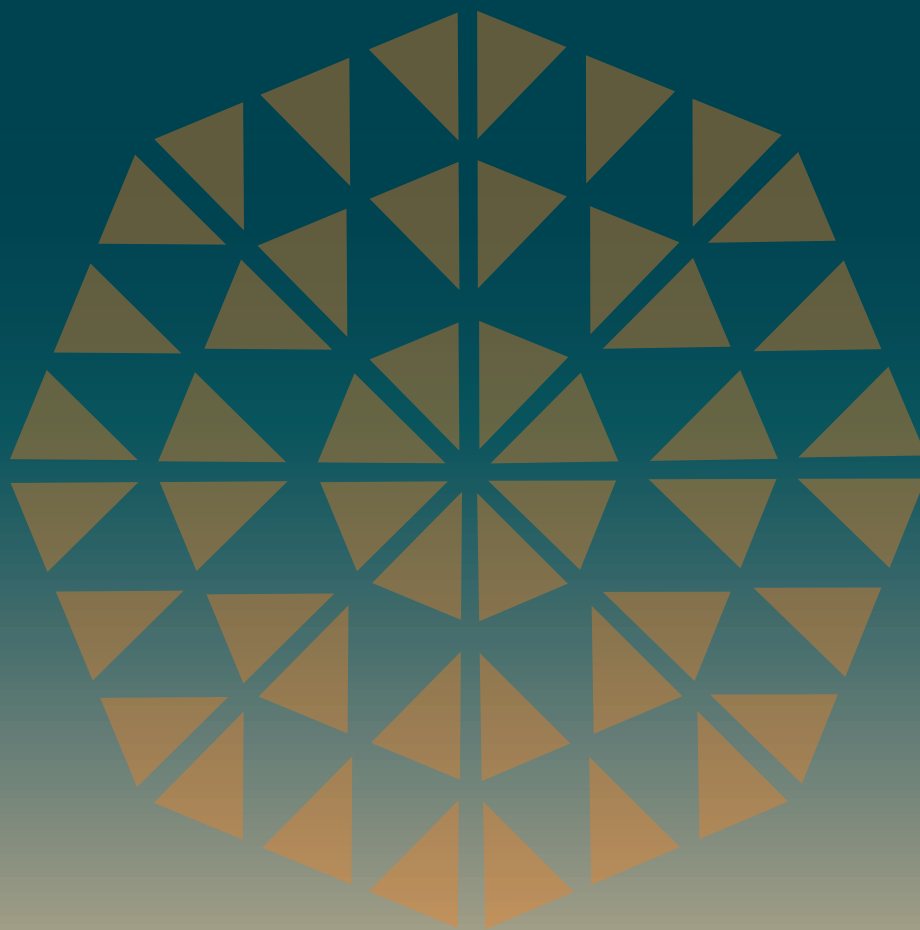


DENTAL BITES

Volume 9 Issue 4 | October - December 2022

**Periodontics, Public Health Dentistry
and Implantology**



a quarterly publication of



KMCT
DENTAL COLLEGE
Recognized Research Centre of KUHS

DENTAL BITES

Volume 9 Issue 4 | October - December 2022

Periodontics, Public Health Dentistry and Implantology

a quarterly publication of



KMCT Medical College Campus, Mukkam, Kozhikode - 673602

Editorial Board

Managing Director

Dr. K. M. Navas
Managing Trustee – KMCT Group of Institutions

Chief Editor

Dr. Manoj Kumar K. P.
Principal – KMCT Dental College

Executive Editor

Dr. Usha Balan – Dept.of Oral Pathology & Microbiology

Associate Editor

Dr. Prejith Sampath – Dept.of Oral Medicine and Radiology

Editorial Board Members

Dr. Sarin Koroth – Dept. of Conservative Dentistry &Endodontics

Dr. Vipin Das – Dept. of Oral & Maxillofacial Surgery

Dr. Prejith Sampath – Dept. of Oral Medicine & Radiology

Dr. Swapna Honwad – Dept. of Oral Pathology & Microbiology

Dr. Amrita Ashok – Dept. of Orthodontics & Orofacial Orthopedics

Dr. Anju R. V –Dept. of Pedodontics and Preventive Dentistry

Dr. Navia George – Dept. of Periodontics

Dr. Swapna C – Dept. of Prosthodontics

Dr. Arun Paul – Dept. of Public Health Dentistry

Technical Support

Maneesh T
Aswinraj M P

Importance of developing research culture in undergraduates.....

Our students don't understand the relevance of research during under graduate phase. We have inculcated several programs to enrich research into young minds. In the current world, we come across lots of innovative ideas in youngsters which can become a reality through your passion towards the work you do. A researcher can open doors to so many unseen facts, we have to focus on our areas of interest and turn our dreams into reality.

Research culture encompasses the behaviours, values, expectations, attitudes and norms of our research communities. It influences researchers' career paths and determines the way that research is conducted and communicated. A positive research culture helps you to freely explore ideas, make mistakes and learn from them, and share good practice. You will feel supported and valued. You will thrive in a positive environment that embraces inclusion, openness and integrity. The culture you work in can influence your career path. Research is what propels humanity forward. It's fuelled by curiosity: we get curious, ask questions, and immerse ourselves in discovering everything there is to know. Learning is thriving. Without curiosity and research, progress would slow to a halt, and our lives as we know them would be completely different.

Research culture is a hazy concept, which includes the way we evaluate, support and reward quality in research, how we recognize varied contributions to a research activity, and the way we support different career paths. Of all the things you could do to improve research culture, start from the priorities that you think matter most to your organization; those that reflect its values, fit with what your community really cares about, or align to the activities that are already in progress.

Research supports the development of enquiring minds and inspires innovation, creativity, critical thinking, and problem-solving. In many countries, the development of policies and practices is largely backed by R&D, instead of being based on ideology. Existing literature also indicates that there is a strong, positive relationship between research and practice. Likewise, there is a strong and positive relationship between higher education research and national economic growth.

Our institution gives a lot of opportunities for enrichment of research culture, we look forward for all our undergraduates to be a part of it.

Keep learning and help others learn.....

Dr. Manoj Kumar KP

Editor

TABLE OF CONTENTS

1. Biomedical waste management knowledge, attitude and practices - A cross sectional survey of students of a Dental teaching institute in Kerala- Original Research pg 6

Dhanya Muralidharan, Arun Paul, Shahla A, Shadiya K, Dr Shibini Shareef
2. Management of a complicated frontal and naso-orbito-ethmoid complex fracture - Case report pg 20

Appu Mohan, Anahita Ann Koruth, Sanju Lakshmanan, Subin Varughese Mathew, Manoj Kumar K P
3. The role of growth factors for regeneration around teeth and Dental implants - Review pg 33

Risvana S, Dona Susan Varghese, Sneha Shajan, Aparna T K, Navia George, Santhosh V C, Harishkumar V V
4. Root coverage by connective tissue graft: A case report pg 49

Sneha Shajan, Dr. Risvana S, Dona Susan Varghese, Subisha S B, Anish Varkey, Santhosh V C, Harish Kumar V V
5. Robotics in prosthodontics: a state of art and future challenges - Review article pg 56

Ranjith M, Melisa Cheriyan, Sheejith M, Niveditha

Original Research

BIOMEDICAL WASTE MANAGEMENT KNOWLEDGE, ATTITUDE AND PRACTICES - A CROSS SECTIONAL SURVEY OF STUDENTS OF A DENTAL TEACHING INSTITUTE IN KERALA

*Dr Dhanya Muralidharan, **Dr Arun Paul, ***Dr Shahla A, ***Dr Shadiya K,
***Dr Shibini Shareef

Abstract

Dental waste consists of both hazardous and infectious wastes which can be harmful to the public and environment if not disposed carefully. Dentists' need to be aware of correct methods of waste segregation and disposal in order to prevent health hazards. The present study was undertaken to determine the dental student's Knowledge, Attitudes and Practices of Biomedical Waste Management of a dental teaching institution in Kerala. A cross-sectional descriptive online questionnaire study was conducted for a period of four months from August to November 2021. A total of 414 students participated for the study with a mean age of 23.66 ± 2.042 . The current study revealed Dental students had positive attitudes towards Biomedical waste management but definite inadequacies in their Knowledge and Biomedical waste management Practices. Modifications in the dental curriculum stressing on importance of Biomedical waste management as early as in the pre-clinical years will help improve understanding of Biomedical waste management concepts and its application.

Key words: Biomedical waste management, Dental students, Knowledge, Attitudes, Practices

Corresponding author: Dr Dhanya Muralidharan, email: kappoordhanya@hotmail.com

Professor and Head, **Reader, *Intern, Department of Public Health Dentistry,*

KMCT Dental College, Kozhikode, Kerala

Introduction:

According to bio-medical waste rule, 1998 of India, Biomedical waste- means any waste generated during the diagnosis, treatment or immunization of human beings or animals, or in research activities pertaining thereto or in the production or testing of biologicals in the production or testing of biological or in health camps.^{1,2} 10-25% of the Hospital waste is hazardous to general population and environment³ and only 15% is infectious, however, poor segregation can cause the mixing of non-infectious with infectious waste and increase the total hazardous waste volume.⁴ The current principles of Biomedical Waste management follow the “Cradle to Grave approach” which includes waste generation, collection, storage, transportation, treatment, and ultimate destination.⁵

Dental diagnosis and treatment procedures can generate Mercury containing wastes, Silver containing wastes, Lead containing wastes, sharps and infectious wastes such as cotton, gauze, teeth, needles contaminated with blood and saliva etc.⁶ Dental waste consists of both hazardous and infectious wastes which can be harmful to the public and environment if not disposed carefully.

Dental amalgam contains mercury which is a neurotoxin, nephrotoxin and bio-accumulative element.⁶ A review of 40,000 dentists have shown dental personnel to have higher exposure to mercury.⁷ Studies have revealed Dental practitioners are not aware of the categories of waste generated in their clinics and practiced wrong measures to dispose the waste generated in their clinics.^{8,9} Dentists’ need to be aware of correct methods of waste segregation and disposal in order to prevent health hazards.

Dental teaching hospitals and colleges also generate large amounts of Biomedical waste. Reviews on Biomedical waste management practices of employees of dental teaching hospitals have revealed that knowledge and practices of biomedical waste segregation and disposal are inadequate.^{10,11,12} A few of the studies assessing the Biomedical waste management knowledge and practices in dental teaching institutes have included dental interns as a part of the study population assessed.^{10,13} These studies revealed poor knowledge regarding Biomedical waste management practices and policies and indicated a need for improvement. Studies focusing primarily on dental student’s awareness of BMW

management practices are limited.^{14,15,16} Hence, the present study was undertaken to determine the dental student's Knowledge, Attitudes and Practices of Biomedical Waste Management of a dental teaching institution in Kerala.

Methodology:

Study design and sample:

The study is a cross-sectional descriptive online questionnaire study conducted for a period of four months from August to November 2021 following approval from the Institutional Ethical Committee [KMCTDC/IEC/2021/03].

All consenting undergraduate dental students undergoing clinical postings of Third year, Final Year Part I and Part II students, Interns and Post graduate students of KMCT Dental College present during the study period were included for the study. Convenience sampling method was used to recruit participants for the study. The sample size was estimated as 412 persons considering the prevalence of knowledge of Biomedical waste management among dental students from previous literature as 49%.¹⁵ The sample size was estimated as 412 using the formula, $n = 4pq \div d^2$, where Z

$\alpha/2$ = Normal deviate for two tailed hypothesis = 1.96, p is the Proportion or Prevalence from previous studies as 49%, d is the permissible error of 10%.

Questionnaire:

The data regarding Biomedical Waste Management Practices was collected using a questionnaire designed specifically for the study. The questions were adapted from previous studies by Singh T et al,¹⁵ and Khubchandani A et al,¹⁶ assessing Biomedical Waste Management Knowledge, Attitudes and Practices of dental students. The questionnaire is a self-administered, structured, closed ended electronic questionnaire in English language. The questionnaire comprised of four sections focusing on demographic details such as age, gender, year of study etc, Sixteen questions assessing Knowledge of Biomedical Waste Management Practices, Four questions assessing Awareness regarding Biomedical waste management policies and Six questions assessing Attitudes to Biomedical waste management. The response options are either dichotomous or of multiple-choice type. The questionnaire was pilot tested on 15 undergraduate final year part I dental

students randomly selected. (Cronbach's alpha coefficient of 0.80)

The questionnaire was transformed into electronic format using Google forms (via docs.google.com/forms). The Google form link was distributed through student's emails (Gmail, Outlook, Yahoo etc) and social media platforms such as WhatsApp, Facebook, Instagram, LinkedIn, Telegram etc based on the list provided from the College dental office.

The questionnaire link first opens to the section containing the informed consent where the background and objectives of the study are explained, following which, the participant can select "Agree" option to indicate their consent to participate in the study. On consenting the participant will be automatically directed to the main questionnaire section on Biomedical Waste Management.

Statistical analysis:

Data was analyzed using Statistical Package for Social Sciences version (SPSS) 20.0 software (IBM, Armonk, NY, United States of America). Categorical variables will be described as frequencies and percentages and continuous variables as Means and

standard deviation (SD). Chi square test will be used to associate demographic variables and Biomedical Waste Management Knowledge, Attitudes and Practices. Statistical significance was set at $p < 0.05$.

Results:

A total of 414 students participated for the study with a mean age of 23.66 ± 2.042 . 83% ($n=347$) of the participants were females and the rest were males (16.2%). Figure 1 shows the distribution of Dental students according to their year of study. (Figure 1)

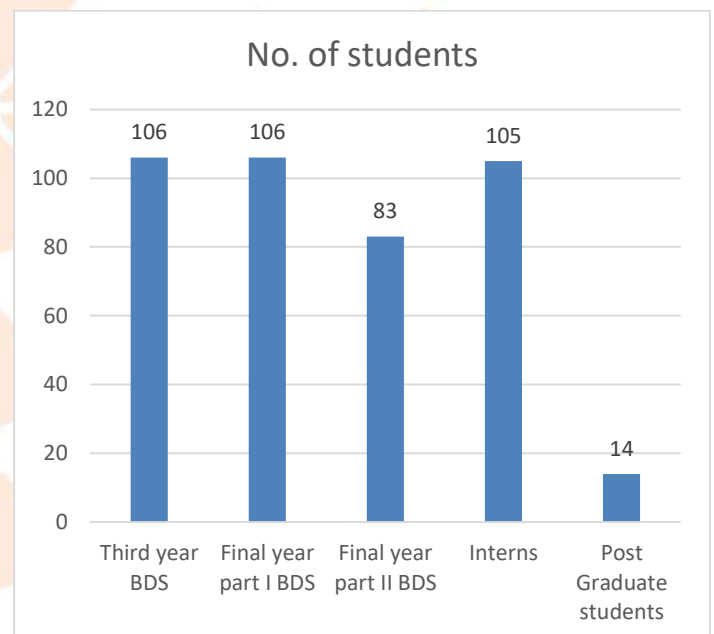


Figure 1: Distribution of Dental Students according to their year of study

Dental student's Knowledge of Biomedical Waste Management:

Assessment of Dental student's knowledge of Biomedical Waste Management revealed that not all Biomedical wastes are hazardous was known only to about 62.3% to 72.6% of the students in each batch except for Final year part II BDS students among whom only 36.1% knew ($p=0.000$), the rest considered all Biomedical waste to be hazardous. (Table 1) More than 65% of the Dental students in each batch were aware that any plastic bag could not be used to dispose Biomedical waste. Other than Postgraduate students (92.9%), only a few of the Undergraduates (10.4%-37.3%) and Interns (50.5%) were aware of 'IMAGE'. Majority ($> 82\%$) correctly identified the symbol for 'Biohazard'. Less than half of the students were only able to correctly identify the maximum time limit for which biomedical waste can be stored according to National guidelines. (Table 1) Majority ($>70\%$) of the students correctly answered that segregation of Biomedical waste was to be done at the point of generation. Almost all the students were aware that different colored bags are used to dispose different types of waste. (Table 1)

Only less than 40% of the undergraduate students and interns were able to correctly identify the type of bag into which 'Disposable plastic items' are to be disposed of. (Table 1) Similarly approximately 50% of the students in each batch were aware of the type of bag into which Soiled dressings, used Impression materials, Extracted teeth and Human tissue are to be disposed into except for Third year BDS students of whom only 33% and 40.6% knew. However, majority ($>73\%$) in each batch knew the correct method of disposal of Used sharps and needles. (Table 1) Awareness of the type of bag for disposal of Plaster of Paris was lacking among the Third year and Final year part I BDS students compared to Final year part II BDS, Interns and Post Graduate students. Almost all students in each batch were aware of the correct method of disposing excess Mercury. Majority were aware that there are guidelines laid down by Government of India for Biomedical waste management, however many of the students (17.9%-71.4%) were not aware of the Biomedical Waste Management and Handling law established by Government of India in 1998. (Table 1) Except for the Final Year Part II BDS students many were not aware of a College Policy for Biomedical waste disposal.

S.No.	Question (Correct Response)	Third year BDS (n=106)	Final year part I BDS (n=106)	Final year part II BDS (n=83)	Interns (n=105)	Post Graduate students (n=14)	p-value
Q1	Are all Health care waste hazardous?	77 (72.6)	66 (62.3)	30 (36.1)	68 (64.8)	9 (64.3)	0.000*
Q2	Can any plastic bag be used for Biomedical waste disposal?	73 (68.9)	98 (92.5)	65 (78.3)	74 (70.5)	14 (100.0)	0.000*
Q3	Are you aware of IMAGE?	19 (17.9)	11 (10.4)	31 (37.3)	53 (50.5)	13 (92.9)	0.000*
Q4	Which of the following is the universally accepted symbol for biohazard?	88 (83.0)	95 (89.6)	82 (98.8)	97 (92.4)	14 (100.0)	0.003*
Q5	According to national guidelines, what is the maximum time limit for which biomedical waste can be stored?	52 (49.1)	41 (38.7)	39 (47.0)	59 (56.2)	11 (78.6)	0.084
Q6	Should segregation of waste be done at the point of generation?	79 (74.5)	74 (69.8)	65 (78.3)	81 (77.1)	12 (85.7)	0.235
Q7	Are different colored bags used to dispose different types of waste?	105 (99.1)	102 (96.2)	82 (98.8)	101 (96.2)	14 (100.0)	0.383
Q8	Used disposable plastic items (e.g., Suction tubes) are disposed of in?	23 (21.7)	58 (54.7)	40 (48.2)	50 (47.6)	9 (64.3)	0.000*
Q9	Soiled dressings and used impression materials are disposed of in?	35 (33.0)	53 (50.0)	43 (51.8)	63 (60.0)	12 (85.7)	0.000*
Q10	Used sharps and needles are disposed of in?	78 (73.6)	84 (79.2)	73 (88.0)	84 (80.0)	14 (100.0)	0.002*

Q11	Extracted teeth and human tissue are disposed of in?	43 (40.6)	70 (66.0)	44 (53.0)	59 (56.2)	12 (85.7)	0.000*
Q12	Plaster of Paris is disposed of in?	30 (28.3)	42 (39.6)	42 (50.6)	53 (50.5)	10 (71.4)	0.000*
Q13	Excess mercury is disposed of in?	101 (95.3)	98 (92.5)	79 (95.2)	101 (96.2)	14 (100.0)	0.044*
Q14	Are there any guidelines laid down by Government of India for BMW management?	103 (97.2)	89 (84.0)	70 (84.3)	102 (97.1)	14 (100.0)	0.000*
Q15	Have you heard of Biomedical Waste Management and Handling law established by Government of India in 1998?	52 (49.1)	19 (17.9)	34 (41.0)	56 (53.3)	10 (71.4)	0.000*
Q16	Are you aware of any biomedical waste disposal policy in your College?	62 (58.5)	46 (43.4)	40 (48.2)	88 (83.8)	9 (64.3)	0.000*

Note: (*) represents p value <0.05

Table 1: Knowledge of Biomedical Waste Management of different batches of Dental students

Dental students Biomedical Waste Management Practices:

Assessment of Biomedical waste management practices showed majority (>90%) of the students would not dispose all kinds of Biomedical waste into General garbage. Almost all students used protective barriers (e.g. gloves, masks) during handling of Biomedical waste. (Table 2) Only 50% of the Final year Part I and Part II students

would treat infectious waste before disposing them compared to the other Batches (p=0.000). Only 41.5% to 71.4% of the students have received training in any form (e.g. lecture, Workshop) on Biomedical waste management. (Table 2)

S.No.	Question (Correct Response)	Response options	Third year BDS (n=106)	Final year part I BDS (n=106)	Final year part II BDS (n=83)	Interns (n=105)	Post Graduate students (n=14)	p-value
Q1	Do you dispose all kinds of Biomedical waste into general garbage?	Yes	10 (9.4)	8 (7.5)	3 (3.6)	6 (5.7)	0 (0)	0.420
		No	96 (90.6)	98 (92.5)	80 (96.4)	99 (94.3)	14 (100.0)	
Q2	Do you use protective barriers (e.g. gloves, masks) during handling of BMW?	Yes	104 (98.1)	105 (99.1)	81 (97.6)	103 (98.1)	14 (100.0)	0.923
		No	2 (1.9)	1 (0.9)	2 (2.4)	2 (1.9)	0 (0)	
Q3	Do you treat infectious waste before disposing them?	Yes	87 (82.1)	52 (49.1)	42 (50.6)	74 (70.5)	13 (92.9)	0.000*
		No	19 (17.9)	54 (50.9)	41 (49.4)	31 (29.5)	1 (7.1)	
Q4	Have you ever received training in any form (e.g. lecture, workshop) on BMW management?	Yes	44 (41.5)	50 (47.2)	53 (63.9)	60 (57.1)	10 (71.4)	0.009*
		No	62 (58.5)	56 (52.8)	30 (36.1)	45 (42.9)	4 (28.6)	

Table 2: Biomedical Waste Management Practices of different batches of Dental students

Attitudes of Dental students towards Biomedical Waste Management:

Assessment of Dental Students attitudes towards Biomedical waste management showed almost all students irrespective of the year of study felt that Biomedical wastes should be segregated into different categories prior to disposal ($p=0.573$). (Table 3) All the dental students felt it is

important to know about Biomedical waste generation, hazards, and legislation. (Table 3) Similarly almost all students agreed with statement that “Waste management is team work and no single class of people is responsible for safe management”. Majority in each batch felt that their knowledge regarding biomedical waste management is not adequate ($p=0.128$). Nearly all students

in each batch felt they required further training on biomedical waste management and almost all would voluntarily attend

programs that enhance and upgrade their knowledge about waste management .

S.No.	Question (Correct Response)	Response options	Third year BDS (n=106)	Final year part I BDS (n=106)	Final year part II BDS (n=83)	Interns (n=105)	Post Graduate students (n=14)	p-value
Q1	Do you feel Biomedical wastes should be segregated into different categories?	Yes	106 (100.0)	105 (99.1)	83 (100.0)	105 (100.0)	14 (100.0)	0.573
		No	0 (0.0)	1 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	
Q2	Do you feel your knowledge regarding biomedical waste management is adequate?	Yes	24 (22.6)	11 (10.4)	13 (15.7)	20 (19.0)	1 (7.1)	0.128
		No	82 (77.4)	95 (89.6)	70 (84.3)	85 (81.0)	13 (92.9)	
Q3	Do you think you require any further training on biomedical waste management?	Yes	99 (93.4)	104 (98.1)	82 (98.8)	100 (95.2)	14 (100.0)	0.205
		No	7 (6.6)	2 (1.9)	1 (1.2)	5 (4.8)	0 (0.0)	
Q4	Will you like to attend voluntarily, programs that enhance and upgrade your knowledge about waste management?	Yes	103 (97.2)	105 (99.1)	83 (100.0)	99 (94.3)	14 (100.0)	0.081
		No	3 (2.8)	1 (0.9)	0(0.0)	6 (5.7)	0 (0.0)	
Q5	Do you think it is important to know about Biomedical waste generation, hazards, and legislation?	Yes	106 (100.0)	106 (100.0)	83 (100.0)	103 (98.1)	14 (100.0)	0.206
		No	0(0.0)	0(0.0)	0(0.0)	2 (1.9)	0(0.0)	
Q6	Waste management is team work, no single class of people is responsible for safe management	Agree	99 (93.4)	103 (97.2)	77 (92.8)	98 (93.3)	14 (100.0)	0.519
		Disagree	7 (6.6)	3 (2.8)	6 (7.2)	7 (6.7)	0(0.0)	

Table 3: Attitudes of different batches of Dental students towards Biomedical Waste Management

Discussion

Dental clinics, hospitals, teaching institutes generate both infectious and hazardous wastes that are harmful to both individuals, community and the environment. Knowledge of management of Biomedical waste generated in a Dental setting is a necessity for not only established Dental Practitioner but also budding Dental graduates in order to prevent health hazards. Biomedical waste management is a part of the dental curriculum for Undergraduate students prescribed by the Dental Council of India, however studies have shown limited knowledge regarding Biomedical waste management practices and policies and among Dental college employees and interns.¹⁰ Hence, the present study was undertaken to evaluate the Knowledge, Attitudes and Practices of Biomedical waste management among Dental students of a dental teaching institute in Kerala.

The present study revealed inadequate knowledge of Biomedical waste management among the dental students studied. Only 10-25% of health care waste is considered as hazardous,³ this fact was not known to many Dental students in the present study. These findings were however

better than the findings of Khubchandani K et al,¹⁶ and Saini R et al,¹⁴ in which only half the students were aware. A fair majority in the current study were aware that any plastic bag could not be used to dispose Biomedical waste and almost all were aware that different coloured bags are used to dispose different types of waste. Similar response was observed in a study conducted among students of another Dental Teaching Institution in India¹⁶ as well as among Undergraduate students pursuing their education in Dental Colleges in Nepal.¹⁵

According to National guidelines, the maximum time limit for which biomedical waste can be stored was correctly identified by less than half of the students studied however this was much higher than in the study by Khubchandani K et al,¹⁶ wherein only 22% of the dental students were aware. Awareness regarding 'IMAGE' was observed to very low among the Undergraduate students and Interns in the current study which was consistent with observations in other similar study conducted ranging from 19.1%-23.6% and this was attributed to the fact that the Institution where the study was conducted had their own Biomedical waste disposal system.¹⁶ However the universally accepted

symbol for biohazard was correctly identified by >83% of the students in each year of study and this is much higher than observed among dental residents among whom only 41.3% could correctly recognize.¹³ In the study by Saini R et al,¹⁴ among Dental Undergraduate students, 76% of the students were aware segregation of Biomedical waste was to be done at the point of generation which is consistent with the results of our study.

Assessment of the knowledge of disposal of different categories of waste showed that apart from Post Graduate students, only half the Undergraduate students and interns in each batch were able to correctly identify the colour coded bag for disposal of Soiled dressings, used Impression materials, Extracted teeth, Human tissue and Plaster of Paris. Similar findings were observed among dental students and Residents in the study by Khubchandani K et al,¹⁶ Kulkarni SS et al,¹³ and Singh T et al,¹⁵ however in the study by Saini R et al,¹⁴ among students of rural Dental College in Maharashtra showed on an average 88%-95% had knowledge of the correct biomedical waste disposal method. According to World Health Organization, most of the human Mercury exposure is through exposure from dental

amalgam or occupational, hence proper disposal of excess Mercury is necessary to prevent both environmental and human toxicity.¹⁷ The knowledge of the Dental students regarding disposal of excess Mercury (92.5%-100.0%) and used Sharps and needles (73.6%-100.0%) was much higher in our study compared to other similar studies¹⁶ wherein only 27% knew the correct disposal for Excess Mercury and 56% knew that used Sharps and needles are to be disposed in puncture proof containers.

In July 1998, first Biomedical waste management rules were introduced and further modified in 2000, 2003, 2011 and recently amended in 2016 for strengthening capacity of Biomedical waste management system.² In the present study it was observed that majority were aware that there are guidelines laid down by Government of India for Biomedical waste management, however very few in each batch had knowledge of 'Biomedical Waste Management and Handling law, 1998' as well as awareness regarding a College policy for Biomedical waste disposal. Similar scenario was observed not only from other Indian studies^{16,10} but also among Dental students in Nepal.¹⁵ Biomedical waste management practices of Dental students

showed that almost all used protective barriers (e.g. gloves, masks) during handling of Biomedical waste and would never dispose Biomedical waste into General garbage. As per the Biomedical waste management rule 2016² pre-treatment of Microbiological and Laboratory waste is compulsory prior to disposal however only 50% of Final Year Part I and Part II dental students had knowledge of this fact.

The present study revealed positive attitudes among dental students towards Biomedical waste management. Positive attitudes regarding need for segregation of Biomedical waste was observed and majority were of the opinion that it is important to know about Biomedical waste generation, hazards, and legislation. In the study by Bala S et al,¹⁰ among Dental College and Hospital employees, majority reported that waste segregation was the responsibility of auxilliary staff and very few opined that doctors have a role in segregation, however almost all students in the present study opined that waste management is team work. Only 41.5% to 71.4% of the students have received training in any form (e.g. lecture, Workshop) on Biomedical waste management, however majority felt that their knowledge regarding

biomedical waste management is not adequate and were willing to attend programs that enhance and upgrade their knowledge about waste management.

Conclusion:

The current study revealed Dental students had positive attitudes towards Biomedical waste management but definite inadequacies in their Knowledge and Biomedical waste management Practices. The present study has its limitations as the findings cannot be generalized to all dental students as the study was conducted in a single Dental teaching institution. Modifications in the dental curriculum stressing on importance of Biomedical waste management in preventing both environmental and occupational hazards as early as in the pre-clinical years will help improve understanding of Biomedical waste management concepts and its application. Dental students who graduate imbibing the importance of Biomedical waste management practices will protect the environment and health in their practice.

References:

1. Park K. Hospital waste management. Park's textbook of Social and Preventive medicine. Chapter Banarasidas Bhanot Publishers, 2013, 22nd edition, 734-739.
2. Datta P, Mohi GK, Chander J. Biomedical waste management in India: Critical appraisal. J Lab Physicians 2018;10:6-14.
3. Chartier Y, Emmanuel J, Pieper U, Prüss A, Rushbrook P, Stringer R. Safe Management of Wastes from health-care activities. Second edition, Geneva, Switzerland: WHO Blue Book; 2014.
4. Parida A, Capoor MR, Bhowmik KT. Knowledge, attitude, and practices of Bio-medical Waste Management (principle) rules, 2016; Bio-medical Waste Management (amendment) rules, 2018; and Solid Waste Rules, 2016, among health-care workers in a tertiary care setup. J Lab Physicians 2019;11:292-9.
5. Capoor MR and Bhowmik KT. Current perspectives on Bio-medical Waste Management: Rules, conventions and treatment technologies. Indian J Med Microbiol 2017;35:157-64.
6. Agarwal B, Vikram SS, Bhansali S, Agarwal S. Waste management in Dental Office. Indian J Community Med 2012;37(3):201-202.
7. Nagpal N, Bettiol SS, Isham A, Hoang H, Crocombe LA. A review of mercury exposure and health of dental personnel. Safety and Health at Work 2017;8(1):1-10. <https://doi.org/10.1016/j.shaw.2016.05.007>
8. Bansal M, Vashisth S and Gupta Nidhi. Knowledge, awareness and practices of dental care waste management among private dental practitioners in Tricity (Chandigarh, Panchkula and Mohali). J Int Soc Prev Community Dent 2013;3(2):72-76.
9. Singh RD, Jurel SK, Tripathi S, Agrawal KK, Kumari R. Mercury and Other Biomedical Waste Management Practices among Dental Practitioners in India. BioMed Research International 2014;Article ID 272750, 6 pages.
10. Bala S, Narwal A. Awareness of Bio-medical Waste Management Among Dental College and Hospital

- Employees-A Panoramic View. J Oral Health Comm Dent 2013;7(1):1-7.
11. Kapoor D, Nirola A, Kapoor V, Gambhir RS. Knowledge and awareness regarding biomedical waste management in dental teaching institutions in India-A systematic review. J Clin Exp Dent 2014;6(4):e419-24.
 12. Tompe PP, Pande NA, Kamble BD, Radke UM, Acharya BP. A systematic review to evaluate Knowledge, Attitude and Practice regarding Biomedical Waste Management among Dental Teaching Institutions and Private Practitioners in Asian Countries. J Int Soc Prev Community Dentistry 2020 Sep-Oct; 10(5): 531–539
 13. Kulkarni SS, Sushanth VH, Prashant GM, Imranulla M, Vivek HP, Costa FD. Current knowledge, attitude and practices of dental residents towards biomedical waste management: A cross sectional study. J Global Oral Health 2019;2(1):23-8.
 14. Saini R, Pithon MM, Singh HK, Popoff DV. Knowledge of Biomedical Waste Management among the Students of Rural Dental College, Maharashtra, India. Int J Experiment Dent Sci 2013;2(1):24-26.
 15. Singh T, Ghimire TR and Agrawal SK. Awareness of Biomedical Waste Management in Dental Students in Different Dental Colleges in Nepal. BioMed Research International 2018; Article ID 1742326, 6 pages. <https://doi.org/10.1155/2018/1742326>
 16. Khubchandani A, Devi KM, Gunasekaran S, Yeturu SK, Ramanarayanan V. Knowledge, attitude, and practices of biomedical waste management among clinical dental students. J Global Oral Health 2020;3(2):110-117.
 17. World Health Organization, “Inorganic mercury: Environmental Health Criteria 118,” in International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland, 1991.

Case report

MANAGEMENT OF A COMPLICATED FRONTAL AND NASO-ORBITO-ETHMOID COMPLEX FRACTURE

*Dr Appu Mohan *Dr Anahita Ann Koruth ***Dr Sanju Lakshmanan **Dr Subin Varughese
Mathew**** Dr Manoj Kumar K P

Abstract

The Frontal and nasoorbitoethmoidal fractures remain the most complex of all facial fractures to diagnose and treat, largely because of the complex anatomy and difficulty in fracture reduction and fixation. Such fractures are increasing with the rising incidence of high-speed, high-force accidents. The nasoorbitoethmoidal fracture rarely occurs as an isolated event. Associated injuries often include central nervous system injuries, cribriform plate fracture, cerebrospinal fluid rhinorrhea, and fractures of the frontal bone, orbital floor, and middle third of the face as well as injury to the lacrimal system. The appropriate management of these injuries require an understanding of the anatomic features of the region and the degree of severity of damage. This article discusses about a complex nasoorbitoethmoidal fracture, diverse approaches to expose the fracture and recontouring the fracture segments. The purpose of this article is to provide a general overview of the topic, with a specific focus on the pearls of managing these fractures. Postoperative results show stable symmetrical fixation of the frontal bone, anterior table of the frontal sinus and nasal septum. Prompt and proper management of these injuries can achieve adequate functional and aesthetic outcomes

Key words: NOE, ORIF, Titanium mesh

Corresponding Author: Dr Anahita Ann Koruth

* Post graduate student ** Senior Lecturer ***Professor **** Professor and Head,
Department of Oral and maxillofacial surgery, KMCT Dental College, Kerala.

Introduction

Fractures of the naso-orbito-ethmoid (NOE) complex involves anterior cranial fossa, the frontal bone, the bones of the ethmoid, frontal sinuses, the nasal bones, and the orbital bone.¹ These injuries often occur concurrent with injuries to other parts of the face and body but can also occur in isolation. Road traffic accidents and interpersonal violence are the leading cause of these injuries, but the current picture is changing with improved vehicle and road safety.²

Thorough knowledge of regional anatomy is crucial in assessing and managing NOE fractures. The approach to patients with these injuries begins with the advanced trauma life support algorithm. These patients may also have injuries to critical structures such as airway, brain, and cervical spine. Further evaluation relies on a thorough clinical assessment aided by radiological imaging. Any operative intervention will depend on the classification of the NOE complex fracture, which is based on the status of the medial canthal tendon (MCT).³ Meticulous primary surgical correction is the key to aesthetic restoration of the facial features and prevention of future complications.

When performing surgery, it is essential to find a balance between correcting any deformities and avoiding additional cosmetic disturbance by choosing an appropriate operative approach and exposure.⁴

Case Report:

A 26-year-old gentleman reported to Department of Oral and Maxillofacial Surgery with the chief complaint of swelling of upper part of face and bleeding from nose since a day. Patient gave an alleged history of road traffic accident. History of epistaxis was present. No history of loss of consciousness, vomiting and seizure. No relevant medical history and no known allergy to drugs.

On examination, gross oedema over the nose and right periorbital region noted along with the loss of glabellar prominence and telecanthus present. Bilateral periorbital ecchymosis and epistaxis present and chemosis noted in left eye.

On palpation, tenderness and crepitus noted over the root of the nose and supra orbital margin of right eye and glabellar region.

CT reveals: 1) Comminuted fracture involving the superior wall of bilateral orbits with extension into frontal bone with

associated frontal hemosinus. 2) Comminuted fracture noted involving nasal bone and bony nasal septum with blood within the nasal cavity. 3) Displaced fracture noted involving the medial and anterior wall of left maxillary sinus with associated hemosinus. 4) Fracture line running perpendicular to the ethmoid and bilateral laminae papyracea with associated ethmoidal hemosinus. Patient was diagnosed with fracture of frontal and naso orbito ethmoidal complex. Patient was posted for O.R.I.F under G.A.

Surgical Procedure

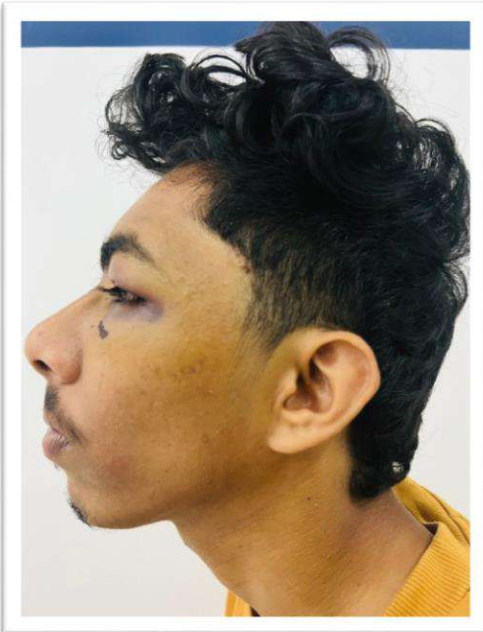
Under GA, orotracheal intubation was done. LA with adrenaline was administered to the surgical site. Tarsorrhaphy was done using 2-0 mersilk. Surgical site was exposed through Butterfly incision. Layer by layer dissection was done to expose the fracture site and reduction of fracture segments were done. Fixation was done using 1.5mm mesh (1 no) and 1.5x6mm (9 nos) screws and 1.5x8mm (1 no) screw over the glabellar region. Fixation was done over the right frontolateral region using 1.5mm 3D plate (1 no) and 1.5x6mm

screws (3 nos). Fracture of nasal septum was reduced using Asch's forceps. Copious sinus irrigation was done to flush out the debris. Hemostasis was attained. Layer by layer closure was done using 3-0 vicryl and 6-0 prolene. Ivalon nasal pack was placed. Patient extubated uneventfully. Post-operative period was uneventful hence patient was discharged after Ivalon pack removal and was kept under standard antibiotic coverage.

PRE OP PHOTOGRAPHS



SIDE PROFILE VIEW (RIGHT)



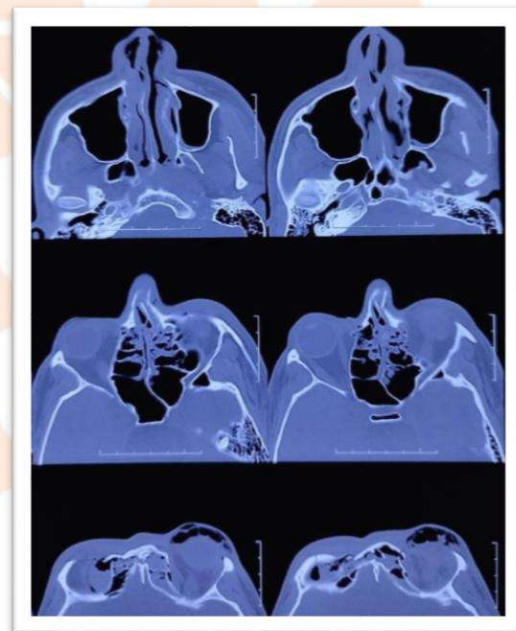
SIDE PROFILE VIEW (LEFT)



PROFILE VIEW (FRONT)



3-D CT VIEW OF FRACTURE



AXIAL SLICES REVEALING FRACTURE

INTRA OPERATIVE PHOTOGRAPHS



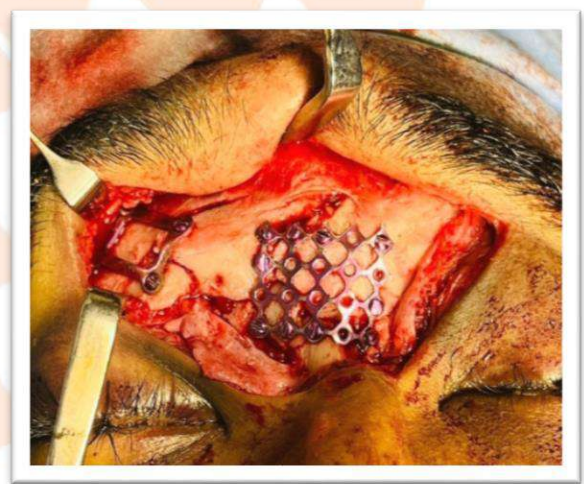
INCISION MARKING



INCISION PLACED



FRACTURE SITE EXPOSED

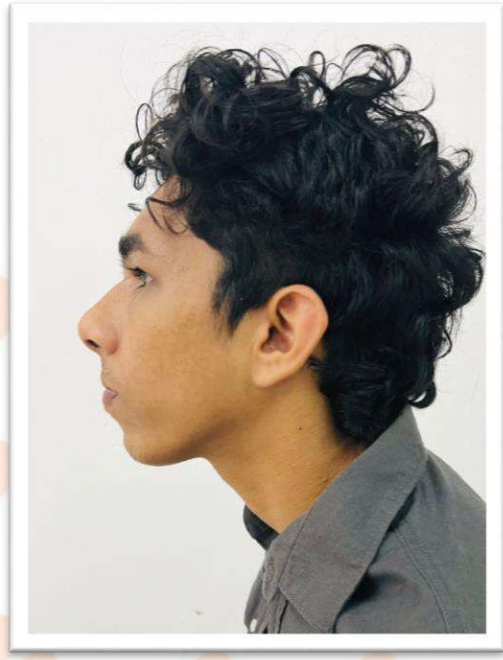


FRACTURE SITE RECONSTRUCTED

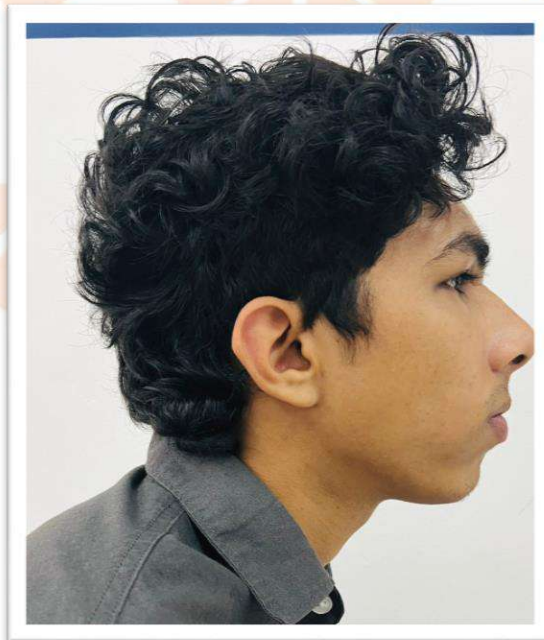
POST OPERATIVE PHOTOGRAPHS



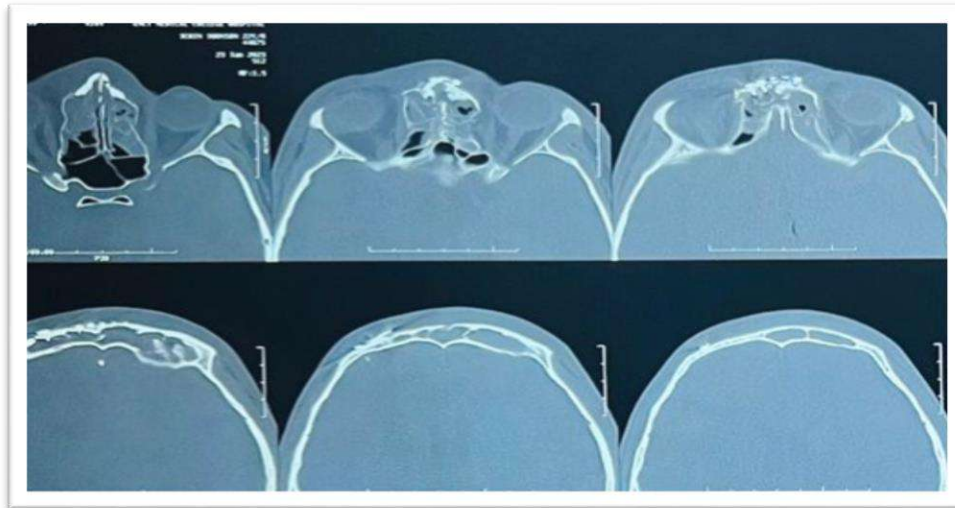
PROFILE (FRONT)



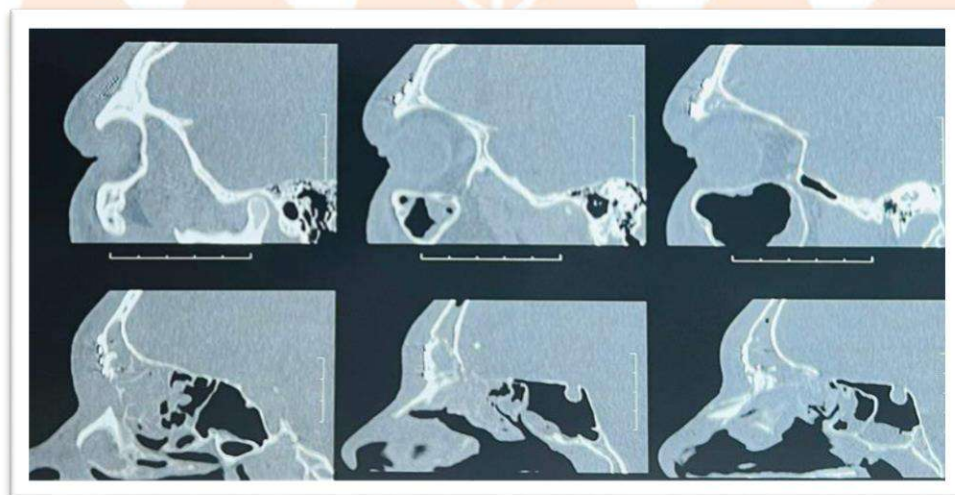
PROFILE (RIGHT)



PROFILE (LEFT)



RECONSTRUCTION (AXIAL SECTION)



RECONSTRUCTION (SAGITTAL SECTION)

DISCUSSION

The goals of frontal sinus fracture treatment include minimizing early and late complications, establishing a “safe sinus,” restoring normal frontal sinus function, and restoring frontal contour. Lately numerous articles have explained different approaches towards treating frontal sinus fractures, and research has aimed to identify the best treatment techniques. These treatment algorithms share some common features, but there are several controversial aspects of treatment, particularly related to the posterior table and frontal sinus outflow tract (FSOT)⁶.

Early diagnosis and prompt treatment are crucial in minimizing complications of NOE fractures. Inadequate treatment or lack of recognition of concomitant injuries can result in severe functional and aesthetic deformities. Late scarring significantly affects the end result of surgery with soft tissue becoming adherent to its new, abnormal position. As the anatomy in the midface region is so complex, there can be varied long-term sequelae of NOE fractures. Complications from NOE fractures include lateral displacement of medial orbital walls with resultant hypertelorism, nasal foreshortening, lack of

nasal projection, soft tissue contracture, thickening, enophthalmos, globe dystopia, saddle nose deformity, nasolacrimal duct obstruction, and eyelid malposition's including ectropion. Persistent telecanthus and nasolacrimal duct obstruction account for the most common complications seen in NOE fractures. Telecanthus is difficult to repair secondarily and can lead to poor cosmetic results and ophthalmic complications. NOE fracture repair by ORIF can result in immediate development of epiphora secondary to nasolacrimal duct obstruction. However, the problem will resolve within a period of 6 months in most of the patients. For patients with persistent nasolacrimal duct obstruction, external dacryocystorhinostomy with mitomycin-C has been proven effective.⁹

In Nigeria, most surgeons would approach the naso-orbito-ethmoid region from an existing laceration, and where this is not present or inadequate, majority employs the open sky or Lynch incision. Coronal approach has been found to be most effective despite all these approaches.¹²

In this case scenario we had approached the fracture site through a combination of gull wing and open sky incision called Butterfly

incision. Bilateral vertical incision over the lateral wall of the nose provides good exposure. Better exposure was obtained when the vertical incisions were joined by a transverse one across the root of the nose. After dissecting, exposing and preserving the lacrimal, nasolacrimal duct and identifying the fragments one by one along with the medial canthal ligament, the subperiosteal exposure of the medial walls of orbit was extended backwards behind the area of fracture. It was possible to replace the fragments under direct vision into acceptable alignment, aided by an instrument placed intranasally. Repair of lacrimal apparatus was done under direct vision. Fragments of nasal bone and frontal process of maxilla was joined to each other, as well as to frontal bone by interosseous wiring. The medial walls of orbit are maintained in their corrected position by trans osseous wiring. Post-surgical scars are inconspicuous and hardly perceptible. Thus, open sky approach permits reduction of the fracture and the realignment of the fragments under direct vision, and is preferred over a closed approach.¹³

An extended medial canthal/lateral nasal approach helped in reduction and fixation of the NOE complex fractures and to

reconfirm the medial canthal tendons to their proper position. The incision is gull-wing shaped and is placed 8–10 mm from the inner palpebral angle, extending superiorly and inferiorly for approximately 15–20 mm. The periosteum was elevated laterally, exposing the lacrimal fossa, medial orbit (lamina papyracea), and ethmoid arteries. The exposure helped to reduce medial orbit entrapments and fixate the intercanthal distance to the proper width. The incision was extended superiorly (as with a Lynch incision) to expose the region of the trochlear slip, in case that structure needs repair, or can be reattached to the superior-medial orbital wall. If incision was extended much beyond 1 centimetre, a small Z-plasty had to be incorporated so as to reduce the risk of web formation in this concave anatomic area.¹⁴

Recently, an endoscopic approach has been introduced which has the advantage of producing similar outcomes with only small incisions, reducing patient morbidity, shortening operation duration and shortening patients recovery period. Major drawback of this endoscopic approach is requirement of additional instrumentation and its learning curve. In some cases, it

may need additional skin incision such as infraorbital, subciliary, transconjunctival, and/or lateral rim incisions, which will negatively impact the facial aesthetics. A transcaruncular approach is often used to access the nasofrontal suture. However, there were limitations in preventing injury to normal orbital structures, such as violating the posterior limb of the MCT and limited visibility. Sometimes a local cutaneous approach is used but not often because of the post-operative scar, unless it is very much needed. The percutaneous MCT approach exposes the entire medial orbital wall, nose, and orbital apex percutaneously with an incision of only 1.5 cm to 2.0 cm, which is more cosmetically acceptable than a Lynch incision⁷. Despite much progress, surgical approach to NOE or Le Fort II fractures requiring extensive access, has largely remained unchanged. Coronal approach remains the gold standard for complicated NOE fractures, but it may be too invasive to treat simple NOE fractures, because of the need for large incisions. In addition to the length of the procedure it has risk of complications such as scalp paralysis, hair loss and flap hematoma. Furthermore, coronal incision may not be sufficient to achieve the desired result if the fracture is at a lower level. To

avoid these drawbacks, some authors have introduced a mid-facial degloving (MFD) approach that can expose the entire mid-facial skeleton through the sublabial incision of the maxilla and expand to upper and lateral sides according to fracture extent. Nevertheless, the MFD method is likely to result in a few complications to the nose such as deformities to its appearance, blockages, and short-term numbness in the infraorbital region⁷.

Choosing the appropriate approach is crucial when it comes to repairing bone deformities to restore the natural contour and function. An autograft typically sets the benchmark or gold standard for correcting a bone defect. The survival of autograft depends on many factors, such as graft orientation, embryonic origin, periosteum, rigid fixation, revascularization, recipient site and mechanical stress. The autograft has only been used in reconstruction of critical size bone defect and its drawback is that it increases the time of surgery and risk of complications such as the morbidity to the donor-site bone. Allograft has the limitations of immunologic rejection and disease transmission from donor to recipient. Since there are no ideal guidelines to fulfil the requirement of bone

defect treatment, bone tissue engineering has helped the surgeons in solving this dilemma. Bone tissue engineering has to undergo further researches to be considered as the gold standard for correcting bone defects. Successful clinical trials in this field has boosted the confidence of both researchers and surgeons.

Postoperative scars may lead to discoloration, skin dimpling, or disfigurement. Scar revision procedures can be performed thereafter. In this context, strategic operative planning is essential to minimize a postoperative scar in facial plastic surgery. Minimally invasive open reduction supplemented with suture suspension can be an appropriate alternative to treat NOE fractures. This technique was effective in fracture reduction and maintenance of alignment.¹⁰

Postoperative retrobulbar hemorrhage, which can threaten the visual acuity of eye is one the main complications of this surgery involving the orbits. Therefore, it is important to have the patient's eyes tested for visual acuity, pupillary light reflex, pain, and proptosis before the surgical intervention. The most common early complication is CSF leak. If the decision is made to manage a CSF leak conservatively,

a lumbar drain is placed and the patient has to undergo bed rest. The use of antibiotics is controversial in this setting. Antibiotics are usually administered prophylactically if a lumbar drain is in place and for other independent reasons. Meningitis is another early complication related to nasofrontal injuries¹.

CONCLUSION

Frontal sinus and NOE fractures present some of the most challenging constellation of injuries within craniomaxillofacial trauma. A multidisciplinary approach is essential to address the intracranial and orbital injuries that are often seen in association with these fractures. Advances in sophisticated imaging and evolution in minimally invasive surgical techniques have set in motion more conservative options that may provide better patient outcomes while minimizing the risks and morbidity associated with more traditional approaches.

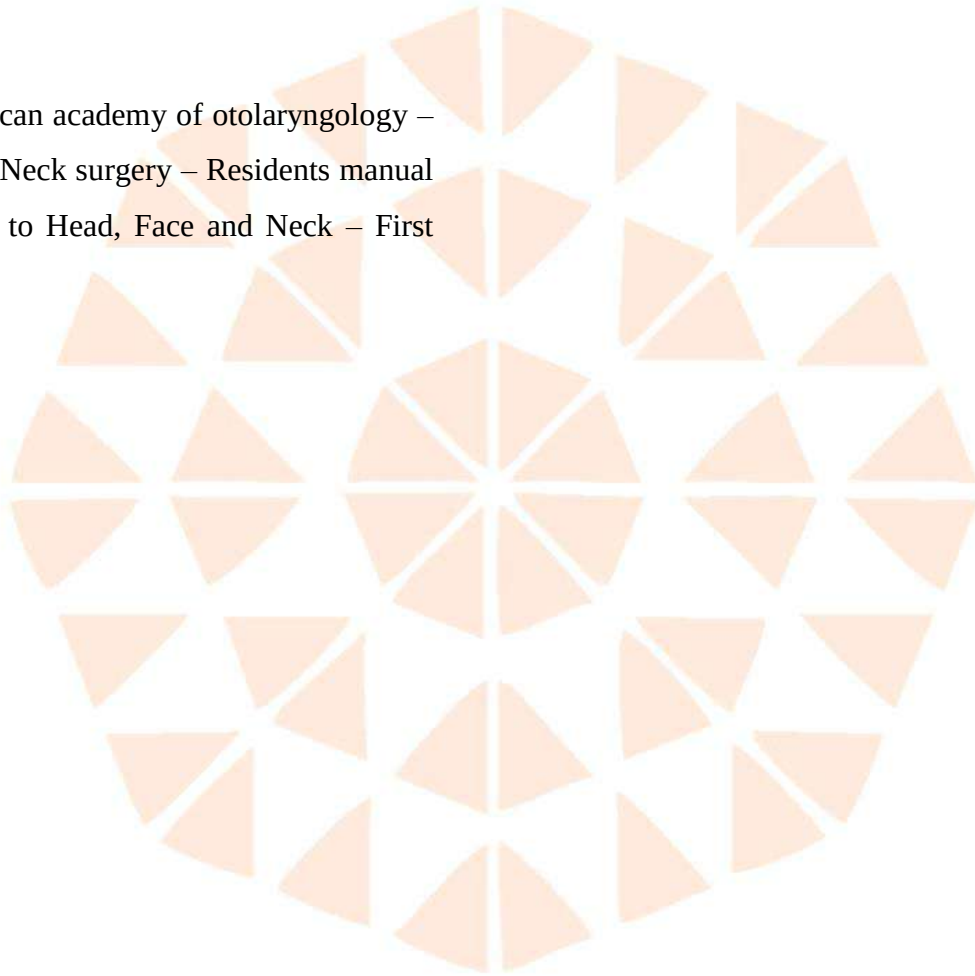
References:

1. Nguyen M, Koshy JC, Hollier LH. Pearls of nasoorbitoethmoid trauma management. *Semin Plast Surg.* 2010 Nov;24(4):383-8. [PubMed]
2. Murphy RX, Birmingham KL, Okunski WJ, Wasser T. The influence of airbag and restraining devices on the patterns of facial trauma in motor vehicle collisions. *Plast Reconstr Surg.* 2000 Feb;105(2):516-20. [PubMed]
3. Markowitz BL, Manson PN, Sargent L, Vander Kolk CA, Yaremchuk M, Glassman D, Crawley WA. Management of the medial canthal tendon in nasoethmoid orbital fractures: the importance of the central fragment in classification and treatment. *Plast Reconstr Surg.* 1991 May;87(5):843-53. [PubMed]
4. Sargent LA. Nasoethmoid orbital fractures: diagnosis and treatment. *Plast Reconstr Surg.* 2007;120(7 Suppl 2):16S-31S. [PubMed]
5. Pawar SS, Rhee JS. Frontal sinus and naso-orbital-ethmoid fractures. *JAMA Facial Plast Surg.* 2014 Jul-Aug;16(4):284-9.
6. Pawar SS, Rhee JS. Frontal sinus and naso-orbital-ethmoid fractures. *JAMA Facial Plast Surg.* 2014 Jul-Aug;16(4):284-9.
7. Ha YI, Kim SH, Park ES, Kim YB. Approach for naso-orbito-ethmoidal fracture. *Arch Craniofac Surg.* 2019 Aug;20(4):219-222.
8. Wei JJ, Tang ZL, Liu L, Liao XJ, Yu YB, Jing W. The management of naso-orbital-ethmoid (NOE) fractures. *Chin J Traumatol.* 2015;18(5):296-301.
9. Baril SE, Yoon MK. Naso-orbito-ethmoidal (NOE) fractures: a review. *Int Ophthalmol Clin.* 2013;53(4):149-55.
10. Na Y, Seo C, Kwon Y, Kim J, Choi H, Shin D, Lee M. Treatment of a naso-orbito-ethmoid fracture using open reduction and suspension sutures: a case report. *Arch Craniofac Surg.* 2022 Dec;23(6):269-273.
11. Morrison AD, Gregoire CE. Management of fractures of the nasofrontal complex. *Oral Maxillofac Surg Clin North Am.* 2013 Nov;25(4):637-48.
12. Akadiri OA. Naso-orbito-ethmoid fractures: perspective and practices of

nigerian surgeons. Ann Ib Postgrad Med.
2012 Dec;10(2):40-7.

13. Converse, John Marquis; Hogan, V Michael (1970). Open-sky approach for reduction of naso-orbital fractures. Plastic and Reconstructive Surgery, 46(4), 396–398.

14. American academy of otolaryngology – Head and Neck surgery – Residents manual of trauma to Head, Face and Neck – First edition.



Review

THE ROLE OF GROWTH FACTORS FOR REGENERATION AROUND TEETH AND DENTAL IMPLANTS

*Dr. Risvana S, *Dr. Dona Susan Varghese, *Dr. Sneha Shajan, **Dr. Aparna T.K,

Dr. Navia George,*Dr. Santhosh V.C, *****Dr. HarishKumar V.V

Abstract

Dental diseases are wide spread in nature and the complexity of damage it causes is a major concern. Many new scientific developments try to limit the damage or restore the health of the individual. Regenerative technology now represents a therapeutic reality applicable to various organic substrates, with the aim of repairing deficient tissues and restoring normal organ function. Of many tissue engineering and regenerative science, growth factor plays a important role in regeneration. Its ability in clinical science puts a promising front and provides cutting edge technology to treat periodontal destruction or any oral problems. An extension of conventional technology is the need of the hour and this provides a great insight in making life better.

Key words; Growth Factors, Regeneration, Teeth, Dental Implants

Corresponding Author: Dr.Risvana S (svannet2@gmail.com)

Post graduate student, **Senior Lecturer, *Reader, ****Professor, *****Professor and Head, Department of Periodontology, KMCT Dental College, Kerala.*

Introduction:

Oral cavity is one of the major complex structures of human body which augments the proper function, esthetics and phonetics of any individual. Any deviation can disturb the quality of life and subject the individual to suffer to different scales. Oral diseases are not new to human race but the impact it does, has called for new solutions with time. Oral structures include teeth, supporting oral tissues like – gingiva, alveolar bone, cementum, periodontal ligaments, pulpal tissues, connective tissues, neural tissues etc. Some of the oral diseases like dental caries, periodontal diseases, orthodontic corrections and benign and malignant conditions have caused serious damaged to healthy tissues and for proper repair or regeneration, many factors play a very important role in restoring health. One such important factor is the *Growth Factor*. The recent advances in tissue engineering have opened the Pandora box and have given many openings or scope to explore new challenges.¹

In any periodontal problem, the primary aim of conventional clinical treatment is to eliminate the infectious

source and reduce inflammation thereby arresting disease progression and the problem with this is, it cannot regenerate the lost periodontal tissues.^{2,3} In order to address these issues, for the last two decades many research has been conducted and many regenerative periodontal therapies have been put forward. These include Guided Tissue Regeneration (GTR), Enamel Matrix Derivative, Bone Grafts, Growth Factor Delivery and combinations of Matrix Based Scaffolds and combinations of cell and growth factors have been developed to treat restoration of lost tooth supporting structures/tissues. These structures include periodontal ligaments, alveolar bone and cementum.⁴⁻⁷ In the recent years many advances in material science i.e. bio-materials has been achieved along with controlled drug delivery for regeneration of periodontal structures but the reality of clinical success is always questionable due to the fact that many of the clinical studies are conducted either in controlled environment or it lacks long term follow up studies. It's also difficult to estimate general outcomes and how useful the procedures are due to the inherent scarcity or small number in cases and practicality.⁸ This has not

pushed back the continuous efforts of researchers and with fair share of success, a new journey of wealth of opportunities, looking for better treatment techniques which are close to the natural are tried out.

What makes the pathogenesis so serious?

Remodelling of alveolar bone is a continuous process and involves fine-tuned balance of bone resorption and bone formation. It is maintained by multiple cells and signaling mechanisms (Nanci and Bosshardt 2006).⁹ In people with weak immunity, any diseases process can lead to destruction of periodontium, resulting in loss of connective tissue and bone, as well as apical migration of the junctional epithelium.¹⁰ Restitution ad integrum cannot normally be expected, leading to residual alveolar bone defects and in advances case, it may lead up to loss of tooth support and eventual loss of tooth itself which calls for augmentation of alveolar bone regeneration and other supporting structure/tissues revival. This in turn helps to overcome common infections like periodontitis or peri-implantitis.¹¹

Tissue engineering and Regenerative science:

This represents the field of the functional restoration of the tissue structure and the physiology for impaired or damaged tissue due to disease, trauma and cancer. It provides wide range of hopes or solutions to challenging clinical problems in dentistry which are not addressed with conventional treatments.¹ Mainly it has 3 elements,

- Stem cells/Progenitor cells
- Scaffolds or extracellular matrix
- Morphogenesis (Signalling Molecules) /Growth Factors.

Stem cells/Progenitor cells: They are cells which have the ability to continuously divide and produce progeny cells that differentiate (develop) into various other types of cells or tissue.¹² The following are different types of stem cells

Totipotent stem cells: Each cell is capable of developing into an entire organ.

Pluripotent stem cell: Cells from embryo (embryonic stem cells) that when grown in the right environment in vivo are capable of forming all types of tissues.

Multipotent stem cells: Postnatal stem cells or commonly called adult stem cells that are capable of giving rise to multiple lineages of cells. Dental stem cells belong to this category.

Scaffolds or extracellular matrix: The stem cells have to be organized in three dimensional structures that can support cell organization and vascularization. This can be accomplished using scaffold seeded with stem cells. It should contain growth factors to aid stem cell proliferation and differentiation leading to improved and faster tissue development. Also it exerts essential mechanical and biological functions need for the recovery. Example: Polylactic acid, Polyglycolic acid, Tricalcium phosphate, synthetic hydroxyapatite, collagen and Chitosan.^{13, 14}

Morphogens (Signalling Molecules/ Growth Factors: They denote a class of naturally occurring proteins that function in the body to promote the mitogenesis (Proliferation), directed migration and metabolic activity of cells. They belonged to large family of polypeptide molecules which modulate cell response like cell attachment or adhesion, cell survival, proliferation, chemotaxis and differentiation.¹⁵ They are typical signal molecules used for communication between the cells of an organism; for example, cytokines or hormones that bind to specific receptors on cell membrane of their targets. The main function of growth factors is the external control of the cell cycle, through the abandonment of cellular quiescence (Phase G0) and entry of the cell into phase G1 (growth). However, this is not their only function; in fact, they regulate the entry into mitosis, cell survival, cell migration and differentiation. Together with proliferation, they always simultaneously promote differentiation and maturation.^{16, 17}

Growth factors are classified under

a) *Arachidonic acid metabolites*

(Prostaglandin E₂)

b) *Extracellular Matrix Growth Factor*
(Fibronectin, Citric acid, Enamel matrix protein and Adhesion factors like Osteopontin)

c) *Polypeptide growth factors* (Mitogenic polypeptides, Insulin like growth factor, Fibroblast growth factor, Epidermal growth factor, transforming growth factor i.e. TGF- α and TGF- β , Platelet derived growth factor i.e. PDGF-AA, AB and BB, cementum derived growth factor, Bone morphogenic proteins i.e. BMP)^{18, 19}

	secreted in a soluble form outside the cell then binds to surface receptors on the same cell to evoke an effect	
Juxtacrine	The factor produced by the cell of origin is cell surface bound and requires cell contact by target cell to evoke a response	Stem cell factor
Intracrine	A factor is produced by one cell and not secreted but acts intracellularly to facilitate its effect	PTHrP

Mode of action of growth factors:

Mode	Action	Example
Paracrine	It involves the production of a factor by one cell, with receptors present on another cell in local micro environment	TGF- β PDGF
Autocrine	Those factors that are synthesized by one cell,	BMP TGF- α

Regeneration can be defined as complete restoration of tissues lost after trauma or following development of disease such as destructive periodontal diseases including that of periodontal ligament, gingival connective tissue, cementum and alveolar bone. Different regenerative approaches have been used in oral cavity with the goal of reconstructing hard and soft tissues. Primarily they are aimed to correct

anatomical, developmental or traumatic deformities in the morphology, position and/or amount of gingiva surrounding the teeth. (American Academy of Periodontology 1996)

Bone, periodontal ligament and cementum are highly differentiated tissues and different growth factors are involved in the signalling events that regulate their neo-formation during wound healing. Considering that the periodontium is composed of distinct tissues namely alveolar bone, periodontal ligament, cementum and gingiva, it is difficult to identify the appropriate combination and doses of growth factors necessary to achieve proper periodontal regeneration.²⁰

Of the many growth factors mentioned in the literature, important one are described below:

1. *Transforming Growth Factor –Beta (TGF- β)*: These are produced by platelets, epithelial cells, macrophages and myofibroblasts and stimulate cell adhesion through integrins.^{21, 22, 23} These growth factors stimulate cell proliferation in periodontal ligament cells. It also modulates stimulation of cell chemotaxis in gingiva

and periodontal ligament fibroblasts.²⁴ It has potent effect on myofibroblastic differentiation and production of extra cellular matrix molecules and has contradictory results for TGF- β on osteoblastic differentiation. In animal in-vivo studies, it has shown to stimulate periodontal regeneration but in humans, no studies were found in the area of periodontal regeneration.²⁵⁻²⁷

2. *Platelet Derived Growth Factor (PDGF)*:

These growth factors are produced by platelets, epithelium, macrophages, endothelial cells and vascular smooth muscle cells. It stimulates cell adhesion through integrins, but evidence shows increased adhesions are scant. They help in proliferation of periodontal ligament cells and have potent stimulation of cell chemotaxis in gingival and periodontal fibroblasts. They have signaling receptors involved in myofibroblastic differentiation and in-vitro they potentiate mesenchymal cell proliferation and osteoblastic differentiation. In immortalized cementoblasts, PDGF stimulates bio-mineralization. In-vivo studies among animals show improved regeneration around dental implants and periodontal

regeneration, while in humans, clinical studies have been performed to evaluate periodontal regeneration in furcation defects, bone augmentation and gingival recession but justifications are still not concrete.²⁸⁻³³

3. Bone Morphogenetic Protein (BMP): It is produced in bone marrow, skeletal muscle, spleen, brain, liver and lung. No studies were found in regards to cell adhesion. It stimulates cell proliferation in endothelial cells, mesenchymal stem cells, muscle cells and osteoblasts. It has potent chemotaxis stimulation on osteoblasts and endothelial cells. It has discrepant effects for BMPs on myofibroblastic differentiation. In general, BMPs stimulate both osteoblastic and cementoblastic differentiation. In-vivo evidence of tissue regeneration in animal studies shows a positive effect for BMPs in periodontal regeneration and also has similar effect on humans in clinical trials for bone regeneration.³⁴⁻³⁹

Mode of action of BMPs:

- Activation and migration of undifferentiated mesenchymal cells by chemotaxis.
- Anchorage dependent cell attachment to the matrix via Fibronectin
- Mitosis and proliferation of responding mesenchymal cells
- Differentiation of chondroblasts and deposition of cartilage
- Mineralization of cartilage
- Angiogenesis, vascular invasion and chondrolysis
- Differentiation of osteoblasts and bone matrix deposition
- Mineralization of the newly induced bone
- Differentiation of hemopoietic marrow in the newly formed ossicles.

4. *Platelet Rich Plasma/Platelet Poor Plasma (PRP/PPP)*: These are produced by platelets and have potent stimulation of cell adhesion in fibroblasts. It stimulates cell proliferation in fibroblasts and stem cells. It also stimulates cell migration in fibroblasts. Both PRP and PPP stimulate myofibroblastic differentiation and extracellular matrix production. In-vitro evidence of osteoblastic differentiation is seen and In-vivo evidence of tissue regeneration in animal studies shows enhanced soft tissue healing. However, contradictory results do not show a definite effect on mineralized tissue formation. Multiple clinical trials have been performed to assess tissue regeneration. However, evidences of periodontal regeneration are still contradictory.⁴⁰⁻⁴²

5. *Concentrated Growth Factor (CGF)*: Recent research on growth factors recognized that the best tissue regenerative

stimulus is present amongst the autologous growth factors, which have clinically proven to induce regeneration and tissue healing. Concentrated Growth Factor was first developed by Sacco (2006) and is a relatively new technology within the area of regenerative medicine. It is an advanced second generation platelet concentrate which is obtained with differential continuous centrifugal technology containing many kinds of growth factor and fibrins and these are able to facilitate the recovery of soft and hard tissues. CGF is different from PRP and PPP in the methods for production because no additives are added during the production. It has higher adhesive strength tensile strength, higher viscosity than other platelet preparations. It has larger and denser fibrin rich organic matrix which are rich in growth factors, fibrinogen, coagulation factors platelets, leukocytes, VEGF (vascular endothelial

growth factor) and CD34+ stem cells which help in regeneration and has immunological cells that are effective in regulating inflammation and minimize the risk of infection. It is a biological inducing material which improves the quality of the formed bone and facilitates the formation of bones and healing of tissues. This action is because of stimulatory effect on epithelialization and angiogenesis. It is mixed with autologous bone particles or biomaterials to fill the bone defects to induce bone regeneration. The very advantage is no need of biochemical modification, easy method of preparation, application with minimal expense. It also serves as resorbable interpositional membrane. It also avoids the early invigilation of the gingival epithelium is inhibited by the CGF layer results as a barrier to epithelium migration.⁴³⁻⁴⁷

In short it induces vascularization, promotes endothelial cell proliferation,

stimulates epidermal growth, keratinization, promotes angiogenesis resulting in gingival modification, enhances osteogenic differentiation and prolongs growth factor activity which are conducive for growth factor synergy.

Clinical applications of tissue engineering:

The clinical applications are very vital and can be utilized in dentistry for in situ partial pulp generation, de novo pulp replacement, regeneration or replacement of mineralized tissues such as enamel, dentin cementum, bone and regeneration of periodontium. The pulp tissue repair/regeneration recapitulates tooth development and points to the brighter possibilities in the future.⁴⁸

Nanoscale and microscale for dental tissue engineering and regeneration:

Nanoscale and microscale are present alternatives to conventional tissue engineering approaches in terms of scaffolds and the ability to direct stem cells. Even though many advances have taken place, many challenges still remain in this context. In this regard microscale approaches that

spatially pattern and support the development of different cell types in close proximity can be used to regulate the cellular microenvironment and as such are promising approaches for tooth development.⁴⁹

Regenerative dentistry: Barriers and Future directions

Cell transplantation is a meritorious approach for tissue generation. However there are difficulties in the translation of cell delivery based tissue generation into therapeutics. The most common problem is the inaccessibility of autologous embryonic germ cells for human applications. Xenogenic embryonic germ cells may have immune rejections and dysmorphogenesis. The cost of commercialization process and difficulties in regulatory approval in association with ex vivo cell manipulation are a major concern which needs immediate care.

Even though tooth transplantation and dental implants are commonly practiced, they have never been totally satisfactory. And seeing the recent scientific developments has opened a sea of opportunities in this area of regeneration. We may appreciate stem cell banks in future which are easily accessible. Also the assembly of bio-proteins by the nanorobots is not very far. Where, these entities are imply injected to the desired location. The possibilities are infinite and coveting. These ground breaking strategies may provide an innovative and novel biology based new generation of clinical treatments for dental diseases.⁵⁰

Conclusion:

In general, several laboratory and clinical studies have provided good evidence that use of growth factors can aid in tissue generation. It is not just useful in hard tissue generation but also makes an impressive impact on soft tissue regeneration. Long term prospective assessments among humans are needed to ensure the strength of impact and practicality. This is no doubt an area which should invite more researchers to explore the truth.

References:

1. Nakashima M, Akamine A. The application of tissue engineering to regeneration of pulp and dentin in endodontics. J Endod 2005;31:711-8.
2. Yildirim S, Fu SY, Kim K, Zhou H, Lee CH, Li A, et al. Tooth regeneration: A revolution in stomatology and evolution in regenerative medicine. Int J Oral Sci 2011;3:107-16.
3. Huang GT. Pulp and dentin tissue engineering and regeneration: Current progress. Regen Med 2009;4:697-707.
4. Sun HH, Jin T, Yu Q, Chen FM. Biological approaches toward dental pulp regeneration by tissue engineering. J Tissue Eng Regen Med 2011;5:1-16.
5. Cordeiro MM, Dong Z, Kaneko T, Zhang Z, Miyazawa M, Shi S, et al. Dental pulp tissue engineering with stem cells from exfoliated deciduous teeth. J Endod 2008;34:962-9.
6. Morgunkova AA. The p53 gene family: Control of cell proliferation and developmental programs. Biochemistry (Mosc) 2005;70:955-71.
7. Khademhosseini A, Langer R, Borenstein J, Vacanti JP. Microscale technologies for tissue engineering and biology. Proc Natl Acad Sci U S A 2006;103:2480-7.

8. Bartold PM, Gronthos S, Ivanovski S, Fisher A, Hutmacher DW. 2016. Tissue engineered periodontal products. J Periodontal Res. 51(1):1–15.
9. Nanci A, Bosshardt DD. 2006. Structure of periodontal tissues in health and disease. Periodontol 2000. 40:11–28.
10. Seymour G, Berglundh T, Trombelli L. 2015. Pathogenesis of periodontitis. In: Lindhe J, Lang NP, editors. Clinical periodontology and implant dentistry. London (UK): Wiley-Blackwell.
11. Du J, Shan Z, Ma P, Wang S, Fan Z. 2014. Allogeneic bone marrow mesenchymal stem cell transplantation for periodontal regeneration. J Dent Res. 93(2):183–188.
12. Rao MS. Stem sense: A proposal for the classification of stem cells. Stem Cells Dev 2004;13:452-5.
13. Chen FM, Shelton RM, Jin Y, Chapple IL. Localized delivery of growth factors for periodontal tissue regeneration: Role, strategies, and perspectives. Med Res Rev 2009;29:472-513.
14. Chen FM, Jin Y. Periodontal tissue engineering and regeneration: Current approaches and expanding opportunities. Tissue Eng Part B Rev 2010;16:219-55.
15. Chen FM, Jin Y. Periodontal tissue engineering and regeneration: Current approaches and expanding opportunities. Tissue Eng Part B Rev 2010;16:219-55.
16. Rutherford RB, Wahle J, Tucker M, Rueger D, Charette M. Induction of reparative dentine formation in monkeys by recombinant human osteogenic protein-1. Arch Oral Biol 1993;38:571-6.
17. Jin QM, Anusaksathien O, Webb SA, Rutherford RB, Gian nobile WV. Gene therapy of bone morphogenetic protein for periodontal tissue engineering. J Periodontol 2003; 74: 202–213.
18. Ramesh V. Text on Regenerative Science. In Chapter 1, Basics of

- Regenerative Science, (2015) Rajoot Publications, Bangalore, India. page number 3-9.
19. Gailit J, Xu J, Bueller H, Clark RA. Platelet-derived growth factor and inflammatory cytokines have differential effects on the expression of integrins alpha 1 beta 1 and alpha 5 beta 1 by human dermal fibroblasts in vitro. *J Cell Physiol* 1996; 169: 281–289
 20. Hayashi H, Sakai T. Biological significance of local TGF- β activation in liver diseases. *Front Physiol* 2012; 3: 12.
 21. Hinz B, Phan SH, Thannickal VJ, Galli A, Bochaton-Piallat ML, Gabbiani G. The myofibroblast: one function, multiple origins. *Am J Pathol* 2007; 170: 1807–1816.
 22. Steinsvoll S, Halstensen TS, Schenck K. Extensive expression of TGF- β 1 in chronically-inflamed periodontal tissue. *J Clin Periodontol* 1999; 26: 366–373.
 23. Sant’Ana AC, Marques MM, Barroso TE, Passanezi E, De Rezende ML. Effects of TGF- β 1, PDGF-BB, and IGF-1 on the rate of proliferation and adhesion of a periodontal ligament cell lineage in vitro. *J Periodontol* 2007; 78: 2007–2017.
 24. Teare JA, Ramoshebi LN, Ripamonti U. Periodontal tissue regeneration by recombinant human transforming growth factor- β 3 in *Papio ursinus*. *J Periodontal Res* 2008; 43: 1–8.
 25. Tomasek JJ, Gabbiani G, Hinz B, Chaponnier C, Brown RA. Myofibroblasts and mechano-regulation of connective tissue remodelling. *Nat Rev Mol Cell Biol* 2002; 3: 349–363.
 26. de Gorter DJ, van Dinther M, Korchynskyi O, ten Dijke P. Biphasic effects of transforming growth factor β on bone morphogenetic protein-induced osteoblast differentiation. *J Bone Miner Res* 2011; 26: 1178–1187.
 27. Smith PC, Caceres M, Martinez J. Induction of the myofibroblastic

- phenotype in human gingival fibroblasts by transforming growth factor-beta1: role of RhoA-ROCK and c-Jun N-terminal kinase signaling pathways. *J Periodontal Res* 2006; 41: 418–425.
28. DiCorleto PE, Bowen-Pope DF. Cultured endothelial cells produce a platelet-derived growth factor-like protein. *Proc Natl Acad Sci USA* 1983; 80: 1919–1923.
 29. Green RJ, Usui ML, Hart CE, Ammons WF, Narayanan AS. Immunolocalization of platelet-derived growth factor A and B chains and PDGF-alpha and beta receptors in human gingival wounds. *J Periodontal Res* 1997; 32: 209–214.
 30. Nilsson J, Sjolund M, Palmberg L, Thyberg J, Heldin CH. Arterial smooth muscle cells in primary culture produce a platelet-derived growth factor-like protein. *Proc Natl Acad Sci USA* 1985; 82: 4418–4422.
 31. Pierce GF, Mustoe TA, Altrrock BW, Deuel TF, Thomason A. Role of platelet-derived growth factor in wound healing. *J Cell Biochem* 1991; 45: 319–326.
 32. Nishimura F, Terranova VP. Comparative study of the chemotactic responses of periodontal ligament cells and gingival fibroblasts to polypeptide growth factors. *J Dent Res* 1996; 75: 986–992.
 33. Camelo M, Nevins ML, Schenk RK, Lynch SE, Nevins M. Periodontal regeneration in human Class II furcations using purified recombinant human platelet-derived growth factor-BB (rhPDGF-BB) with bone allograft. *Int J Periodontics Restorative Dent* 2003; 23: 213–225.
 34. Bragdon B, Moseychuk O, Saldanha S, King D, Julian J, Nohe A. Bone morphogenetic proteins: a critical review. *Cell Signal* 2011; 23: 609–620.
 35. Helder MN, Karg H, Bervoets TJ, Vukicevic S, Burger EH, D’Souza RN, Woltgens JH, Karsenty G,

- Bronckers AL. Bone morphogenetic protein-7 (osteogenic protein-1, OP-1) and tooth development. *J Dent Res* 1998; 77: 545–554.
36. Scharpfenecker M, van Dinther M, Liu Z, van Bezooijen RL, Zhao Q, Pukac L, Lowik CW, ten Dijke P. BMP-9 signals via ALK1 and inhibits bFGF-induced endothelial cell proliferation and VEGF-stimulated angiogenesis. *J Cell Sci* 2007; 120: 964–972.
37. Li G, Cui Y, McIlmurray L, Allen WE, Wang H. rhBMP-2, rhVEGF(165), rhPTN and thrombin-related peptide, TP508 induce chemotaxis of human osteoblasts and microvascular endothelial cells. *J Orthop Res* 2005; 23: 680–685.
38. Taba M Jr, Jin Q, Sugai JV, Giannobile WV. Current concepts in periodontal bioengineering. *Orthod Craniofac Res* 2005; 8: 292–302.
39. Wikesjö UM, Sorensen RG, Kinoshita A, Jian Li, X, Wozney JM. Periodontal repair in dogs: effect of recombinant human bone morphogenetic protein-12 (rhBMP-12) on regeneration of alveolar bone and periodontal attachment. *J Clin Periodontol* 2004; 31: 662–770.
40. Caceres M, Hidalgo R, Sanz A, Martinez J, Riera P, Smith PC. Effect of platelet-rich plasma on cell adhesion, cell migration, and myofibroblastic differentiation in human gingival fibroblasts. *J Periodontol* 2008; 79: 714–720.
41. Caceres M, Martinez C, Martinez J, Smith PC. Effects of platelet-rich and -poor plasma on the reparative response of gingival fibroblasts. *Clin Oral Implants Res* 2012; 23: 1104–1111.
42. Jaishree Tukaram Kshirsagar, Rubine S. Innovation in regeneration— Concentrated growth factor. *International Journal of Applied Dental Sciences*. 2017;3(2): 206–208.
43. Shuqi He, Mengjie Zhang, Zhaoqiang Zhang, et al. Application of CGF in Dental Clinic. *HPBS*. 2015;1(4):54–56.

44. Bozkurt Dogan S, Ongoş Dede F, Ballı U, et al. Concentrated growth factor in the treatment of adjacent multiple gingival recessions: a split-mouth randomized clinical trial. *J Clin Periodontol*. 2015;42(9):868–875.
45. Ramakrishnan T, Shobana P, Vidya Sekhar. Concentrated growth factor membrane - A novel barrier for accelerated repair of gingival defect along with sliding flap technique. *Int J Cur Res Rev*. 2016;8(21).
46. Gökmenoğlu C, Yavuz MC, Sadik E, et al. Treatment of Different Types of Bone Defects with Concentrated Growth Factor: Four Case Reports. *Int J Oral Dent Health*. 2016;2(2).
47. Demarco FF, Conde MC, Cavalcanti BN, Casagrande L, Sakai VT, Nör JE. Dental pulp tissue engineering. *Braz Dent J* 2011;22:3-13.
48. Khademhosseini A, Langer R, Borenstein J, Vacanti JP. Microscale technologies for tissue engineering and biology. *Proc Natl Acad Sci U S A* 2006;103:2480-7.
49. Morgunkova AA. The p53 gene family: Control of cell proliferation and developmental programs. *Biochemistry (Mosc)* 2005;70:955-71.
50. Rutherford RB. BMP-7 gene transfer to inflamed ferret dental pulps. *Eur J Oral Sci* 2001;109:422-4.

Case Report

ROOT COVERAGE BY CONNECTIVE TISSUE GRAFT: A CASE REPORT

*Dr. Sneha Shajan, *Dr. Risvana S., *Dr. Dona Susan Varghese, ** Dr. Subisha S.B

Dr.Anish Varkey, *Dr.Santhosh V.C, *****Dr. Harish Kumar V.V

Abstract

Gingival recession is the exposure of root surfaces due to apical migration of the gingival margins. The increase in esthetic concerns and the subsequent need to solve related problems such as hypersensitivity and root caries have favoured the development of many surgical procedures that permit the coverage of exposed roots. This article describes the use of the subepithelial connective tissue graft as a donor source for root coverage. The success of these grafts has been attributed to the double-blood supply at the recipient site from the underlying periosteum and the overlying recipient flap. Case report is illustrated to demonstrate this procedure for coverage of a single gingival recession.

Key words; Sub epithelial connective tissue graft, Root coverage, Gingival recession, Periodontal Plastic Surgery

Corresponding Author: Dr.Sneha Shajan (snehashajan264@gmail.com)

Post graduate student, ** Senior Lecturer, *Reader, ****Professor,
*****Professor and Head, Department of Periodontology, KMCT Dental College, Kerala.*

Introduction

Gingival recession is defined as the displacement of the soft tissue margin apical to the cemento-enamel junction (CEJ)¹. It is one of the most common esthetic concerns associated with the periodontal tissues. The primary causes of gingival recessions are periodontal disease, faulty toothbrushing, abnormal frenum attachment, improper restorations, calculus accumulations and tooth malpositioning. Gingival recessions may result in hypersensitivity, impaired esthetics, root caries and also these sites retain plaque and calculus. Therefore, coverage of exposed root surface is one of the primary goals of periodontal therapy. Root coverage procedures belong to integral component of Periodontal Plastic Surgery. In 1985, Langer and Langer described the root coverage technique in which the overlying partial thickness flap with two vertical incisions covers the transplanted connective tissue graft². In 1987 Nelson proposed using a full-thickness flap design to cover the subepithelial connective tissue graft³. Raetzke reported the 'Envelope' technique, where the subepithelial connective tissue graft was seated in an envelope created around the denuded root surface by using the split-thickness

incision⁴. Clinical trials were continued by Allen in 1994, in which a suprapariosteal envelope technique on multiple adjacent recessions was performed⁵. In 1999, Zabalegui et al. used a suprapariosteal envelope technique by performing a tunnel approach⁶. Numerous authors have provided various modifications and result of these studies states that the sub epithelial connective tissue graft is a predictable procedure for esthetic root coverage.

Case Report

A 30year old male patient came to Department of periodontology with a chief complaint of receding gums. On intra oral examination Miller's class I recession was observed in the anterior tooth region 13 (Fig.1). Vigorous tooth brushing was evident. Abrasion was present in the cervical region of the tooth.

Procedure

Recipient Site:

A full thickness flap is elevated in the region 12,13 and 14 (Fig.2). Care must be taken to extend the flap to the mucobuccal fold without perforations which could seriously affect the blood supply.

Donor Site:

A second surgical site is created on the palate. Connective tissue graft is harvested using 'trap door approach' (Fig.3). The length of this is determined by the combined width of the teeth to be covered. A horizontal incision is made 3 mm from the gingival margins of the maxillary teeth to the desired width. Vertical incisions are made on either side of the horizontal incision which will further facilitate the removal of the connective tissue graft and aid in wound closure. It is advisable to suture the palatal flap back into position immediately after taking the donor tissue in order to reduce the size of the blood clot which might cause tissue necrosis (Fig.5).

Connective tissue graft is placed over the denuded root and sutured in place. The connective tissue graft is sutured to the recipient site using 4-0 silk. The recipient flap is positioned coronally in a manner to cover as much of the graft as possible and sutured in position (Fig.6). A relieving incision is given in the vestibular area in order to avoid extensive pull or tension on the surgical site. Periodontal pack is given on the recipient site and postoperative

instructions were given to the patient (Fig.7).

The patient is recalled on the 10th postoperative day to remove the periodontal dressing and sutures (Fig.8,9). No additional dressing was necessary, and plaque control techniques were resumed.



Figure 1 - Before the procedure. Miller's class I recession can be seen on 13.



Figure 2 - Periodontal flap elevated irt 12,13,14



Figure 3 -Connective tissue graft harvested by trap door approach on the palate in the tooth region 23,24



Figure 6 -Sutures placed after placing the graft in recipient site.



Figure 4 -Connective tissue graft harvested from palate



Figure 7 -After placement of periodontal pack.



Figure 5 -Sutures placed immediately after extracting the connective tissue graft in order to avoid bleeding and tissue necrosis.



Figure 8 -Post operative healing after 10 days



Figure 9 -Post operative healing after 10 days in the donor site.



Figure 10 -Post operative healing after 3weeks

Discussion

With the connective tissue graft, the blood supply from the periosteum and the overlying flap may result in a more rapid reestablishment of circulation within the graft and contribute to more predictable and successful root coverage. Capillary proliferation and extension into the connective tissue graft's vasculature may be enhanced due to more intact capillary systems within the graft itself. These capillaries may anastomose with the recipient bed's vasculature. Connective tissue grafts resulted in a better colour match with the adjacent gingiva⁷. The tattoo or keloid-like appearance is less common in this procedure. Healing of the donor site by primary intention, which involves less postoperative pain in the donor site. The connective tissue graft technique provide the best root coverage in areas of thin gingiva and alveolar bone.

The success of root coverage after performing the procedure is dependent on many factors. The outcome is reduced if patient has poor oral hygiene habits, vigorous tooth brushing and smoking habit. Also depending up on type of defects, full coverage of denuded roots is seen in Miller's

class I and class II recessions. Complete root coverage cannot be expected in class III and class IV recessions.

Prognosis for root coverage related to defect morphology ⁸
Class I and II Initial recession depth <5 mm Favourable prognosis: complete root coverage can be achieved. Initial recession depth >5 mm Uncertain prognosis: limited number of teeth will show complete root coverage.
Class III Poor prognosis: no tooth will present complete root coverage.
Class IV No root coverage can be anticipated.

Table 1: Prognosis for root coverage

Conclusion

As demand for esthetics in dentistry has increased connective tissue grafts have become an integral component of periodontal therapy. Periodontal plastic surgery continues to be a challenging and exiting area of speciality of periodontology. Periodontal plastic surgery help us get closer

to achieving goal of restoring our patient's dentition to its most natural and esthetic potential.

References

1. Periodontology Aa. Glossary of periodontal terms. Chicago (IL): The American Academy of Periodontology. 2001;
2. Langer B, Langer L. Subepithelial Connective Tissue Graft Technique for Root Coverage. Journal of Periodontology. 1985 Dec;56(12):715–20.
3. Nelson SW. The subpedicle connective tissue graft: A bilaminar reconstructive procedure for the coverage of denuded root surfaces. Journal of periodontology. 1987;58(2):95–102.
4. Raetzke PB. Covering Localized Areas of Root Exposure Employing the “Envelope” Technique. Journal of Periodontology. 1985 Jul;56(7):397–402.

5. Allen AL. Use of the suprapariosteal envelope in soft tissue grafting for root coverage. I. Rationale and technique. International Journal of Periodontics & Restorative Dentistry. 1994;14(3).
6. Zabalegui I, Sicilia A, Cambra J, Gil J, Sanz M. Treatment of multiple adjacent gingival recessions with the tunnel subepithelial connective tissue graft: a clinical report. International Journal of Periodontics & Restorative Dentistry. 1999;19(2).
7. Jahnke PV, Sandifer JB, Gher ME, Gray JL, Richardson AC. Thick Free Gingival and Connective Tissue Autografts for Root Coverage. Journal of Periodontology. 1993 Apr;64(4):315–22.
8. Bouchard P, Malet J, Borghetti A. Decision-making in aesthetics: root coverage revisited: Bouchard et al. Periodontology 2000. 2001 Oct;27(1):97–120.

Review article

ROBOTICS IN PROSTHODONTICS: A STATE OF ART AND FUTURE CHALLENGES

****Dr.Ranjith. M, *Dr. Melisa Cheriyan, ***Dr.Sheejith.M, ****Dr.Niveditha**

Abstract: Robotics is a disruptive technology that will change diagnostics and treatment protocols in dental medicine. Robots can perform repeated workflows for an indefinite length of time while enhancing the overall quality and quantity of patient care. Early robots required a human operator, but robotic systems have advanced significantly over the past decade, and the latest medical robots can perform patient intervention or remote monitoring autonomously. Application of robot to prosthodontics is a novel application of robot technology in medical field. These kind of robots can realize the manufacturing of complete or partial denture, dental implantology. Robots are automatically operated machines that have replaced humans in performing various tasks. With advancements in robotic technology, a robotic system, the da Vinci Robot (Intuitive Surgery, Sunnyvale, CA, USA), has been gaining popularity for helping surgeons deliver a less invasive approach in the medical fields across gynecology, urology, and general surgery. Proven advantages of robot- assisted surgery include precise execution of technically demanding procedures and elimination of human tremors. This paper will provide dental practitioners and researchers with a comprehensive and transparent overview of the characteristics of literature regarding initiatives of robot technology in dentistry.

Key words: *Robotics, Prosthodontics, Implantology, Yomi, Dental technology*

Corresponding Author: Dr Melisa Cheriyan

Professor, *Post graduate student, *** Professor & Head, * Assistant Professor, Department of Prosthodontics and Crown and Bridge, KMCT Dental College, Kozhikode, Kerala.*

Introduction

Robots are becoming more and more widespread throughout the world today. It is interesting to look at how currently available robotic devices can be used to clean the house and now the lawn, as well as the benefits and disadvantages of using robots instead of casual labor.

Robots are being used in almost every industry, allowing the economy to shift towards one that is more service-based and information-oriented. From the first humanoid robot ELEKTRO, an Isaac Asimov's pioneering research to the use of robotic arms in surgery, robotics have been one of the most important areas of applied science throughout history. Robotic surgery is no longer fiction, it is a reality.¹

The origins of robot-assisted surgery stem from pioneering work done at the National Aeronautics and Space Administration (NASA).¹ In the mid- 1980s, NASA developed a remotely controlled robotic system to surgically operate on astronauts in space.¹

With advancements in robotic technology, a robotic system, the da Vinci Robot (Intuitive

Surgery, Sunnyvale, CA, USA) has been gaining popularity for helping surgeons deliver a less invasive approach in the medical fields across gynaecology, urology, and general surgery.¹

Some robotic solutions have become commercially available in recent years and are marketed for use in the general dentist practice, such as the implantology robot 'Yomi'. Application of robot in surgery and other medical fields reminds us that an automatic system may also be able to play an important role in Prosthodontics.²

Proven advantages of robot-assisted surgery include precise execution of technically demanding procedures and elimination of human errors. Among their various applications in the dental field, robots have been successfully implemented in implant surgery.³ Robot in prosthodontics, orthodontics, endodontics is a whole new application of robotics in medical field.⁴

Robot in prosthodontics can realize the following functions, such as the manufacturing of complete or partial denture, tooth preparations and dental implantology. The study about robot also will be a theoretical and technical innovation

and breakthrough. Its successful application will not only realize the quantification of complete denture or partial restoration and the dental implantology, but also promote the development of prosthodontics and relative fundamental theory.⁴

Robotic systems can also play a role in education. Training dental students with the aid of full-body robotics, haptic interface technology, and advanced simulation can teach basic learning needs before interaction with real patients.³

Machine learning:

The term machine learning (ML) summarizes different methods for making use of possibly large amounts of data to learn and self-improve from own experience.⁵

It distinguishes itself from classical artificial intelligence (AI) which is mostly concerned with planning and search problems, knowledge representation and logical reasoning. More specialized branches of machine learning are e.g. transfer learning, reinforcement learning, object detection and speech recognition. Examples of recent applications and research works are translators such as

diagnostic tools, speech recognition frameworks or manipulation learning schemes for robots. ML in dentistry is generally not intended to replace the dentist, but rather to be a method to create a second informed opinion based on mathematical decision making and prediction. Clearly, although existing methods can be very powerful for the specific domain, they have been designed for they are still far from being general purpose tools.⁵

Artificial intelligence

In the context of robotics, the field of autonomous task planning comprises methods from classical artificial intelligence such as tree-search algorithms and symbolic task planning that are used to autonomously plan a sequence of actions in order to achieve a desired goal.⁵

Most of these methods originate from works that are unrelated to robotics yet very much applicable. Generally, autonomous robots depend on a knowledge base in order to reliably perform their assigned tasks. Examples for stored knowledge are taxonomies of skills, i.e. the capabilities of the robot, 3D-maps of the surroundings or general information about

the robot. Furthermore, they have to be able to reason about current events and new information in order to adapt to new situations.⁵

Studies investigated the use of AI in digital dental radiography analysis for caries diagnostics radiographic landmarks, sinusitis, root fracture or differential jaw pain diagnosis. Furthermore, genome wide expression profiles have been investigated in periodontitis. Reviews discussed the possible impact of AI on esthetic dentistry, orthodontics, oral surgery or future concepts of oral healthcare in general. Interestingly, the use of AI has also been investigated for age estimation in forensic science.

Robotics in Dental Implantology

Dental implants should be placed at a prosthetically desired position for the longevity of the implant and prosthesis because inaccurate placement may cause clinical complications, such as damage to adjacent teeth, nerves, and blood vessels, as well as periodontal and esthetic problems. In robot-assisted surgery, the direction of the surgical handpiece attached to the robot arm is continuously monitored and dynamically controlled using an optical tracking device

based on the preplanned coordinate transformation algorithm.⁶ Robot-assisted implant surgery has shown deviation values similar to those of static guided surgery, validating the feasibility of robot-assisted implant surgery.⁶

The robotic system tended to show fewer deviations at the implant apex and guide system at the implant top.⁶ The robotic system is expected to help dentists perform accurate and safe implant surgery in future owing to its advantages, such as short surgery preparation time, possibility of changing the plan during surgery, and prevention of operator errors.⁶

Robotics in tooth arrangement

Tooth arrangement robot: - Single manipulator robot system for the manufacture of complete denture is developed using 6DOF (degree of freedom) CRS robot produced by Canada. The structure, tooth-arrangement algorithm, and motion control of single manipulator tooth-arrangement robot system are studied.⁴ Single manipulator tooth arrangement robot system for complete denture consists of the following components: 6DOF CRS robot, electromagnetic gripper, computer, a central

control system with tooth-arrangement and robot control software for tooth-arrangement, motion planning and control, denture base, light source device, and light-sensitive glue. Three-dimensional virtual tooth-arrangement software is programmed based on VC++ and OpenGL.⁴

The functions of the virtual tooth-arrangement software are as follows.

- (1) Choose or create medical history files of a patient, draw a jaw arch and dental arch curves by expert's experience according to the jaw arch parameters of the patient, and adjust the dental arch curve by expert's experience reasonably.
- (2) Display three dimensional virtual dentitions on the screen, provide a virtual observation environment for designed dentitions, and interactively modify each tooth posture. The functions of the robot control software are to calibrate tooth-arrangement initial position for tooth arrangement robot, create control data profile for real tooth arrangement with the robot, and control the robot for tooth arrangement operation.⁴

Robotics in tooth preparation

For clinicians, tooth preparation for crown and bridge is routine work, but it is still challenging even after years of clinical experience. The primary challenge is to decrease the tooth sufficiently to make space while applying the least possible harm to healthy tooth substance. For clinicians, the concept of a robotic system utilized for tooth preparation appears sensible and tempting. An in vitro testing of a mechatronic system has been conducted to aid the clinician in tooth drilling. The report demonstrated good outcomes, however, its validation has not been performed so far in the clinical setup. With a mechatronic system, the accuracy of the clinician's position was 53% more efficient than without it.³

A tooth preparation robotic system was presented by Yuan and colleagues, which consisted of the following hardware parts:

- (a) a tooth fixture that connects the target tooth with the robotic tool and safeguards the adjoining tooth from laser-cutting;
- (b) a 6-DOF robotic arm;

(c) an efficient low-heat laser appropriate for the preparation of hard tissue;

(d) a CAD/CAM software to generate a 3D motion path of the laser and to design the target shape for tooth preparation and

(e) an intraoral 3D scanning machine for obtaining the 3D information of the subject's teeth fixture, opposing teeth, adjoining teeth, and the target tooth.

Key problems on application of robotics in prosthodontics

Basic Requirement of Design.

Qualitative description language in prosthodontics and orthodontics is transferred to quantitative description.^[4] With the help of three-dimensional oral character, the manufacturing of complete or partial denture and dental implants are realized automatically by the limited space robot. ^[4] Main difficulty of the design and manufacturing for robot in prosthodontics and orthodontics is whether it can satisfy the demand of the different patient's mouth characteristics after oral repair.⁴

Basic design requirement of tooth-arrangement robot, dental implantology robot is as follows:

(1) For tooth-arrangement robot, in virtual environment, qualitative description tooth-arrangement principle should be quantitatively expressed. Accurate grasping and sequential location of artificial teeth should be realized with fewer degrees of freedom.⁴

(2) Dental implantology robot should have the following functions: preoperation 3D reconstruction and path preplanning, real time navigation of intraoperative image. The structure of the robot should realize the flexible adjustment of insertion angle and position in the limited workspace with help of image guidance.⁴

Research difficulty

Function of the application of robot in prosthodontics and orthodontics is different, so the research difficulty also is not identical. Research difficulty of tooth-arrangement robot system is parameterized description oral character, such as jaw arch curve and dental arch curve, 3D reconstruction of complex shape artificial teeth, digital description, accurate grasping

and location of artificial teeth, trajectory planning, and coordinated control of robot.⁴

1. Research difficulty of dental implantology robot system is 3D reconstruction of preoperation oral cavity CT image, the registration between intraoperative navigation image and preoperative reconstruction image, structure design of robot in limited workspace, and trajectory planning of robot.⁴

Future development in application of robotics in prosthodontics

Progress has been made in the research of the application of robot in prosthodontics, but it is not complete. Viewing from the state of the art of application of robot in prosthodontics and orthodontics and the market demand of oral cavity repair, the following research aspects should be done in the future.

(1) Novel Structure

High flexibility, reliability, and accuracy are needed for the robot in prosthodontics and orthodontics, but the workspace is limited by the oral cavity. The flexibility and the limited workspace are one pair of technical

contradictions, so the total planning and optimization to the robot is necessary.⁴

(2) Sensor and Control Technique

For tooth-arrangement robot, it needs to grasp and manipulate accurately 14 complicated artificial teeth. So tooth-arrangement robot needs a lot of degrees of freedom and sensors. A highly efficient and coordinated control algorithm that is suitable for the tooth arrangement by robot is very crucial. For dental implantology robot, the research in the future focuses on the registration between intraoperative navigation image and preoperative reconstruction image, real-time acquisition, and feedback of drilling depth and the implant force.⁴

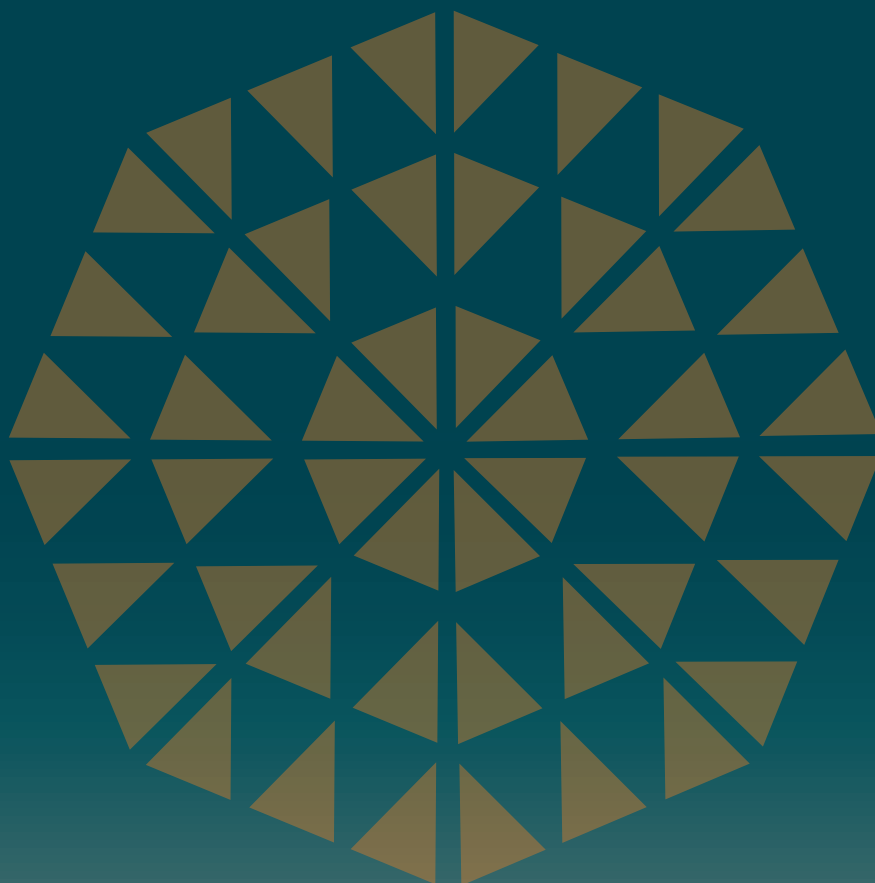
(3) Human- Computer Interaction Technology

Human-computer interaction technology is one of the key technologies of motion control of the robot in prosthodontics and orthodontics. For tooth-arrangement robot and dental implantology robot, the working environment is limited; there exist some illusions to the operators, such as the capturing and adjustment operation of the whole

robot and the adjustment operation of drilling depth and posture.⁴

References

1. Wu Y, Wang F, Fan S, Chow JK. Robotics in Dental Implantology. Oral Maxillofac Surg Clin North Am. 2019 Aug;31(3):513-518.
2. Tom C.T. van Riet, Kevin T.H. Chin Jen Sem, Jean-Pierre T.F. Ho, René Spijker, Jens Kober, Jan de Lange, Robot technology in dentistry, part one of a systematic review: literature characteristics, Dental Materials, 10.1016/j.dental.2021.06.001, 37, 8, (1217-1226), (2021).
3. Ahmad,P.;Alam,M.K.; Aldajani, A.; Alahmari, A.; Alanazi, A.; Stoddart, M.; Sghaireen, M.G. Dental Robotics: A Disruptive Technology. *Sensors* **2021**, 21, 3308
4. Jiang J, Zhang Y, Wei C, He T, Liu Y. A Review on Robot in Prosthodontics and Orthodontics. *Advances in Mechanical Engineering*. 2015;7.
5. Grischke J, et al. Dentronics: Towards robotics and artificial intelligence in dentistry. *Dent Mater* (2020)
6. Chiarelli T, Franchini F, Lamma A, Lamma E, Sansoni T. From implant planning to surgical execution: an integrated approach for surgery in oral implantology. *Int J Med Robot*. 2012 Mar;8(1):57-66. doi: 10.1002/rcs.422. Epub 2011 Oct 18.



INNOVATION AND
ENTREPRENEURSHIP
DEVELOPMENT CENTRE



INSTITUTION'S
INNOVATION
COUNCIL
(Ministry of Education Initiative)