seems to lower the reliability. Replacement of the mechanical articulator with the virtual articulator will solve these problems.

Working of virtual articulators: Initially scanning is carried out with help of intra oral scanner, the scanned data is then transferred to the software tool for analysis.

After a definite parameterization is achieved the scanned model data is located in articulator and static design is obtained stimulation and collision detection is archived followed by the process of fabrication and then the prosthesis is placed in mouth.[4]



Advantages of virtual articulator:

- Provides best quality of communication between the dentist and dental technician.
- Analyses both static and dynamic occlusions.
- Designing of occlusal surface in CADCAM system.
- Analyses gnathic and joint conditions.
- Offers a detailed 3-D visualization of region of interest.
- Possible to modify or introduce new setting according to the patient and helpful for patient's education.[1]

Disadvantages of virtual articulator:

- Cost effective as it requires the digital scanners, digital sensors, software's, and different types of virtual articulator models mimicking the mechanical ones according to the patient need.
- Knowledge about the CAD/CAM technology, mechanical articulators, designing and modeling of virtual articulators etc and technical skills regarding the interpretation of data recorded scanners, sensors, minor adjustments, incorporating motion parameters.[1]

Recent haptic based first touch enabled virtual articulator.

Virtual Reality Haptic System: It is derived from Greek word 'haptein', meaning "contact or to touch". This sensation can now be added to the current computer models which have sight and sound only that provides bi-directional flow of information

some special devices like joysticks, data gloves, are used in it. The Haptic technology along with visual display can be used to train people for tasks which require hand-eye coordination such as a dental surgeon makes an incision, drilling into a carious lesion, etc. Quickly teach preclinical dental students about dental procedures, while increasing their hand-skills considerably. Haptic Based First Touch Enabled Virtual Articulator is a SensAble Dental Technologies has developed the newest version of its Intellifit™ TE (Touch-Enabled) Digital Restoration System that offers dental labs even more choice, performance and flexibility in digitally designing and fabricating a wide range of dental restorations. Haptic based virtual reality system's touch enabled virtual articulators allow lab technicians to actually feel how the teeth, including the new restorations produced will fit together in the patient's mouth.[5]

Conclusion: The concept of Digital Articulator will revolutionized the conventional ways in dentistry and replace the mechanical tools. The use of recent dental technology is not only just time saving but has increased the precision of work even more. The concept of virtual articulator will change conventional ways of production and communication in dentistry.

References:

1 Luthra RP, Gupta R, Kumar N, Mehta S, Sirohi R. Virtual articulators in prosthetic dentistry: A review. J Adv Med Dent Scie Res 2015;3(4):117-121.

2 Singh N, Dandekeri S, Shenoy K, Bhat V. Digital Articulators : A Promising Technology of the Future. Int J Dent Med Res 2014;1(2):98-102

3 Solaberrieta E, Arias A, Barrenetxea L, Etxaniz O, Minguez R, Muniozguren J. A virtual dental prostheses design method using a virtual articulator. InDS 60: Proceedings of DESIGN 2010, the 11th International Design Conference, Dubrovnik, Croatia 2010 (pp. 443-45)

4 Koralakunte PR, Aljanakh M. The role of virtual articulator in prosthetic and restorative dentistry. Journal of clinical and diagnostic research: JCDR. 2014 Jul;8(7):ZE25.

5 Bisler A, Bockholt U, Kordass B, Suchan M, Voss G. The virtual articulator. Int Jrnl of Comp Dent 2002;5(2-3):101-6.

Metal-free prosthodontics: A review.

Dr Twinkle Hatmode[1], Dr Kalyani Deshmukh[2], Dr Neelam Pande[3], Dr Usha Radke[4], Dr Saee Deshpande[5], Dr Rajlakshmi Banerjee[6]

Abstract: Dentistry today, focuses not only on the prevention and treatment of disease but also on meeting the demands for better esthetics. Therefore it has evolved from a creative to creative science in a short span. Due to the increase in importance and attention towards esthetics, the demand for metal free prosthesis is on a verge of increase. This article will review all the materials on the progress in dental materials owing to increase in demand for aesthetic.

Introduction: In dentistry, we have a long history of contributing to the needs of patients by offering dental restorative and prosthetic devices such as inlays, onlays, crowns, fixed partial dentures (FPDs), and removable dentures, to recover patient's oral function and maintain their health. During the 20th century, both dental materials and dental devices progressed remarkably.[1] Owing to the increased demand for safe and esthetically pleasing dental materials, new high strength metal free materials have been recently introduced.

Biomaterials for dental use are classified into metal, ceramics, synthetic polymer and composite materials. For dental prosthesis, previous ceramics and resin were brittle, and the use of these alone for restoration and dental prosthesis preparation was limited due to the problem of the materials strength. Thus, metal has been frequently used; prioritizing mechanical strength over esthetics, but demands for metal-free restoration has recently increased due to esthetic problems of metal colour penetration through the marginal gingiva and gingival staining by metal, a problem of metal allergy, and environmental protection concerning rare metals.[2]

This review outlines the developments and progress in dental materials over the past decade which has lead to the evolution of metal free prosthesis in complete dentures, fixed partial dentures, removable partial dentures, implantology and maxillofacial prosthesis.

Complete denture: In ancient time metal denture bases were used but these dentures have heavy weight and esthetically poor appearance that's why a newer material called PMMA(Polymethyl methacrylate) used for fabrication of denture. Glass fiber reinforcement significantly increases the mechanical properties of PMMA. Silane coupling agents play a central role in improving bonding between fillers and the resin matrix, and they subsequently improved the resin's properties.[3]

Complete denture by PMMA

The fabrication of complete dentures using a conventional method associated with certain problems. To avoid this, computer-aided design/

computer-aided manufacturing (CAD/CAM) system have been successfully introduced into restorative dentistry and maxillofacial technology to simplify the fabrication procedure and resolve the associated problems.[4-8]

Complete denture by CAD/CAM

While, Panasonic Corporation of Japan presented NANOZR, a composite material comprised of zirconia and alumina using ceria as a stabilizing material, and acquired pharmaceutical approval in October 2006.[2]

Since it has a marked mechanical strength, and long-term stability in the mouth, clinical application for fixed prosthesis and dental implants has been progressing.[9,10,11] The load-bearing ability of Yttria partially stabilized tetragonal zirconia(Y-TZP) has been shown to be equivalent to that of Co-Cr alloy,[12] and NANOZR may also be applicable for denture base material substituting for metal because its mechanical strength is greater than that of Y-TZP

Complete denture using NANOZR as a denture base material substituting for metal

Fixed Partial Denture: For the past 200 years, ceramics have domain the field of dentistry.

Porcelain is intermittently brittle & has relatively low tensile strength, it is therefore generally fused to a metal substrate to increase its resistance to fracture.[13] However, this metal base reduces light transmission through the porcelain & creates metal ion discolorations that may affect the aesthetics of the porcelain. In addition, some patients have allergic reactions or sensitivity to various metals. These drawbacks, together have prompted the development of new all-ceramic (metal free ceramic) systems that do not require metal.[14]

All ceramic prosthesis

Advancement in the metal free ceramic systems like the IPS EMPRESS 2 has resulted in a functionally durable metal free ceramic restoration.

Finally, advancements in CAD-CAM has resulted in the restoration with esthetics, strength, and ease of fabrication done in a single visit. The only disadvantage with the CAD/CAM system is the occlusion with the opposing tooth, which requires manual refinement at present. But with the advent of newer software and advancement in systems, this minor hiccup is expected to be solved in the near future resulting in a restoration that is functionally durable, aesthetically excellent with accurate margins and low wear on the opposing teeth, less technique sensitive with ease of fabrication and less time consuming.[14]

Although many types of zirconia-containing ceramic systems are currently available,[15,16] only three are used to date in dentistry. These are yttrium cation-doped tetragonal zirconia polycrystals (3Y-TZP), magnesium cation-doped partially stabilized zirconia (Mg-PSZ) and zirconia-toughened alumina (ZTA).[17]

Crowns with zirconia core materials are the strongest among all the metal-free restorations, Yttrium-oxide

is added to pure zirconia to control the volume expansion and to stabilize it in the tetragonal phase, at room temperature.[18] Yttrium-oxide partially stabilized Zirconia (Y-TZP) has mechanical properties with a flexural strength of 900-1200 MPa[19] and high fracture toughness, making it suitable for anterior and posterior crowns as well as for long-span fixed partial dentures.[20]

Zirconia crown before cementation

Zirconia crown after cementation

Removabe Partial Denture: Denture esthetics are the effect produced by a dental prosthesis that affects the beauty and attractiveness of the person.[21] Removable partial dentures (RPDs) are the widely accepted treatment of choice for most cases as it is both effective, affordable and best treatment option for partial edentulism[22] but patients are concerned about the metal exposure in cast partial dentures and hence worried about the esthetic appearance.[23,24] The traditional use of the conventional metal clasps such as cobalt-chromium (Co-Cr), gold, stainless steel, and titanium damages esthetics due to display in the oral cavity which hampers the patient's selfesteem.

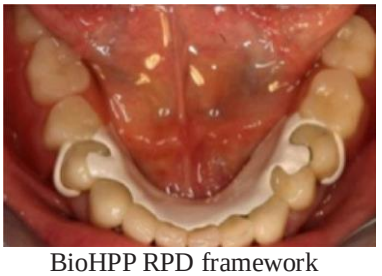
Hence, Acetal resin (polyoxymethylene [POM]), a thermoplastic resin, may be used as an alternative denture clasp material. Acetal was first proposed as an unbreakable thermoplastic resin RPD material in 1971. These injection molded resins were promoted mainly on its ability for superior esthetics, which allowed the clasps to better match the colour of abutment tooth.[25]

POM material showing clasp of RPD

An esthetically unacceptable display of metal clasps, increased prosthesis weight, the potential for metallic taste, and allergic reactions to metals have led to the introduction of a number of thermoplastic materials in clinical practice.[26,27,28]

Due to its white colour and high strength, PEEK permits RPD fabrication with metal-free esthetic clasps and occlusal rests with better occlusal stability.[29]

A modified PEEK high performance polymer (BioHPP) combined with regular acrylic denture teeth and conventional heat-cured denture base acrylic resin was used as an alternative RDP framework material. Due to its white color and high strength, BioHPP permits the fabrication of metal-free clasps and occlusal rests, providing occlusal stability and metal-free esthetics.[29]



BioHPP RPD framework

Implant: A dental implant is used to support one or more false teeth. For this, Titanium (Ti) and its alloys have been used as dental implants since Brånemark introduced them at the end of the 1960s.[30] Ti materials possess good physicochemical characteristics, mechanical properties and biocompatibility.[31,32] However, Ti materials have an elastic modulus

significantly higher than that of bone (titanium: 110 GPa; cortical bone: 14 GPa), and the difference may result in inadequate stress-shielding, bone resorption, and implant fracture.[33,34] In addition, Ti materials have been implicated in clinical problems, such as occasional metal hypersensitivity and allergies, surface degradation and contamination related to peri-implantitis, and scattered radiation.[35] The metallic appearance of Ti materials may also be problematic, as highly aesthetic restorations are becoming important. Many researchers have undertaken efforts to develop substitutes for Ti dental implants, such as zirconia[36,37], which has a high elastic modulus and low temperature degradation.[38,39] Polymeric compounds, such as polyetheretherketone (PEEK),which is a semicrystalline linear polycyclic thermoplastic that was developed in 1978 [40].

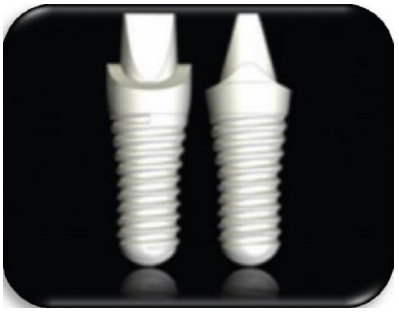
According to Wolff's Law, the bone remodels according to the load that has been applied to it. Stress shielding is the reduction in volume of the bone around an implant due to the shielding of normal loads by the implant. Finite-element analysis (FEA) of carbon-fiber reinforced PEEK (CFR-PEEK) implants suggested that they could induce lesser stress shielding than titanium.[41]

Because of its mechanical and physical properties being similar to bone and dentin, PEEK can be used for a number of applications in dentistry including dental implants. Increasing the bioactivity of PEEK dental implants without affecting their mechanical properties is a major challenge. PEEK is also an attractive material for producing CAD-CAM fixed and removable prosthesis owing to its superior mechanical properties compared to materials such as acrylic. Further research and clinical trials are required to explore this material and possible modifications for further dental application.[42]

In recent years, high strength zirconia ceramics have become attractive as new materials for dental implants. They are considered to be inert in the body and exhibit minimal ion release compared with metallic implants. Yttrium-stabilized tetragonal zirconia polycrystals appear to offer advantages over aluminum oxide for dental implants because of their higher fracture resilience and higher flexural strength.[43,44]

PEEK implant

The inflammatory response and bone resorption induced by ceramic particles are less than those induced by titanium particles, suggesting the biocompatibility of ceramics.[45,46]



Zirconia implant

Maxillofacial: It is an artificial device used to replace missing facial or oral structures. Now a days CAD CAM device is used for this.

Advantages of using CAD / CAM are:

- The patient spends less time in the office;
- Easy to use in case of reduced mouth opening;
- A simplified procedure;
- Reduced consumption of materials;
- Increased productivity;[47]

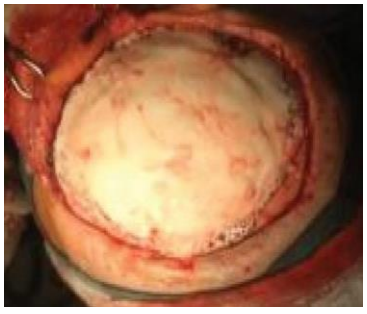
The intra oral scanning of a hemimaxillectomy patient and the implementation of CAD/CAM techniques for obturator fabrication are a viable option for less tissue irritation and more patient comfort.[48]

Obturator by CAD/CAM

Cranioplasties have been performed since the early 1950s.[49] Acrylic resin materials have been used as bone substitutes in dentistry. Acrylic implants are dimensionally stable, nonconductive, inexpensive, and can be easily modified and placed.[50] Acrylic resin has some advantages over metal substances; it is easy to shape, lighter in weight, radiates less heat, and radiolucent.[51,52]

Conclusion: Keeping in mind the various hazards of using metals as prosthetic materials and the awareness and demand for aesthetics has lead to the evolution of metal-free prosthesis which will soon be the future of dental prosthesis. An adequate knowledge about the same is essential amongst the practitioners in order to bring them in practice unlike other conventional materials.

Cranioplasty by Ti



Cranioplasty by resin

References:

1 Miyazaki T, Hotta Y, Kunii J, Kuriyama S, Tamaki Y. A review of dental CAD/CAM: current status and future perspectives from 20 years of experience. Dental materials journal. 2009;28(1):44-56.

2 Takano T, Sakurai K. Overview of zirconia: Application as denture base material substituting for metal. International Journal of Prosthodontics & Restorative Dentistry. 2013 Oct 1;3(4):153.

3 Gad MM, Fouda SM, Al-Harbi FA, Näpänkangas R, Raustia A. PMMA denture base material enhancement: a review of fiber, filler, and nanofiller addition. International journal of nanomedicine. 2017;12:3801.

4 Kanazawa M, Inokoshi M, Minakuchi S, Ohbayashi N. Trial of a CAD/CAM system for fabricating complete dentures. Dental materials journal. 2011:1101210106-.

5 Ciocca L, Mingucci R, Gassino G, Scotti R. CAD/CAM ear model and virtual construction of the mold. J Prosthet Dent 2007; 98: 339-343.

6 Ciocca L, Scotti R. CAD-CAM generated ear cast by means of a laser scanner and rapid prototyping machine. J Prosthet Dent 2004; 92: 591-595.

7 Conrad H, Seong W, Pesun I. Current ceramic materials and systems with clinical recommendations: a systematic review.J Prosthet Dent 2007; 98: 389-404.

8 Jiao T, Zhang F, Huang X, Wang C. Design and fabrication of auricular prostheses by CAD/CAM system. Int J Prosthodont 2004; 17: 460-463.

9 Andreiotelli M, Wenz HJ, Kohal RJ. Are ceramic implants a viable alternative to titanium implants? A systematic literature review. Clin Oral Implants Res 2009;20 Suppl 4:32-47.

10 Karakoca S, Yilmaz H. Influence of surface treatments on surface roughness, phase transformation and biaxial flexural strength of Y-TZP ceramics. J Biomed Mater Res B Appl Biomater 2009;91(2):930-937

11 Nakazato T, Takahashi H, Yamamoto M, Nishimura F, Kurosaki N. Effect of polishing on cyclic fatigue strength of CAD/CAM ceramics. Dent Mater J 1999;18(4):395-402.

12 Sanaoka S, Goto T, Watanabe K, Higashino Y. Application of dental zirconia to major connector. J. Gifu Dent Soc 2010;37(1):41-46.

13 McCabe JF. Anderson's applied dental materials. ed 7. Oxford: Blackwell Scientific; 1990:73.

14 Pathrabe A, Lahoti K, Gade JR. Metal Free Ceramics in Dentistry: A Review.

15 Green D, Hannink R, Swain M. Transformation toughening of ceramics. Boca Raton, FL: CRC Press; 1988.

16 Hannink RHJ, Kelly PM, Muddle BC. Transformation toughening in zirconia-containing ceramics. J Am Ceram Soc 2000;83:461–87.

17 Denry I, Kelly JR. State of the art of zirconia for dental applications. Dental materials. 2008 Mar 1;24(3):299-307.

18 Luthardt RG, Sandkuhl O, Reitz B. Zirconia-TZP and aluminaadvanced technologies for the manufacturing of single crowns. Eur J Prosthodont Restor Dent 1999;7:113-9.

19 Raigrodski AJ. Contemporary materials and technologies for allceramic fixed partial dentures: A review of the literature. J Prosthet Dent 2004;92:557-62.

20 Hegde C, Nitin A, Vijai S, Anil SR, Ramya D. Metal-free restorations: Clinical considerations. Journal of interdisciplinary dentistry. 2011 Jan 1;1(1):10.

21 The glossary of prosthodontic terms: Ninth edition. J Prosthet Dent. 2017;117:e1–105.

22 Shah R, Aras M. Esthetics in removable partial denture – A review. Kathmandu Univ Med J (KUMJ) 2013;11:344–8.

23 Cowan RD, Gilbert JA, Elledge DA, McGlynn FD. Patient use of removable partial dentures: Twoand four-year telephone interviews. J Prosthet Dent. 1991;65:668–70.

24 Donovan TE, Derbabian K, Kaneko L, Wright R. Esthetic considerations in removable prosthodontics. J Esthet Restor Dent. 2001;13:241–53.

25 Turagam N, Mudrakola DP, Yelamanchi RS, Deepthi M, Natarajan M. Esthetic clasp cast partial denture. Journal of International Society of Preventive & Community Dentistry. 2019 Jan;9(1):94.

26 Behr M, Zeman F, Passauer T, et al: Clinical performance of cast clasp-retained removable partial dentures: a retrospective study.Int J Prosthodont 2012;25:138-144

27 Donovan TE, Cho GC: Esthetic considerations with removable partial dentures. J Calif Dent Assoc 2003;31:551-557

28 Harb IE, Abdel Khalek EA, Hegazy SA. CAD/CAM constructed poly (etheretherketone) (PEEK) framework of Kennedy class I removable partial denture: a clinical report. Journal of Prosthodontics. 2019 Feb;28(2):e595-8.

29 Zoidis P, Papathanasiou I, Polyzois G: The use of a modified poly-ether-ether-ketone (PEEK) as an alternative framework material for removable dental prostheses. A clinical report.J Prosthodont 2016;25:580-584

30 Brånemark P.I.,Adell R., Breine U., Hansson B.O., Lindstrom J., Ohlsson A. Intraosseous anchorage of dental prostheses. I. Experimental studies. Scand. J. Plast. Reconstr. Surg. 1969;3:81–100.

31 Lautenschlager E.P., Monaghan P. Titanium and titanium alloys as dental materials. Int. Dent. J. 1993;43:245–253.

32 Renouard F., Nisand D. Impact of implant length and diameter on survival rates. Clin. Oral Implants Res. 2006;17:35–51.

33 Lee W.T., Koak J.Y., Lim Y.J., Kim S.K., Kwon H.B., Kim M.J. Stress shielding and fatigue limits of poly-ether-ether-ketone dental implants. J. Biomed. Mater. Res. B Appl. Biomater. 2012;100:1044–1052.

34 Huiskes R., Ruimerman R., Van Lenthe G.H., Janssen J.D. Effects of mechanical forces on maintenance and adaptation of form in trabecular bone. Nature. 2000;405:704–706.

35 Schalock P.C., Menné T., Johansen J.D., Taylor J.S., Maibach H.I., Lidén C., Bruze M., Thyssen J.P.Hypersensitivity reactions to metallic implants-Diagnostic algorithm and suggested patch test series for clinical use. Contact Dermat. 2012;66:4–19.

36 Nakamura K., Kanno T., Milleding P., Ortengren U. Zirconia as a dental implant abutment material:A systematic review. Int. J. Prosthodont. 2010;23:299–309.

37 Özkurt Z., Kazazoğlu E. Zirconia dental implants: A literature review. J. Oral Implantol. 2011;37:367–376.

38 Akagi K., Okamoto Y., Matsuura T., Horibe T. Properties of test metal ceramic titanium alloys. J.Prosthet. Dent. 1992;68:462–467.

39 Kelly J.R., Denry I. Stabilized zirconia as a structural ceramic: An overview. Dent. Mater.2008;24:289–298.

40 Eschbach L. Nonresorbable polymers in bone surgery. Injury. 2000;31:22–27.

41 Lee W, Koak J, Lim Y, Kim S, Kwon H, Kim M. Stress shielding and fatigue limits of poly-ether-ether-ketone dental implants. J Biomed Mater Res Part B: Appl Biomater 2012;100:1044–52

42 Najeeb S, Zafar MS, Khurshid Z, Siddiqui F. Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics. Journal of prosthodontic research. 2016 Jan 1;60(1):12-9.

43 Sennerby, L., Dasmah, A. Larsson, B. and Iverhed, M. Bone tissue responses to surface-modified zirconia implants: a histomorphometric and removal torque study in the rabbit. Clin Implant Dent Relat Res. 2005. 7(suppl 1):S13–S20

44 Özkurt Z, Kazazoğlu E. Zirconia dental implants: a literature review. Journal of oral implantology. 2011 Jun;37(3):367-76.

45 Ichikawa, Y., Akagawa, Y. Nikai, H. and Tsuru, H. Tissue compatibility and stability of a new zirconia ceramic in vivo. J Prosthet Dent. 1992. 68:322–326.

46 Warashina, H., Sakano, S. Kitamura, S. et al. et al Biological reaction to alumina, zirconia,titanium and polyethylene particles implanted onto murine calvaria. Biomaterials. 2003. 24:3655–3661.

47 Susic I, Travar M, Susic M. The application of CAD/CAM technology in Dentistry. InIOP Conference Series: Materials Science and Engineering 2017 May (Vol. 200, No. 1, p. 012020). IOP Publishing.

48 Michelinakis G, Pavlakis M, Igoumenakis D. Rehabilitation of a maxillectomy patient using intraoral scanning impression technology and a computer-aided design/computer-aided manufacturing fabricated obturator prosthesis: A clinical report. The Journal of the Indian Prosthodontic Society. 2018 Jul;18(3):282.

49 Martin JW, Ganz SD, King GE, Jacob RF, Kramer DC. Cranial implant modification. J Prosthet Dent. 1984;52:414–416.

50 Firtell DN, Grisius RJ. Cranioplasty of the difficult frontal region. J Prosthet Dent. 1981;46:425–429

51 Aydin S, Kucukyuruk B, Abuzayed B, Aydin S, Sanus GZ. Cranioplasty: Review of materials and techniques. J Neurosci Rural Pract. 2011;2:162–167.

52 Gupta L, Aparna IN, Balakrishnan D, Deenadayalan L, Hegde P, Agarwal P. Cranioplasty with custom made alloplastic prosthetic implant: A case report. World Journal of Clinical Cases: WJCC. 2014 Sep 16;2(9):482.