

DENTAL BITES

VOLUME 2, ISSUE 2

April - June 2015

A publication of



Manassery P.O., Mukkom, Calicut-673602, Kerala
Phone (0495) 229 0690/229 0693, Fax (0495) 229 4726

E-mail: dental@kmct.du.in, Web: www.kmct.edu.in

MANAGING DIRECTOR

DR. K.M. NAVAS

Executive Trustee

KMCT Group of Institutions

CHIEF EDITOR

DR. K.M. KUNJAMMA THOMAS

Principal

KMCT Dental College

ASSOCIATE EDITORS

DR. MOHAMMED SADIQUE

Professor, Conservative Dentistry & Endodontics

DR. RAVI S.V.

Reader, Conservative Dentistry & Endodontics

DR. SAMEERA G. NATH

Senior Lecturer, Periodontics

ADVISORY BOARD MEMBERS

DR. RAM MANOHAR

Former Professor & HOD, Oral Pathology, Educare Institute of Dental Sciences, Malapuram

Former Principal, Educare Institute of Dental Sciences, Malapuram

Former Principal, Govt. Dental College, Kozhikode

Former Professor & HOD, Oral Pathology, Govt. Dental College, Kozhikode

DR. ROSAMMA JOSEPH V.

Professor & HOD, Periodontics, Govt. Dental College, Kozhikode

EDITORIAL BOARD MEMBERS

DR. SANTHOSH V.C, *Periodontics*

DR. USHA BALAN, *Oral Pathology*

DR. E RAMAKRISHNAN, *Pedodontics*

DR. HARISH KUMAR V.V, *Periodontics*

DR. VAISHALI S SHENDE, *Oral Pathology*

DR. PRADEEP KUMAR C, *Prosthodontics*

DR. BINU PURUSHOTHAMAN, *Orthodontics*

DR. AUSWAF AHSAN, *Oral Medicine & Radiology*

DR. BENNY JOSEPH, *Oral & Maxillofacial Surgery*

DR. MANOJ KUMAR K.P, *Oral & Maxillofacial Surgery*

DR. PRASANTH DHANAPAL, *Conservative Dentistry & Endodontics*

Editorial

“To get to know, to discover, to publish - this is the destiny of a scientist”

***- François Arago
(26 Feb 1786 - 2 Oct 1853)
French Physicist & Astronomer***

In clinical practice, we often encounter many problems which might not be fully explained by the existing knowledge or theory. Out of curiosity for the unknown, clinicians will make their efforts to solve these problems through observation, analysis, and practice. This is what we call research. Clinicians should be engaged in research, clinically or fundamentally. Clinical research should be encouraged for each specialist who is more knowledgeable in their own definitive area. Their current and latest publications containing the doubts and oppositions with the old views can provoke inspirations to other clinicians for further research, for better detection of the patho physiological relationships so that disease can be managed more efficiently.

Research is the thinking hone. Research activities should be necessarily accompanied by paper writing, which is a process of condensing, precipitating and sorting of our thinking. With this message I present before you Volume II Issue 2 of Dental Bites, our College Journal.

Yours,

Sd/-

Dr. Kunjamma Thomas
Chief Editor

TABLE OF CONTENTS

Original Research

1. Comparative evaluation of the antimicrobial efficacy of conventional needle irrigation, sonic activated irrigation, high power diode LASER and photo-activated disinfection on *Enterococcus faecalis* – an ex vivo study
Dr. Benny Varghese pg 5

Literature Review

1. Nanorobots in Periodontics
Dr. Shyama Haridas pg 17
2. Communication as a behaviour management tool in Pediatric dentistry
Dr. Dhanya Krishnan pg 24
3. Piezosurgery- a new frontier in Periodontology and Oral Implantology
Dr. Renjith K.P pg 34
4. Radicular Cyst: A Review
Dr. Faiz Aboobacker pg 40

Awards & Achievements pg 47

COMPARATIVE EVALUATION OF THE ANTIMICROBIAL EFFICACY OF CONVENTIONAL NEEDLE IRRIGATION, SONIC ACTIVATED IRRIGATION, HIGH POWER DIODE LASER AND PHOTO-ACTIVATED DISINFECTION ON ENTEROCOCCUS FAECALIS – AN EXVIVO STUDY

*Dr. Benny Varghese, **Dr. Kunjamma Thomas, ***Dr. Mohammed Sadique. K.P,
****Dr. Elsy.P.Simon, ***** Dr.Ravi.S.V

Abstract

Aim: To evaluate the antimicrobial effect of conventional needle irrigation, sonic activated irrigation, high power diode laser irradiation and photo-activated disinfection with 2.5% sodium hypochlorite (NaOCl) on Enterococcus faecalis.

Methodology: Root canals of 75 human extracted teeth with single straight canals were prepared with ProTaper files, sterilized, contaminated with an E.faecalis suspension and incubated for 7 days. They were then randomly distributed into 5 groups: G1-Conventional needle irrigation with 2.5%NaOCl, G2-Sonic activated irrigation with 2.5% NaOCl, G3- high power diode laser irradiation, G4-Photo-activated disinfection(PAD), G5-Positive control group. The root canals were sampled by flushing with saline solution at baseline and after the treatments. The number of bacteria in each canal was determined by plate count.

Results: There was a significant reduction in the bacterial population after all methods of root canal disinfection ($p < 0.001$). The PAD and High power diode laser irradiation were significantly more effective than Sonic activated irrigation and Conventional needle irrigation in reducing CFUs ($p < 0.05$). The difference in antibacterial efficacy of PAD and High power diode laser irradiation was not statistically significant.

Conclusion: All methods used significantly reduced the bacterial count. However, PAD and High power diode laser system were found to be more successful in reducing the root canal infection than the Sonic activated and Conventional needle irrigation alone.

Key words: anti microbial efficacy, conventional irrigation, sonic activated irrigation, high power diode LASER irrigation, photoactivated disinfection, E.faecalis

Corresponding Author: Dr. Benny Varghese

Post Graduate Student, **Professor & Head, *Professor, ****Reader, Department of Conservative Dentistry & Endodontics, KMCT Dental College, Manassery P.O., Kozhikode, Kerala, India*

Introduction

The success of endodontic therapy is solidly based on efficient disinfection of the root canal system and prevention of

reinfection.^{1,2} Anatomical complexities and microbial complexities of the root canal system are the two main obstacles that have to be overcome in achieving this. Traditionally successful endodontic result is

accomplished by a combination of mechanical instrumentation, the use of disinfecting solutions for irrigation and placement of inter appointment intracanal medicaments. They have successfully dealt with the microbial complexities, but whether they are sufficiently effective in dealing with anatomical complexities is still doubtful.^{3,4}

Irrigants have been traditionally delivered using a syringe and needle. Paque et al (2009) reported that after NaOCl syringe & needle irrigation and instrumentation 40-60% of the canals still contained cultivable bacteria.⁵ The problem with conventional irrigation technique is inadequate replacement of the irrigant throughout the root canal system because the highest streaming velocity is present only in the lumen of the needle and around the tip off the needle.⁶ Furthermore, the high surface tension of sodium hypochlorite prevents direct contact of the irrigant with the dentinal walls of the anatomical complexities.⁷

The efficacy of sonic and ultrasonic devices is based on the creation of hydrodynamic phenomenon in well-shaped canals filled with an irrigant.^{8,9} Such active root canal irrigation has been shown to facilitate the disruption of biofilms and make cell membrane of bacteria more permeable to NaOCl. But their superiority over conventional needle irrigation is still inconclusive, as per the contradictory results given by various studies.^{10,11}

Relatively, new approaches to disinfecting the root canals include the use of high-power diode lasers as well as photo-

activated disinfection (PAD). The laser light is thought to be able to reach areas that are impossible with the traditional techniques.¹² The bactericidal effect of high-power lasers is based on dose dependent heat generation. Its antimicrobial effectiveness against diverse microorganisms has already been demonstrated in previous studies.^{13,14} Nevertheless, according to some, it was not more effective than NaOCl.^{15,16} Moreover, high power lasers have the potential to cause dentine charring, ankylosis, root resorption and periradicular necrosis.¹⁷ PAD is an antimicrobial strategy in which low laser energy is used to activate a nontoxic photosensitizer, and the singlet oxygen released from these dyes causes damage to the membrane and DNA of microorganisms.¹⁸ It has been recommended in root canal treatment as an alternative or a supplement to currently used disinfection methods.^{19,20} The photosensitizers have a high degree of selectivity for killing microorganisms without affecting host cell viability.²⁰ Many *in vitro*^{21,22} and *ex-vivo*^{20,23} studies using the PAD have shown that this approach has the potential to maximize the root canal disinfection. Yet, there are still some controversies regarding the effect of the PAD on the multibacterial biofilms in the root canals.^{24,25}

Over the years, an increasing number of studies on root canal disinfection techniques have been published but with contradictory results. Therefore, this subject merits additional study to determine the most effective root canal disinfection protocols. That is why this study has been contemplated.

Materials & methods

1. Selection and preparation of specimen

The study sample consisted of 75 extracted human single rooted teeth with completely developed roots and without root caries or previous endodontic treatment (Fig 1). Teeth were decoronated with a water-cooled diamond straight fissure bur (Fig 2). The working length (WL) of 12 mm was established by passing a size 10 or 15 K-file in the canal until it was visible at the apical foramen and subtracting 1 mm. If initial instrumentation to the apical foramen could not be performed with a size 08 K-file, or could be easily passed with a size 20 K-file, those teeth were excluded.

Fig1: Study samples

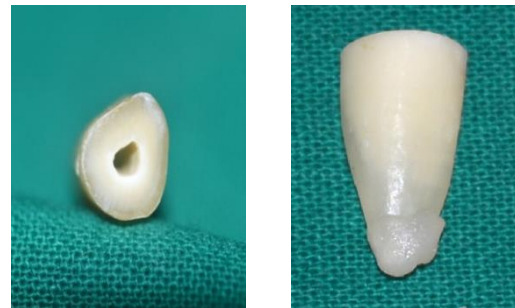


All root canals were instrumented with the conventional sequence of rotary ProTaper Universal NiTi according to the manufacturer's instructions at a rotational speed of 300 rpm and a torque 2Ncm. The coronal two-thirds of the canals were prepared with the shaping file SX. Subsequently, rotary instrumentation was accomplished using S1, S2, F1, F2 and F3 to WL.

Each canal was irrigated with 1 mL of 2.5% NaOCl between each instrument using a disposable 2-mL syringe and 30-

gauge needle. After the instrumentation, canals were filled with 1 mL 15% ethylene diamine tetra acetic acid (EDTA) for 2 min followed by a final rinse with 1 mL 2.5% NaOCl and 1 mL saline solution.

Fig 2: Decoronated tooth



Finally, the canals were dried with the sterile F3 paper points. Each apical foramen was sealed with a composite resin, and the root surface covered with the bonding agent to prevent leaking of bacteria and the passage of irrigant through the apical foramen.

To simplify the manipulation during contamination and irrigation procedures, specimens were fixed in an oasis block. Samples stabilized on oasis block was placed inside an autoclavable box and autoclaved for the standard regimen (Fig 3).

Fig 3: Samples in an autoclavable box



Sterilization control was performed on 5 samples. Root canals of these 5 samples were filled with 1 mL sterile broth culture using insulin syringes and incubated for 24 h in 100% humidity; followed by the sterilization of all the samples. After that, samples from the root canals of the sterilization control (n=5) were spread on plates containing blood agar with 7% horse blood and immersed in tubes containing sterile broth. Sterilization was confirmed when, after 48 h, there was no growth of bacteria on the agar plates and when the content of the test tubes was without turbidity.

2. Cultivation of *Enterococcus faecalis* and root canal contamination

A suspension was prepared by mixing a pure culture of *E. faecalis* ATCC 29212, grown in blood agar plates containing 7% horse blood for 24 h, with 2 mL of sterile 0.85% saline solution. The density of 0.5 McFarland was measured by the densitometer. The 70 remaining root canals were filled with 10 μ L of the bacterial suspension using sterile 1-mL insulin syringes without overflowing. The suspension was carried to the entire root canal length with a size 15 K-file. The samples were incubated at 37 °C for 7 days in 100% relative humidity. Reinoculation was performed on the 1st, 4th and 6th day after initial inoculation. After the incubation period, any residual medium was removed with sterile paper points. The samples were then randomly divided into five experimental groups of 15 teeth each, and 10 samples served as positive controls.

3. Experimental procedures

The remaining 70 samples were randomly allocated to four experimental groups (n = 15 per each) and the positive control group (n = 10).

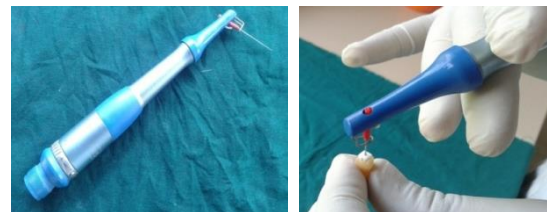
Group 1

The root canals were irrigated with 5 mL 2.5% NaOCl for 60 s using 5-mL syringe and 30-G needle, which was placed 2 mm short of the WL.

Group 2

The root canals were rinsed with 5 mL 2.5% NaOCl for 30 s followed by NaOCl activation for another 30 s, using the Sonic Air device (1500Hz). The instrument tip size 25, 0.02 taper (Shaper sonic) was placed 2-mm short of the WL and moved up and down in short vertical strokes (Fig 4&5).

Fig 4&5: Preparation of Group-2



Group 3

Root canals were irradiated with a pulsed diode LASER for 20 s, repeated three times at intervals of 10 s between each one (Fig 6&7). The physical parameters of the LASER (Laser Kavo GENTLE ray980) were; λ =980 nm, peak power = 2 W, pulsed 20s thrice. The 320 μ m optical fibre was introduced 1 mm short of the WL and was withdrawn from apical to coronal according to the recommendations of Gutknecht et al. (2004).¹⁴

**Fig 6: Diode LASER
(Kavo GENTLE ray980)**



Group 4

Root canals were filled with methylene blue (155 µg/ mL) to the level of the access cavity (Fig 8&9). The solution was agitated with a size 15 K-file and left undisturbed in the canal for 1 min. Irradiation of the root canals was accomplished with a diode laser (Laser HF, $\lambda = 660$ nm, total power = 100 mW). The 320 lm optical fibre was placed to the WL, and spiral movements from apical to cervical were performed for 60 s.

**Fig 7: LASER irradiated root canal
disinfection**

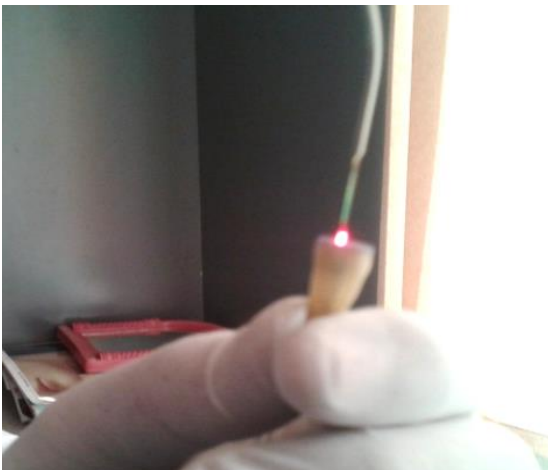


**Fig 8&9: Methylene Blue mediated
irradiation**



Positive control

The root canals were rinsed with 5 mL of sterile 0.85% saline solution using a 30-gauge needle, for 60 s. After each protocol, the root canals were rinsed with 1 mL of 5% sodium thiosulfate for 30 s, to neutralize any NaOCl used, and with 1 mL of sterile saline for 30 s, to standardize all experimental treatments to the same number of rinse procedure (Rios et al. 2011).²⁵

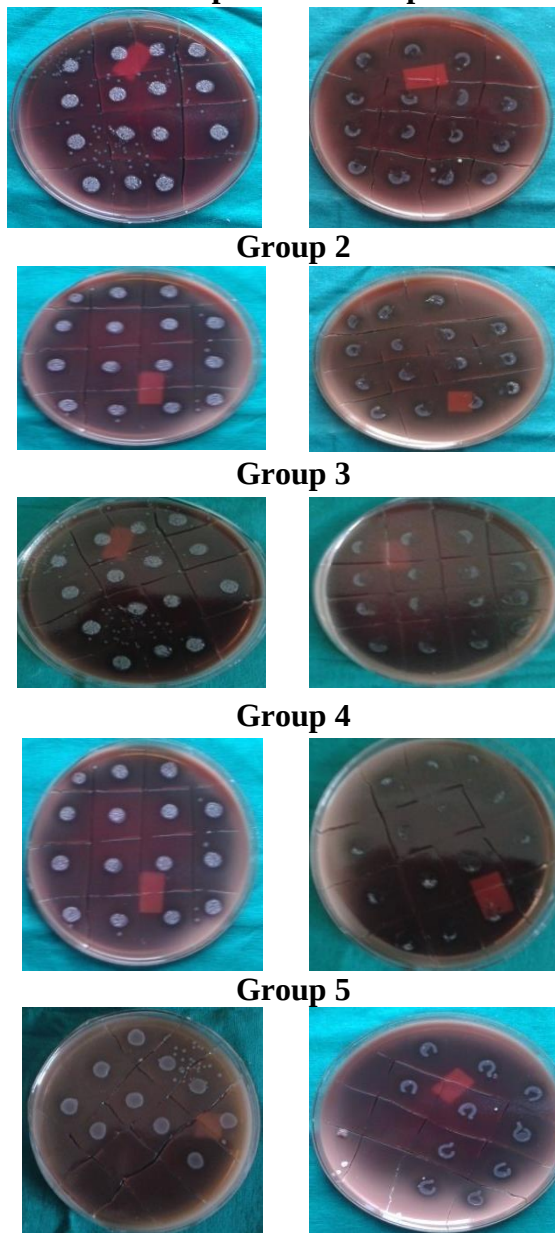
Microbiological procedures

The root canals were sampled twice, at baseline (ie, after the inoculation) and after each protocol. Before collection of the second sample, a size 30 Hedstrom file was used to file the dentinal walls vigorously. The canals were then filled completely with 10µL sterile 0.85% saline solution.

After three aspiration-delivering cycles using a sterile insulin syringe, the canal contents were finally aspirated and transferred to 0.5-mL Eppendorf tube, which contained 90µL sterile saline, to achieve a 10:1 dilution rate. During the sampling procedure, the teeth were held upside down to collect all the sampling fluid.

After 10-fold serial dilutions and agitation in vortex for 1 min, inoculating loop with standard dimensions was used to plate samples onto blood agar plates and incubated for 48 h at 37 °C in 100% humidity. CFUs grown were counted and finally transformed into actual counts based on the dilution factor and total circumferential area of the loop (Fig 10).

Fig 10: Groups at baseline & after protocol Group 1



Statistical analysis

The Mann–Whitney U test was used for intra group analyses (before and after disinfection protocol). The Kruskal– Wallis test was used for the intergroup comparative analysis of data of second samples. The significance level was set at 5%. Analyses were performed using SPSS 14. 0 version.

Results

The table below (Table 1) presents the distribution of the results (mean, median, range, reduction rate of CFUs) before and after treatment protocols. The reduction in the number of CFUs after the treatment protocol was highly significant for all groups ($P < 0.001$). PAD shown the greatest reduction percentage even though there is no statistically significant reduction between PAD and high power laser diode. All experimental techniques were significantly superior over the positive control. According to the results obtained in the present study antimicrobial efficacy is in the order of PAD> Diode Laser> Sonic Air> Conventional needle irrigation.

Discussion

Pulp and periapical diseases occur as a result of microorganisms invading into dental hard tissues and their further progression into the root canal system of the affected teeth. Therefore, the goal of root canal treatment is to eliminate the microorganisms from the root canal system and radicular dentin. After mechanical instrumentation, enormous areas of the root canal system remains untouched, regardless of the manual or rotary system used for cleaning and shaping.^{22,20} Therefore,

additional methods to the traditional treatment have been proposed in order to overcome the limitations of incomplete elimination of biofilm from the root canal system.

Sodium hypochlorite (NaOCl) is widely used as an irrigant at concentrations ranging from 0.5% to 6%. Irrigants have been traditionally delivered using a syringe and needle. The shortcoming with this

technique is inadequate replacement of the irrigant throughout the root canal system.^{9,28} *E. faecalis* was chosen as the microbiological marker because it has the ability to colonize the root canal in biofilms, representing the in vivo growth condition.²⁹ In addition, it often survives chemomechanical preparation because of its resistance to antimicrobial agents and its ability to cause monoinfection in the root canals.^{30,31}

Table 1: Results

Group	Baseline sample			After protocol sample			% Reduction median (range)
	Mean	Median	Range	Mean	Median	Range	
Conventional needle irrigation	5.20x10 ⁹	4.00x10 ⁸	1.00x10 ⁷ -9.00x 10 ⁹	2.12x10 ⁷	6.00x 10 ⁶	1.00x10 ⁴ -2.25x10 ⁷	99.80 (97.78 – 99.90)
Sonic air	6.48x10 ⁹	7.00x10 ⁷	1.00x10 ⁷ - 8.00x10 ⁹	5.5x10 ⁶	8.00x10 ⁵	2.00x10 ³ -5.80x10 ⁶	99.89 (99.90-99.95)
Diode LASER	6.43x10 ⁹	5.00x10 ⁸	3x10 ⁷ - 2.20x10 ⁹	2.05x10 ⁴	6.50x10 ²	0-1.8x 10 ⁵	99.96 (99.93 – 99.98)
PAD	2.55x10 ⁹	2.00x10 ⁸	1.80x10 ⁷ -8.00x10 ⁹	2.02x10 ³	5.50x10 ²	0 - 8.00x10 ³	99.99 (99.97-99.99)
Positive control	1.83x10 ⁹	1.00x10 ⁸	1.00x10 ⁷ - 4.00x10 ⁹	6.50x10 ⁶	3.00x10 ⁵	1.00x10 ⁵ - 2.00x10 ⁶	99.70 (99.00-99.70)

With conventional needle irrigation, smaller gauged cannulas are chosen to achieve deeper and more effective placement. In this study, 30G needles were used, and the irrigation protocol was a

combination of 5% NaOCl and 17% EDTA. Conventional needle irrigation has limitations because a static reservoir of irrigant restricts the potential for any irrigant to penetrate, circulate, and clean into all

aspects of the root canal system. Kouchi *et al.* have shown that bacteria colonize the periluminal dentine up to a depth of 1100 μ . Chemical disinfectants penetrate only by 100 μ into the dentine, as indicated by Berutti *et al.*³² This could be the reason for their lower antibacterial efficiency in this study.

Disinfection agents such as NaOCl require direct contact with the bacteria, which is often impossible in peripheral areas of the root canal such as anastomoses, fins and the most apical part of the main root canal.⁹ The Sonically activated system has been reported to provide deeper penetration of an irrigant to all areas of the endodontic space, and to effectively clean debris from lateral canals, remove the smear layer and dislodge clumps of simulated biofilm.³³ The Sonic Air device is a form of active irrigation. Its primary function is to produce vigorous intracanal fluid agitation through acoustic streaming and cavitation. When cavitation bubbles are produced by acoustic waves, they eventually collapse and the energy released is transferred to the root canal, detaching debris found within²⁷, which could be the reason for the reduction of bacteria within the root canals in the present study.

However, the performance of subsonic agitation appears to be less effective than diode laser and PAD. This may be attributed to the different acoustic streaming velocity and frequency, which positively influence debris removal from the qualitative standpoint. Sonic Air only produces sonic waves. Sonic energy only has the power to produce one node along the length of the instrument, so any constraint of the instrument will eliminate or significantly

decrease the acoustic streaming necessary to dislodge and carry away necrotic debris.⁹

The superior bactericidal effect of diode laser irradiation in the present study could be attributed to its greater depth of penetration (up to 1000 μ m into the dentinal tubules) when compared to the penetration power of chemical disinfectants, which is limited to 100 μ m. It has been found that with progressive decrease in diameter of the deep dentinal tubules, the penetration of irrigants is restricted.

However, laser irradiation with its inherent properties of light scattering, local intensity enhancement and attenuation allows light penetration deeper in the dentinal tubules contributing to a superior antimicrobial efficacy. The diode laser causes a thermal photodisruptive action in the unreachable parts of dentin, resulting in enhanced bactericidal effect in root canal dentin.^{34,35} Regarding the high-power diode laser, the present results are in agreement with previous studies that also demonstrated greater difficulties in eliminating gram-positive *E. faecalis* using diode and Nd:YAG lasers.^{36,21} Laser-induced bacteria killing is because of thermal heating of the environment above the lethal values and local heating inside bacteria. Survival of *E. faecalis* and the lower reduction rates can be attributed to the high resistance of *E. faecalis* to heat, because of its cell-wall structure.

Photo-Activated Disinfection is an antimicrobial strategy which is based on the chemical interaction of a nontoxic photosensitive agent and a low power laser of particular wavelength. The excited photosensitizer reacts with the molecular oxygen from the environment in order to

produce highly reactive oxygen species (ROS), which cause damage to the membrane and intracellular molecules including the proteins and the nucleic acids.³⁷ The photo-sensitizers with strong cationic charge bind and penetrate rapidly into the bacterial cells, without affecting the host cell viability.³⁸ In an *in vivo* study by Garcez et al, the combination of the chemomechanical preparation and the PAD killed all nine multi-drug resistant bacteria, that were found in pre-viously filled root canals with the periapical lesion.³⁹ Since Garcez et al. used higher total energy (9.6 J) in their PAD protocol, it is quite possible that shorter irradiation time(60 s) and lower total energy (6 J), in this study, could be the reason for the remaining bacteria in half of the root canals.

However, another possible explanation for incomplete bacterial elimination in some root canals after the PAD may be limited diffusion of photosensitizer in intracanal irregularities, dentinal tubules and biofilm, and restricted production of Reactive Oxygen Species due to the low concentration of available oxygen in the canals.

Contradictory to the present study, Meire et al. (2009) reported the greater efficacy of 2.5% NaOCl compared to the PAD.²¹ It is well known that biofilm maturity influences its tolerance to killing by antimicrobial agents (Portenier et al. 2003).³¹ Thus, it is quite possible that 7-day-old *E. faecalis* biofilm, used in this study, was more resistant to NaOCl than the 24-h-old biofilm in the study of Meire et al. (2009). In addition, the time of exposure to 2.5% NaOCl was 1 min in the present study, whereas in the study of Meire et al.(2009), it

was 15 min and without subsequent NaOCl inactivation with sodium thiosulfate. On the other hand, regardless of the previously mentioned factors, the PAD may be actually more effective than single NaOCl irrigation in the eradication of intracanal *E. faecalis*.

In this study, the PAD and the highpower diode laser were superior to diode laser and single NaOCl irrigation in eliminating intracanal *E. faecalis*. However, to determine the most effective endodontic disinfection protocol, the efficacy of the techniques should be further determined on multispecies biofilm. Although the time of 1 min caused 99.99% reduction after PAD, it is questionable whether longer exposure time could provide complete eradication in all samples.

Conclusion

Within the limitations of the present study, it can be concluded that PAD and High power diode laser succeeded in reducing root canal infection and had the capacity to eradicate *E. faecalis*. The sonically activated irrigation and the conventional NaOCl syringe irrigation had lower antibacterial effect. Hence PAD and High power diode laser can be recommended as an adjunct following cleaning and shaping procedures to ensure thorough disinfection and sterilization of dental root canal systems. Furthermore, it is necessary to evaluate their real contribution to conventional chemomechanical preparation in in-vivo studies.

Acknowledgement

This study has been conducted in association with the Dept.of Microbiology, KMCT Dental College, Calicut.

References

1. A. Byström, G. Sundqvist; The antibacterial action of sodium hypochlorite and EDTA in 60 cases of endodontic therapy. *Int Endod J* 1985, 18;35–40.
2. J.F. Siqueira Jr, I.N. Rôças, S.R.L.D. Santos, K.C. Lima, F.A.C. Magalhães, M. Uzeda :Efficacy of instrumentation techniques and irrigation regimens in reducing the bacterial population within root canals; *J Endod* 2002, 28 ;181–4.
3. E.S. Akpata, H. Blechman Bacterial invasion of pulpal dentin wall- in vitro study. *J Dent Research* 1982, 61;435–8.
4. M. Haapasalo, D. Ørstavik ;In vitro infection and disinfection of dentinal tubules . *J Dent Res* 1987, 66; 1375–79.
5. Paque F, Laib A, Gautschi H, et al. Hard-tissue debris accumulation analysis by high-resolution computed tomography scans. *J Endod* 2009, 35; 1044–7.
6. Boutsoukias L, Lambrianidis T, Kastrinakis E, et al. Measurement of pressure and flow rates during irrigation of a root canal ex vivo with three endodontic needles. *Int Endod J* 2007, 40: 504–13.
7. Zehnder M. Root canal irrigants. *J Endod* 2006;32: 389–98.
8. Ahmad M, Pitt Ford TR, Crum LA Ultrasonic debridement of root canals: an insight into the mechanisms involved. *J Endod* 1987, 13: 93–101.
9. Ruddle CJ . Endodontic disinfection: tsunami irrigation. *Endodontic Topics* 2008;11: 7–15.
10. Brito PRR, Souza LC, de Oliveira JCM, et al. Comparison of the effectiveness of three irrigation techniques in reducing intracanal *Enterococcus faecalis* populations: an invitro study. *J Endod* 2009;35:1422–7.
11. Huffaker SK, Safavi K, Spangberg LSW, Kaufman B. Influence of a passive sonic irrigaion system on the elimination of bactreia from root canal systems: a clinical study. *J Endod* 2010;36:1315–8.
12. Odor TM, Watson TF, Pitt Ford TR, McDonald F. Pattern of transmission of laser light in teeth. *Int Endod J* 1996, 29: 228–34.
13. Gutknecht N, van Gogswaardt D, Conrads G, Apel C, Schubert C, Lampert F. Diode laser radiation and its bactericidal effect in root canal wall dentin. *J Clin Laser Med and Surgery* 2000, 18:57–60.
14. Gutknecht N, Franzen R, Schippers M, Lampert F. Bactericidal effect of a 980-nm diode laser int he root canal wall dentin of bovine teeth. *J Clin Laser Med and Surgery* 2004, 22: 9–13.
15. Piccolomini R, D’Arcangelo C, D’Ercole S, Catamo G, Schiaffino G, De Fazio P. Bacteriologic Evaluation of the Effect of Nd:YAG Laser Irradiation in Experimental Infected Root Canals. *J Endod* 2002;28: 276–8.
16. Gerek M, Asci S, Yaylali DI. Ex vivo evaluation of antibacterial effects of Nd:YAG and diode lasers in root canals. *Biotech and Biotechnological Equipment* 2010, 24: 2031–34.

17. Bachall J, Howard P, Miserendino L, Walia H. Preliminary investigation of the histological effects of laser endodontic treatment on the periradicular tissues dogs. *J Endod* 1992;18:47–51.
18. Demidova TN, Hamblin MR. Photodynamic therapy targeted to pathogens. *Int J Immunopathol Pharmacol* 2004;17:245–54.
19. Lee MT, Bird PS, Walsh LJ. Photo-activated disinfection of the root canal: a new role for lasers in endodontics. *Aust Endod J* 2004;30:93–8.
20. Rios A, He J, Glickman GN, Spears R, Schneiderman ED, Honeyman AL. Evaluation of photodynamic therapy using a light-emitting diode lamp against *Enterococcus faecalis* in extracted human teeth. *J Endod* 2011;37: 856–9.
21. Meire MA, De Prijck K, Coenye T, Nelis HJ, De Moor RJG. Effectiveness of different laser systems to kill *Enterococcus faecalis* in aqueous suspension and in an infected tooth model. *Int Endod J* 2009;42:351–9.
22. Meire MA, Coenye T, Nelis HJ, De Moore RJG. Evaluation of Nd:YAG and Er:YAG irradiation, antibacterial photodynamic therapy and sodium hypochlorite on *Enterococcus faecalis* biofilms. *Int Endod J* 2012;45:482–91.
23. Bago I, Plečko V, Gabrić Pandurić D, Schaperl Z, Baraba A, Anić I. Antimicrobial efficacy of high-power diode laser, photo-activated disinfection, conventional and sonic activated irrigation during root canal treatment. *Int Endod J* 2013;46:433–47.
24. Souza LC, Brito PRR, Machado de Oliveira JC, Alves FRF, Mor-eira E JL, Sampaio-Filho HR, et al. Photodynamic therapy with two different photosensitizers as a supplement to instrumentation/irrigation procedures in promoting intracanal reduction of *Enterococcus faecalis*. *J Endod* 2010;36:292–6.
25. Muhammad OH, Chevalier M, Rocca JP, Brulat-Bouchard N, Medioni E. Photodynamic therapy versus ultrasonic irrigation: interaction with endodontic microbial biofilm, an ex vivo study. *Photodiagnosis Photodyn Ther* 2014;11:171–81.
26. Silva LAB, Novaes AB, de Oliveira RR, Nelson-Filho P, Santa-maria M, Silva RAB. Antimicrobial photodynamic therapy for the treatment of teeth with apical periodontitis: a histopathological evaluation. *J Endod* 2012;38:360–6.
27. Pasqualini D, Cuffini AM, Scotti N, Mandras N, Scalas D, Pera F, et al. Comparative evaluation of the antimicrobial efficacy of a 5% sodium hypochlorite subsonic-activated solution. *J Endod*. 2010;36:1358–60.
28. Luddin N, Ahmed HM. The antibacterial activity of sodium hypochlorite and chlorhexidine against *Enterococcus faecalis*: A review on agar diffusion and direct contact methods. *J Conserv Dent*. 2013;16:9–16.
29. Love RM. *Enterococcus faecalis*—a mechanism for its role in endodontic failure. *Int Endod J* 2001;34:399–405.

30. Gomes BP, Pinheiro ET, Sousa EL, et al. *Enterococcus faecalis* in dental root canals detected by culture and by polymerase chain reactin analysis. *Oral Pathol Oral Radiol and Endod* 2006;102:247–53.
31. Portenier I, Waltimo TMT, Haapasalo M. *Enterococcus faecalis*-the root canal survivor and star in post-treatment disease. *Endodontic Topics* 2003;6:135–59.
32. Berutti E, Marini R, Angeretti A. Penetration ability of different irrigants into dentinal tubules. *J Endod.* 1997;23:725–7.
33. Caron G. Cleaning efficiency of the apical millimeters of curved canals using three different modalities of irrigant activation: an SEM study (masters thesis). Paris: Paris VII University 2007(unpublished data).
34. Kaiwar A, Usha HL, Meena N, Ashwini P, Murthy CS. The efficiency of root canal disinfection using a diode laser: *In vitro* study. *Indian J Dent Res.* 2013; 24:14–8.
35. Preethee T, Kandaswamy D, Arathi G, Hannah R. Bactericidal effect of the 908 nm diode laser on *Enterococcus faecalis* in infected root canals. *J Conserv Dent.* 2012;15:46–50.
36. Schoop U, Kluger W, Moritz A, Nedjelic N, Georgopoulos A, Sperr W. Bactericidal effect of different laser systems in the deep layers of dentin. *Lasers in Surgery and Medicine* 2004; 35:111–16.
37. Garcez AS, Nunez SC, Lage-Marques JL, Jorge AO, Ribeiro MS. Efficacy of NaOCl and laser-assisted photosensitization on the reduction of *Enterococcus faecalis* in vitro. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;102:93-8.
38. Maisch T, Bosl C, Szeimies RM, Lehn N, Abels C. Photodynamic effects of novel XF porphyrin derivates on prokaryotic and eukaryotic cells. *Antimicrob Agents Chemotherapy* 2005;49:1542-52.
39. Garces AS, Ribeiro MS, Tegos GP, et al. Antimicrobial photodynamic therapy combined with conventional endodontic treatment to eliminate root canal biofilm infection. *Lasers in Surgery and Medicine* 2007;39, 59–66.

NANOROBOTS IN PERIODONTICS

*Dr. Shyama Haridas, **Dr. Harish Kumar V.V, ***Dr. Sreekanth P, **** Dr. Sanara P.P.

Abstract

The medical and dental field has seen several technological revolutions that have changed clinical practice. One concept which has and holds further promise in bringing about a paradigm shift in the field of diagnostics and management is nanotechnology. Nanotechnology will change dentistry, healthcare, and human life more profoundly than many developments of the past. This review provides a comprehensive discussion of the present and future of nanotechnology in the field of Periodontics.

Key words: Nanorobots, nanotechnology, periodontics application.

Corresponding Author: Dr. Shyama Haridas

Post Graduate Student, **Professor & Head, *Reader, ****Senior Lecturer, Department of Periodontics, KMCT Dental College, Manassery P.O., Kozhikode, Kerala*

Introduction

The vision of nanotechnology was introduced in 1959 by late Nobel Physicist Richard P Feynman. The word ‘nano’ is derived from the Greek word for dwarf. Nanotechnology can be defined as science and engineering involved in the design, synthesis, characterisation and application of materials and devices whose smallest functional organisation in at least one dimension is on the nanometre scale (one-billionth of a meter).¹

Robots have been recently introduced to undertake basic surgical procedures, and with the help of nanobiotechnology, another dimension of robotics has been developed known as nanorobots or nanobots.²

The field of “Nanomedicine” is the science and technology of diagnosing,

treating, and preventing disease and traumatic injury, of relieving pain, and of preserving and improving human health, using nanoscale structured materials, biotechnology, and genetic engineering, and eventually complex machine systems and nonorobots.³

Because of growing interests in future of dental applications of nanotechnology, a new field nanodentistry is emerging. Dental nanorobots might use specific motility mechanisms to penetrate human tissues with navigational precision, acquire energy, and sense and manipulate their surroundings in real time. An onboard nanocomputer that executes pre-programmed instructions in response to local sensor stimuli could be utilized to control the nanorobot’s functions. Also the dentist could issue strategic orders directly to the nanorobots in vivo via acoustic signals.⁴

Composition of nanorobots

The exterior of a nanorobot will be constructed of carbon atoms in a diamondoid structure because of their inert properties and strength. Carbon is the principle element in the form of diamond and many other light elements like sulphur, oxygen, nitrogen, silicon etc. They have a diameter of 0.5-3 microns and will be constructed in parts of 1-100 nanometre dimensions. Super smooth surface will lessen the likelihood of triggering the immune system. Glucose or other body sugars might be a source for propulsion and will have specific biochemical or molecular part depending on its task.⁵

Fig 1: Nanorobot



(Picture courtesy-Int Poster J Dent Oral Med 14 (2012), No. 1, Poster 586)

Mechanism of action

The mechanism of action of medical nanorobots was first described by Freitas (1999).⁴The powering of nanorobots can be done by metabolising local glucose and oxygen for energy and externally supplied acoustic energy. Nanorobots's function will be controlled by simple on board computers capable of performing 1000 or fewer

computations per second. Communication with the device can be achieved by broadcast-type acoustic signalling. A navigational device can be installed in the body providing positional accuracy to all passing robots that interrogate them, wanting to know their location. This will help the physician to keep track of the various devices in the body. They will be able to distinguish between different cell surfaces by checking the surface antigen by using chemotactic sensors keyed to specific antigen. On completion of the task, they can be retrieved by the scavenger system or allowing them to effuse themselves via human excretory system.⁶

Clinical Applications in Dentistry

New potential treatment opportunities in dentistry may include, local anaesthesia, dentition renaturalization, and permanent hypersensitivity cure, complete orthodontic realignments during a single office visit, covalently bonded diamondised enamel, and continuous oral health maintenance using mechanical dentifrobots.⁶ This review will mainly emphasize on use of nanorobots in periodontics.

Applications in Periodontics

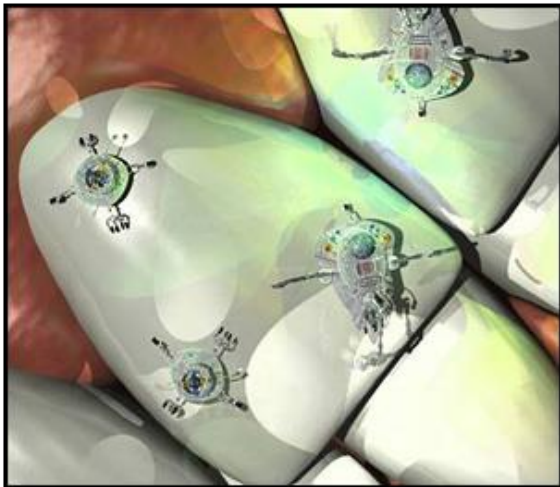
1. Dentifrobots

Nanorobotic dentifrice delivered by mouthwash or toothpaste could patrol all supragingival and subgingival surfaces at least once a day metabolizing trapped organic matter into harmless and odourless vapours and performing continuous calculus debridement (dentifrobots).

Properly configured dentifrobots could identify and destroy pathogenic

bacteria residing in the plaque and elsewhere, while allowing the 500 species of harmless oral microflora to flourish in a healthy ecosystem.⁴ These invisibly small dentifrobots will deactivate themselves if swallowed. Dentifrobots also would provide a continuous barrier to halitosis, since bacterial putrefaction is the central metabolic process involved in oral malodor. Being suspended in a liquid and being able to swim about, they can reach the surfaces beyond the reach of toothbrush bristles or fibres of floss.⁷ With this kind of daily dental care available from an early age, conventional tooth decay and gingival diseases will disappear into the annals of medical history.

Fig 2: Dentifrobots- cleaning the teeth



(Picture courtesy: *Int Poster J Dent Oral Med* 14 (2012), No. 1, Poster 586)

2. Nanoanaesthesia

When nanotechnology or nanoanaesthesia is used to induce anaesthesia, the gingival of the patient is instilled with a colloidal suspension containing millions of active, analgesic, micron-sized dental robots that respond to

input supplied by the dentist. After contacting the surface of the crown or mucosa, the ambulating nanorobots reach the dentin by migrating into the gingival sulcus and passing painlessly through the lamina propria or the 1–3-micron thick layer of loose tissue at the cementodentinal junction. On reaching dentin, the nanorobots enter dentinal tubules holes that are 1–4 microns in diameter and proceed toward the pulp, guided by a combination of chemical gradients, temperature differentials, and even positional navigation, all under the control of the onboard nanocomputer as directed by the dentist.

There are many pathways to choose from, near to CEJ, midway between junction and pulp, and near to pulp. Tubules diameter increases as it nears the pulp, which may facilitate nanorobot movement. Tubules branching patterns, between primary and irregular secondary dentin, regular secondary dentin in young and old teeth (sclerosing) may present a significant challenge to navigation.

Once installed in the pulp and having established control over nerve impulse traffic, the analgesic dental nanorobots may be commanded by the dentist to shut down all sensitivity in any particular tooth that requires treatment.

When on the hand-held controller display, the selected tooth immediately becomes numb. After the oral procedures completed, the dentist orders the nanorobots to restore all sensation, to relinquish control of nerve traffic and to egress, followed by aspiration.

Nanorobotic analgesics offer greater patient comfort and reduced anxiety, no needles, greater selectivity, and controllability of the analgesic effect, fast and completely reversible switchable action and avoidance of most side effects and complications.⁴

3. Dentin hypersensitivity

Dentin hypersensitivity is characterised by transient tooth pain associated with variety of exogenous stimuli. Clinical cause of hypersensitivity is exposed dentinal tubules as a result of gingival recession and subsequent loss of cementum on root surface. Natural hypersensitive teeth have eight times higher surface density of dentinal tubules and diameter with twice that of nonsensitive teeth. Reconstructive dental nanorobots, using native biological materials, could selectively and precisely occlude specific tubules within minutes, offering patients a quick and permanent cure.⁴ The methodology is similar to inducing anaesthesia using nanotechnology.

4. Bone replacement material

Bone is a natural nanostructure that is composed of organic compounds (mainly collagen), reinforced with inorganic ones. Nanotechnology aims to emulate this natural structure for orthopaedic and application and more for the development of nanobone. Nanocrystals show a loose microstructure, with nanopores situated between the crystals. The surface of the pores is modified such that they adsorb protein, due to the addition of silica molecules. Bone defects can be treated by using hydroxyapatite nanoparticles. These can be used in

maxillofacial injuries requiring bone graft, cleft palate and bone defects in periodontal surgeries.⁸ Few examples are -

Ostim (Osartis GmbH, Germany) HA

VITOSO (Orthovita, Inc, USA) HA +TCP

NanOSSTM (Angstrom Medica, USA) HA

Recently developed nano bioactive glass in concentration less than 4mg/ml. was found to be biocompatible with gingival fibroblasts in an in vitro study.

5. Nanomaterials for periodontal drug delivery

Nanomaterials are of interest from a fundamental point of view because the properties of a material (e.g. melting point, electronic properties, and optical properties) change when the size of the particles that make up the material becomes nanoscopic. It has considerable significance in the field of local, or targeted, drug delivery.⁹

Recently, Pinon-Segundo et al. produced and characterized triclosan-loaded nanoparticles by the emulsification–diffusion process, in an attempt to obtain a novel delivery system adequate for the treatment of periodontal disease. Batches were prepared with different amounts of triclosan in order to evaluate the influence of the drug on nano- particle properties. Solid nanoparticles of less than 500 nm in diameter were obtained. A preliminary in vivo study using these nanoparticles has been performed in dogs with only the gingival index (GI) and bleeding on probing (bleeding on probing) being determined. With respect to the gingival index (GI), at days 1 and 8, it was found that a severe inflammation was detected in control and

experimental sites (GI $\frac{1}{4}$ 3). It was concluded that triclosan nanoparticles were able to effect a reduction of the inflammation of the experimental sites.¹⁰

Drugs can be incorporated into nanospheres composed of a biodegradable polymer, and this allows for timed release of the drug as the nanospheres degrade. This also allows for site-specific drug delivery. A good example of how this technology might be developed is the recent development of Arestinin in which tetracycline is incorporated into micro-spheres for drug delivery by local means to a periodontal pocket. A nanostructured 8.5% doxycycline gel was observed to afford periodontal surface preservation following experimental periodontal disease in rats.⁹

6. Photodynamic Therapy

Antimicrobial photodynamic therapy (aPDT) is a new treatment method for the removal of infectious pathogens using a photosensitizer and light of a specific wavelength, e.g., toluidine blue with a wavelength of about 600 nm. Recently, Methylene blue (photo sensitizer) has been encapsulated within poly (D, L lactide – coglycolide) (PLGA) nanoparticles ($\approx$ 150 – 200nm in diameter) and was found to offer a novel design of nano-platform for enhanced drug delivery and photodestruction of oral biofilms. A new photosensitizer, indocyanine green (ICG)-loaded nanospheres with an 805 nm wavelength low-level diode laser irradiation showed a PDT-like effect, which might be useful for a potential photodynamic periodontal therapy.¹¹

7. Dental Implants

Nanotechnologies are increasingly used for surface modifications of dental implants as surfaces properties such as chemistry and roughness play a determinant role in achieving and maintaining their long-term stability in bone tissue.

Direct bone-to-implant contact is desired for a biomechanical anchoring of implants to bone rather than fibrous tissue encapsulation.¹²

Recently three nanostructured implant coatings are developed:

Nanostructured diamond: They have ultrahigh hardness, improved toughness over conventional microcrystalline diamond, low friction, and good adhesion to titanium alloys.

Nanostructured processing applied to hydroxyapatite coatings: This is used to achieve the desired mechanical characteristics and enhanced surface reactivity and has been found to increase osteoblast adhesion, proliferation, and mineralization.

Nanostructured metalloceramic coatings: These provide continuous variation from a nanocrystalline metallic bond at the interface to the hard ceramic bond on the surface.¹³

Studies have suggested that nanophase ZnO and TiO₂ may reduce S.epidermidis adhesion and increase osteoblast functions necessary to promote the efficacy of orthopedic implants.¹⁴

8. Nanomaterials for periodontal tissue engineering

Currently, tissue engineering concepts for periodontal regeneration are focused on the utilization of synthetic scaffolds for cell delivery purposes.⁵ Although the utilization of such systems offers promise, it is very likely that the next generation of materials will rely heavily on nanotechnology and its potential to produce nonbiologic self-assembling systems for tissue engineering purposes.⁶

Using these principles, it is possible to construct systems on a nano-, micro- or even macro-scale. Current materials available for such constructs are metals, ceramics, polymers, and even composite materials, the like of which have not yet been developed. The clinical utility of these nano-constructed self-assembling materials is their capacity to be developed into nanodomains or nanophases, leading to unique nanobuilding blocks with inbuilt nanocontrol and nanodelivery capabilities.

For tissue engineering purposes the potential of nanotechnology is limited only by our imagination. Our present capacity to create polymer scaffolds for cell seeding, growth factor delivery and tissue engineering purposes is well recognized.

Using nano bioactive glass ceramic particle (nBGC) incorporated alginate composite scaffold for periodontal regeneration is an example for this. In the future these processes may well be manipulated via nanodevices implanted to sites of tissue damage.⁹

Limitations

There are several limitations which can be categorized as (1) engineering: feasibility of mass production technique, precise positioning and assembly of molecular scale parts, manipulating and coordinating activities of various microscale robots (2)biological: development of biofriendly nanomaterial, biocompatibility with all intricate of the human body (3) social: ethics, public acceptance, regulation and human safety.

Advantages

In spite of the above mentioned limitations, its gaining importance and is developing rapidly because of its ability to treat and restore lost tissues at cellular level. It's proving its efficacy in the treatment of malignant conditions and other serious illness.

Conclusion

The visions described in this article may sound unlikely, implausible, or even heretic. Yet, the theoretical and applied research to turn them into reality is progressing rapidly. Nanotechnology will change dentistry, healthcare, and human life more profoundly than many developments of the past. As with all technologies, nanotechnology carries a significant potential for misuse and abuse on a scale and scope never seen before. However, they also have potential to bring about significant benefits, such as improved health, better use of natural resources, and reduced environmental pollution. The effect of these developments will probably affect all fields of science and technology.

References

1. Sahoo Sahoo SK, Praveen S, Panda JJ. The present and future of nanotechnology in human health care. *Nanomedicine: Nanotechnology;Biology and Medicine*. 2007; 3:20-31.
2. Freitas R., Jr Nanotechnology, nanomedicine and nanosurgery. *Int J Surg*. 2005;3:243–6.
3. *European Science Foundation*. Nanomedicine. Forward look on Nanomedicine. 2005.
4. Freitas RA. Nanomedicine basic capabilities, George Town TX: Landes Bioscience: 1999,p 345-47.
5. Abhilash M. Nanorobots. *Int J Pharma Bio Sci*. 2010; 1:1–10.
6. Babel, Mathur. Nanorobotics- Headway towards dentistry. *Int J. Res Sci Tech*. 2011; 1:1-9.
7. Bayne SC. Dental biomaterials: Where are we and where are we going? *J Dent Educ*. 2005; 69: 571–585.
8. Bharath N, Gayathri GV, Mehta DS. Nanorobotics in dentistry- The present status and future perspective. *J Dent Pract Res*. 2011; 1: 41-7.
9. Kong LX, Peng Z, Li SD, Bartold PM. Nanotechnology and its role in the management of periodontal diseases. *Periodontol* 2000.2006; 40: 184-96.
10. Pinon-Segundo E, Ganem-Quintanar A, Alonso-Perez V, Quintanar-Guerrero D. Preparation and characterization of triclosan nanoparticles for periodontal treatment. *Int J Pharm* 2005; 294: 217–32.
11. Nagahara A, Mitani A, Fukuda M, Yamamoto H, Tahara K, Morita I. Antimicrobial photodynamic therapy using a diode laser with a potential new photosensitizer, indocyanine green-loaded nanospheres, may be effective for the clearance of *Porphyromonas gingivalis*. *J Periodontal Res*.2013; 48: 591-99.
12. Catledge SA. Nanostructured Ceramics for Biomedical Implants. *J Nanosci Nanotech*. 2002; 2: 293-12.
13. Colon G, Ward BC, Webster TJ Increased osteoblast and decreased *Staphylococcus epidermidis* functions on nanophase ZnO and TiO₂. *J Biomedical Mater Res*.2006; 78:595-04.
14. Meyer U, Bühner M. Fast element mapping of titanium wear around implants of different surface structures. *Clin Oral Implant Res*. 2006; 17:206-11.
15. Freitas RA Jr . Nanodentistry. *J Am Dent Assoc* 2000; 131:1559- 66.
16. Bartold PM, McCulloch CAG, Narayanan AS, Pitaru S. Tissue engineering: a new paradigm for periodontal regeneration based on molecular and cell biology. *Periodontol* 2000.2000; 24:253-269.

COMMUNICATION AS A BEHAVIOUR MANAGEMENT TOOL IN PEDIATRIC DENTISTRY

*Dr. Dhanya Krishnan

Abstract

The basis for establishing a friendly relationship with the child is to allow the successful completion of dental procedures and, at the same time, help the child develop a positive attitude toward dental health. Communication is a two way process involving sender passing a “message” to receiver and a “feedback” obtained from the latter. It is a multimodal behaviour management tool which can be used for any patient with necessary alterations according to the child’s developmental level. While dealing with a child patient, the dentist should adopt more roles than a mere communicator, including those of a teacher, coach, rewarder, psychologist, distracter and an authority figure. This review aims to highlight the importance and variation involved with communication as a behaviour management tool in pediatric dental perspective.

Key words: communication, behaviour, child

Corresponding Author: Dr. Dhanya Krishnan

**Senior Lecturer, Department of Pedodontics & Preventive dentistry, KMCT Dental College, Manassery.P.O., Kozhikode, Kerala, India*

Introduction

MJ Gosby (1985) stated “I know you believe you understand what you think I said, but I am not sure you realize that what you heard is not what I meant”- words which highlights the complexity involved in communication process which forms the primary and most widely used behaviour management tool in dentistry.¹

Behaviour management is a clinical art form & skill built on a foundation of science with skills in communication, empathy, coaching, and listening. Primary goal of behaviour management is to instil and promote positive attitude towards oral health in a child. Establishing communication thus triggers an effective dentist- patient relationship. Considering the

above said relation, pediatric dentistry believes in a triad relationship which includes child, dentist and parent which differs from adult dentistry where a ‘one to one’ relationship acts. So communication as a behaviour management technique incorporates with it maximum difficulty when children are involved because it is very easy to get side tracked by parent while communicating with child. Always ensure that the child is the centre of attention, while remembering to keep the parents appropriately involved. Any information should be delivered to child and parent as well.²

Basics of Communication

Communication is a complex multisensory process which includes

imparting or interchange of thoughts, options or information. Establishing a trusting relationship with the child patient is a requisite for the pediatric dentist in gaining the child's cooperation in the provision of oral health care. Developing such a relationship is predicated on the establishment of effective communication.³ It is the cornerstone of most non pharmacological methods of behaviour management in pediatric dentistry and is used universally in pediatric dentistry for both cooperative & uncooperative child.

Communication is a balancing act in which “when & how” you impart information are equally significant. It comprises a host of techniques which, when integrated together leads to the evolution of a compliant and relaxed patient. It's an ongoing subjective process rather than a singular technique and is often an extension of the personality of the dentist.⁴

According to Moss (1972), the 4 essential ingredients of communication are:-

- 1) Sender / transmitter- DENTIST
- 2) Message - SPOKEN WORD
(includes facial expression and body language of sender)
- 3) Context or setting in which message is sent
- 4) Receiver – CHILD

For successful communication, all four elements must be present & consistent. Although communication may be accomplished by number of means, in dental setting it is affected through dialogue, tone of voice, facial expression and body

language; broadly classified as **Verbal** or **Nonverbal** communication.¹

Establishment of communication

A comfortable and relaxed environment is the basic requirement for establishing proper communication. Dental clinic setup should be neat, quiet and child friendly too. Before involving a child in a conversation, learn about the patient and relax the child. Verbal effects are delineated through selection of words and voice tone.² Voice used should be gentle, constant with empathy and firmness. To kick start the communication process, ask child's name, age, class, background, likes/dislikes.

Verbal communication with younger children is best initiated with complimentary comments. Eg: They are generally proud of their new clothing & liked to be asked about it. Observing anything unique about a child patient offers opportunity to ask questions and helps involve the child in the conversation. Child should be at eye level and a fit between intended message and understood one is required. Any form of negative messages should be avoided to the maximum limit possible.⁵ Physical contact when integrated appropriately between the process was found to have better results thus paving way for nonverbal techniques.

Nonverbal techniques play a special role for younger children.⁶ Listening becomes comparatively more important when dealing with older children. Children are often shy & reluctant to talk when they are first exposed to new experience & people. Once they gain confidence and become comfortable with the new

environment they usually begin to speak more freely. Involvement of the child's toys, mentioning a personal aspect and recalling positive behaviour of the patient helps propagate communication.¹

Some special factors to be considered for the child patient (Verbal/Non-verbal Communication):

- 1) Respect
- 2) Show interest in child as an individual
- 3) Share information freely
- 4) Give well stated instructions
- 5) Communicate at child's level
- 6) Focus on positive things
- 7) Avoid the use of fear producing words (injection, needle etc)
- 8) Display of empathy & support

Establishment of the communicator

Members of the dental team should be aware of their roles when communicating with a pediatric patient. Dental assistant communicates with the child during transfer from reception room to operatory & during preparation in dental chair but once the dentist starts managing the child they will assume a passive role. It's important to remember that communication occurs from a single source and is not 'overdone'.²

Differences according to age groups

Dentist should be familiar with the child's stage of intellectual development and developmental norms of different ages so as to adjust language and behavioural management based on this. For example, very young children may not be helped by rational discussion or explanation. Under the

age of 11 years, they are quite concrete in their cognitive functioning and cannot handle abstract ideas. Eg:-Telling a young child to be "GOOD" is a vague direction. Word "good" is fairly abstract to him / her and can be interpreted in different ways in different situations. They get confused whether it meant being quiet, sitting still, not playing with the instruments, or not using bad language. Ability to deal with abstract concepts develops at about age 11. At this stage, the child can and should be treated intellectually as an adult.

Dentist's conversation

Dentists should always have positive relationship with parent & child, keep both well informed, always involve children in discussions and separate the child from the parent to discuss sensitive issues. Maintaining honesty is important and it's best to avoid a phrase like "There is nothing to worry about"/ "This won't hurt at all". Another fact to be kept in mind is that any command may take some time to sink in and the implied one should be within the ability of the child. Use positive language like "Please can you move your hand" rather than use negative aspect like "Do not get your hand here". Dentist's conversation should always reflect congruence, empathy and respect.¹

Requests and promises

Out of all the speech acts, constitutive speech acts of requests and promises are the most important. For communication to be effective, the dentist must make effective REQUESTS and the child must make effective commitments to

take responsible actions at the reasonable requests of the dentist- PROMISES .When the child declines a request ,behaviour management strategy must be initiated which will ultimately reframe the original request. Essence of this reframing is that it convinces the child that the dentist is serious about the request.

Dentist as an ontological coach

According to Ontology or the way of being, best way for the child to be during the dental appointment is quiet, listening for request & cooperating with these requests. Hysterical, screaming child does not have a “way of being” that works well for the techniques. Therefore dentist becomes not just an educator or requester but an ontological coach in trying to make the child's way of being during dental appointment appropriate for linguistic techniques. This can be enhanced with nonverbal technique as well.⁷

A. Verbal communication

This form of communication basically involves the verbal conversation of the dentist with the child and vice-versa and occupies its position in the Linguistic Domain of behaviour management classification by Pinkham. In verbal communication, WORDS and TONE plays a key role. For young children, words you use will have less impact than your tone of voice and they don't get affected by whatever we are speaking with their parents. For elder children, long explanations to the parents may use up their attention span or make them more anxious if they don't understand what you are saying. Maturity in language is another important factor to be considered

for the child patient. Linguistic techniques can be adopted for most normally developed & socialized children who have no mental / emotional handicaps. Child may become competent in language before the second birthday and all normal children are competent in language after fourth birthday. For young children there is a weightage for mother tongue/ local language and we should refrain from using multiple languages.⁷Linguistic approaches can be permissive, empathic and personal. In permissive approach, patient is provided with relevant information regarding treatment to reduce uncertainty. Empathy is the ability to put oneself in another's place, including the ability to feel and experience the situation that person faces (“I care how you feel”).Personal approach is useful in establishing a rapport with the child by asking open personal questions. The child is made to feel that, as an individual, he or she has been acknowledged.⁸

Some other aspects to consider in verbal communication are-

Jargon

Dentistry has a language all of its own which we usually adopt when talking with fellow professionals. When we are anxious, it's very easy to lapse into jargon that has no meaning for the patient. As a result, the child misunderstands or becomes anxious because the treatment proposition sounds frightening.

Level

Words need to be appropriate for the person you are talking. Explanations given

at the wrong level can be insulting, frightening or at times completely incomprehensible. If you want the child and adult to understand, different levels can be utilized for communicating with either. But it is noticed that most parents will understand that you are trying to make things easier for their child so dentists can comfortably give more emphasis to speak at the child's level.

Listening

It's estimated that we listen to only 25% of our potential and our ability to listen decrease if we are anxious or awaiting treatment. Hence arises the need to give some information in advance of appointment to allow the family to prepare (Pre-appointment behaviour modification). Listening to the spoken words is more important in establishing rapport with older child. Active listening is the second step in encouraging the kind of genuine communication where the patient is stimulated to express feelings.

Retention

50% of the information is forgotten within 5 minutes of leaving the operatory. So it is helpful to write down the critical messages /pieces of information for future references.

Distortion

This includes any faults in interpretation or recall of messages. Eg: "Sugar free" recalled as "Reduced sugar" Or "We will need to put the tooth to sleep" recalled as "We will need to put you to

sleep". Writing down key messages may decrease such problems.¹

Voice tone

Manner in which you say something is as important as what you say. For young children, tone of your voice is what is appreciable rather than the content. Enthusiasm may motivate and any boredom spreads to the child patient. Similarly our patient's tone of voice may indicate if a message is being received or ignored.

Problem ownership

In difficult situations, dentist sometimes forget that they are guiding the behaviour of children and they begin by sending negative "you" messages. Eg: "You must". This may undermine the rapport between the child and dentist. An alternative is to send "I" messages which can establish focus of the problem. Eg: "I can't fix your teeth if you don't open your mouth wide".

Message clarity

Carefully select words/ phrases used to indoctrinate the new pediatric dental patient because for the young child, language labels are the basis for many generalization. Eg: Language label- "doctor"- confuses youngsters & mediates generalization.²

Euphemisms

Second language or euphemisms or word substitutes improve the clarity of messages to young patients. Address the child at his/her level of comprehension which does not suggest the use of baby talk,

but rather reemploying words that have meaning for that child. It can be accompanied by the use of inoffensive or mild expressions. Most effectively used with pre- school children (Table 1).

Table 1: Some euphemisms for dental equipments & procedures

Dental terminology	Word substitute
Probe	Tooth feeler/ counter
Tweezers	Tooth wiggler
Needle prick	Mosquito bite
SSC	Tooth hat/cap
Silver filling	Silver soldier
Radiograph	Tooth photo
X-ray unit	Camera
High speed suction	Vacuum cleaner
Impression material	Pudding/Dough
Bur	Brush or pencil
Caries	Sugar bugs
Matrix	Fence for filling
Prophylactic paste	Special tooth paste
Rubber dam	Raincoat
Rubber dam frame	Coat hanger
Rubber dam clamp	Clip or button
Band	Ring for tooth
Sealant	Paint
Slow handpiece	Buzzy bee
Triple spray/ inhalation sedation	Magic wind
Local anesthetic	'Sleepy juice' or 'Sleepy water for tooth'
Giving a local	Put your teeth off to sleep'

B. Non-verbal communication

Communication is a multisensory process. Non-verbal methods may be often subconscious & far more accurate than the

verbal messages. It includes body language, eye contact and smiling, expression of feelings without speaking like touching the patient, giving a hug. These enhance the effectiveness of other communicative management techniques and help gain or maintain the patient's attention and compliance. Some of the nonverbal methods in brief are as follows:-

Face

Your face can add to or undermine your verbal message. Smiling is a powerful tool & has been shown to motivate. When you have a mask, it may hide your face but a laugh and pleasant eye movement can be appreciated.

Eyes

Eye contact establishes trust at the outset of an appointment. For the best effect; you must have the patient at the same level as yours.

Gestures and body position

Anxious patients fidget & fiddle more than relaxed patients. Crossing arms as you talk may imply disapproval.

Body contact

A touch on the shoulder combined with a sympathetic tone may help reduce anxiety. Shaking hands may increase confidence for some parents and children.¹

According to **AAPD** guidelines (2002-2003), behaviour management techniques based on communication are Voice control, Tell show-do, Positive reinforcement, Distraction, and Parental presence/absence.⁹

1) Tell-show-do (TSD)

This technique was introduced by Addleston (1959). TELL includes verbal explanation of what is about to happen appropriately using second language or word substitutes, SHOW includes demonstration of visual, auditory, olfactory & tactile aspects of the procedure in nonthreatening fashion and DO means the procedure is carried out on the child. Completion of the procedure should be without deviating from what was explained and demonstrated. TSD was rated as the most acceptable technique among parents.¹⁰ Basic steps to remember are as following:

- Tell what you are going to do
- Tell what you are doing
- Tell while you are doing
- Show what you have told
- Show what you will do
- Do what you have shown and told

2) Voice control

Sudden and firm commands are used to gain the patient's attention and compliance, avert negative or avoidance behaviour and establish appropriate adult-child roles. Another form of voice control is using voice in a slow and deliberate cadence that can function like music set to a mood. This technique is used when child exhibits disruptive behaviour and requires the dentist to inject more authority into his/ her communication. Tone of voice is important and it must have an "I'M IN CHARGE HERE" ring to it. Facial expression of the dentist must also mirror this attitude of confidence. Found successful in managing behaviour of preschool children, this

technique is also a useful way of reframing a request that has been refused by the child. Voice control is better effective at intercepting inappropriate behaviours when they first occur than after they are full blown. Greenbaum et al compared the effects of normal and loud voice commands given to 40 children and found that the latter reduced disruptive behaviour. The patient should also be appreciated once positive behaviour is displayed.

3) Reinforcement

According to BF Skinner, 'Strengthening of a pattern of desired behavior and increasing the probability of that behaviour being displayed again in the future' is reinforcement. Directly after an appropriate behaviour is exhibited by the child, providing some form of positive 'reinforcer' which may be a material (toy, badge, stationary, stars), social stimuli (Verbal praise, approval, tapping of the shoulder, positive voice modulation, facial expression) or activity (allowing child to perform his/her choice of activity like watching favorite show or movie or games of interest) encompasses positive reinforcement.

4) Distraction

It's the technique of diverting the patient's attention from what may be perceived as an unpleasant procedure and in turn averting any negative or avoidance behaviour. Giving the patient a short break during stressful procedure is an easy way of distraction. When the child is uncomfortable the following distraction methods can be used - story telling, counting number of

teeth loudly, repetitive statements of encouragements, asking child to recollect a favorite joke, use of audiovisual aids or even making them write name or draw pictures in the air using legs.

5) Parental presence/absence

Wide diversity exists in practitioner philosophy and parental attitude regarding parent's presence or absence during paediatric dental treatment. Parents will expect to be with their infants & young children. Parents' desire to be present during their child's treatment does not mean they intellectually distrust the dentist. Practitioners should become accustomed to this added involvement of parents and welcome the questions and concerns for their children. Practitioners must consider parents' desires and wishes and be open to a paradigm shift in their own thinking.⁹

Communicating with parents

The health professional may be inattentive to communication style, but patients/parents are very attentive to it and not all of such parents may express their desire for involvement. Dentist behaviours reported to correlate with low parent satisfaction included rushing through appointments, not taking time to explain procedures, barring parents from the examination room and being impatient. Relationship/ communication problems can initiate malpractice actions. Even where no error occurred, perceived lack of caring and/or collaboration is associated with litigation.

Allowing parent and their active communication in the operatory, should be

preferably limited to pre-school and special children. Any sort of imbalance in communication between the trio of dentist, child and parent can result in too much arousal or one sided disturbed communication.

Rules of the game

Pinkham recently adopted another approach devised originally by Prejean to facilitate understanding between people and to be utilized in the pediatric dental setting. Rules warrant that the game can be appropriately played to a conclusion that is satisfactory to all. According to Pinkham the rules of a dental game include: the point of the game, the existential rules, the rules of action, the strategy, and the rules to settle disputes. Dentist is encouraged to become an ontologic coach of his / her child patients and uses information to desensitize a possibly suspicious patient. Similar to a game coach the dentist provides the patient with feedback, gives corrective exercises for negative behaviours and awards the desired action with praise. Eg: When the child enters the operatory calmly, gets into the chair correctly, and positions himself properly in it, the dentist should provide positive reinforcement by saying, "You are good at this. You are in just the right place in that chair". However, if the child enters the room reluctantly and buddies suspiciously in the chair, the feedback is different: "I can see that you are a bright little girl and can learn to do this properly. I know that you are able to get into the chair and sit the way that you are supposed to. Let's try it again". The desired action is then explained or shown to the patient until it is performed correctly.⁷

Behavioural contracting

It's a useful technique particularly when dealing with challenging children. Verbal or written contracts can be made between the dentist and the child patient. Verbal contracts often take the form of a "when...then" statement. Eg: "When you cooperate with the treatment, then I will give that". Written contracts are similar but seems more formal.¹

Communication in children with special health care needs

Components of a functional communication cycle are input, processing and output; all three of which will be compromised in special needs patient-Compromised senses (Input), intellectual limitations (Processing) and speech difficulties (Output).¹¹ Thus effective chair side communication may range from sophistication of sign language interpreter or simplicity of pad and pencil.

1) Mental retardation

Introduce the office staff and take a tour of the dental office in the first visit. Speak slowly, be repetitive, give only single instruction at a time and listen carefully to the patient. Ask the parents not to communicate when the dentist is communicating.

2) Autism

Communication techniques like tell show do, positive reinforcement and rewards may help in some autistic children.

3) Cerebral palsy

Communication can be done with such patients in the wheel chair itself. Being patient, kind, empathetic are key factors while dealing with palstic children.

4) Visual impairment

Describe vividly and accurately to the child the operatory, equipment, dental chair and procedures that are about to take place .Care should be taken to minimize noises. Tell feel do approach is best suitable, especially for instruments before being placed into the mouth. Nonverbal behaviour management methods using the remaining senses are advantageous. Any changes in chair positions should be only after informing the child.

5) Hearing loss

Chances are more for such children to often become a very good dental patient. If they have undergone special schooling, the ability to read a speaker's lips enables them to receive information or else use of sign language / interpreter may be needed. Treatment should proceed slowly, with dentist showing what is to be done at each step. Avoid using mask because the child may attempt lip reading. Reassure the patient with physical contact like holding the child's hands. Tell show do is again overemphasized. Use of visual aids can help like video of a child getting treated also helps for a deaf child patient.²

6) Attention deficit hyperactivity disorder

ADHD children have less two way communication with the dentist and particular difficulty in staying focused on the examination & treatment. In accordance with the child's developmental level, dentist should inform the child about what is going to be accomplished during the appointment. Initial discussion can be done with the parent in the room. Any incentives that can be earned by the child should be discussed.

Issue single, relatively short and direct instruction at a time. ADHD children are likely to be forgetful, disorganized, and prone to losing things which warrants important information to be reviewed with the parent and given in writing, even in the case of adolescent patients.¹²

Conclusion

“Contemporary dental care for children must include empathy rather than indifference, structure rather than diffuseness, and flexible authority rather than rigid control” -Troutman (1988). The desired behaviour is most likely to be achieved if, communication pattern is appropriate and the type to adopt depends on many factors including the developmental level of child. Linguistic technique relies on tonality, cadence and other aspects of the quality of the dentist’s communication with the child. In younger age group children, euphemisms, parental presence, TSD, distraction, voice control and in elder ones, TSD & positive reinforcement are considered suitable.

References

1. Barbara LC, Hosey MT. Child taming: *How to manage children in dental practice*. 1st edition. Quintessence, 2003.
2. Dean JA, Avery DR, McDonald RE. McDonald and Avery’s *Dentistry for the Child and Adolescent*. 9th ed. Elsevier, Maryland heights, Missouri: 2011. p27-40.
3. Nash. Engaging children's cooperation in the dental environment through effective communication. *Pediatr Dent* 2006; 28:455-59.
4. Chambers DW. Communicating with the young dental patient. *JADA* 1976; 93:793-99.
5. Wepman BJ, Sonnenberg EM. Effective communication with the pedodontic patient. *J Pedod* 1978; 2:316-21.
6. Greenbaum PE, Lumley MA, Turner C, Melamed BG. *Dentist's reassuring touch: effects on children's behaviour*. *Pediatr Dent* 1993; 15:20-4.
7. Pinkham JR. *Pediatric Dentistry: Infancy through Adolescence*. 4th edition. Elsevier Saunders, 2005.
8. Sarnat H, Arad P, Hanauer D, Shohami E. Communication strategies used during pediatric dental treatment: a pilot study. *Pediatr Dent* 2001;23: 337-42.
9. American Academy of Pediatric Dentistry. Guideline on behaviour guidance for the pediatric dental patient. *Pediatr Dent Reference Manual* 2011;36:179-91.
10. Eaton J, Mc Tighe D, Fields H W, Beck M. Attitudes of contemporary parents toward behaviour management techniques used in pediatric dentistry. *Pediatr Dent* 2005; 27:107-13.
11. Klaassen MA, Veerkamp IS, Hoogstraten J. Dental fear, communication, and behavioural management. Problems in children referred for dental problems. *Intl J Peadiatr Dent* 2007; 17: 469-77.
12. Blomqvist M, Augustsson M, Bertlin C, Holmberg K, Fernell E, Dahllöf G, Ulla EK. How do children with attention deficit hyperactivity disorder interact in a clinical dental examination? A video analysis. *Euro J Oral Sci* 2005; 113:203-09.

PIEZOSURGERY- A NEW FRONTIER IN PERIODONTOLOGY AND ORAL IMPLANTOLOGY

*Dr.Renjith K.P,**Dr.Santhosh V.C,***Dr. Shabeer Mohammed M.,***Dr. Sameera G. Nath

Abstract

Periodontitis is a chronic inflammatory disease of the tooth and its supporting structures. The treatment of this condition is largely based on the removal of local factors and restoration of the bony architecture. Traditionally, osseous surgery has been performed by either manual or motor-driven instruments. However, both these methods have their own merits and demerits. Piezosurgery is a relatively new surgical technique for periodontology and implantology that can be used to complement traditional surgical procedures, and in some cases, replace traditional procedures.

Key words: Piezosurgery, osteotomy, sinus lift procedure, cavitation

Corresponding Author: Dr.Renjith K.P

Post Graduate Student, **Professor,*Senior Lecturer, Department of Periodontics, KMCT Dental College, Manassery P.O., Kozhikode, Kerala*

Introduction

The surgical techniques in dentistry have been developed rapidly over the last two decades. Traditionally, osseous surgery has been performed by either manual or motor-driven instruments.¹ Manual instruments offer good control when used to remove small amounts of bone in areas with relatively less dense mineralization. But they are difficult to control in cortical bone, particularly where precise osteotomies are essential.

As a consequence, they are mostly applied for gross cutting of larger bone segments. Motor-driven instruments are often used when bone is very dense. This is particularly troublesome when cutting across an area of dense cortical bone into either trabecular bone or soft tissue, as when drilling an osteotomy above the mandibular

canal or preparing a lateral window for sinus grafting.¹ The applied force necessary to cut through the denser bone must be instantaneously released when encountering the less dense tissue or the underlying structures may be damaged. One new surgical technique based on the novel application of the principle of piezoelectric ultrasonic vibration is introduced with wide range of applications in dentistry.

What is piezosurgery

Piezosurgery is a technique for osteotomy and osteoplasty that utilizes ultrasonic vibration. The piezosurgery device (Figure1) is essentially an ultrasound machine with modulated frequency and a controlled tip vibration range. The ultrasonic frequency is modulated from 10, 30, and 60 cycles/s (Hz) to 29 kHz.¹ The low frequency enables cutting of mineralized structures, not

soft tissue. Power can be adjusted from 2.8 to 16 W, with preset power settings for various types of bone density. The piezosurgery tip vibrates within a range of 60-200 mm, which allows clean cutting with precise incisions. Ultrasonic vibration is pulsed in blocks to offer greater impact to the hard tissue and improve cutting efficiency, thus shortening treatment time. Clinicians can choose from different types of mode depending on bone density.

Basics of piezosurgery

Diagnostic Medical sonography has been used since the late 1950s. Piezoelectricity was discovered in the 1880s by Pierre Curie and Jacques when he was using natural quartz.²⁻⁴ This effect was named “piezoelectricity” after the greek word “piezein”, which means to squeeze or press. The principle of Piezoelectric effect is converting energy by applying pressure to a crystal. When an electric voltage is applied to a transducer crystal, the crystal gets excited and is deformed.

Piezosurgery was developed by Italian oral surgeon Tomaso Vercellotti in 1988 to overcome the limits of traditional instruments in oral bone surgery by modifying and improving conventional ultrasonic technology. It uses a modulated ultrasonic frequency to permit highly precise and safe cutting of hard tissue.⁵

Piezosurgery can be used for hard tissue crown lengthening, where a flap is raised to gain full control of the dimensions of the biological width. Piezosurgery allows bone to be cut in a selective and atraumatic manner. Bone, being rigid, is cut easily by the high frequency micro-vibrations of the

instrument tips (60 to 200 mm/sec), whereas oral soft tissues (mucosa, neurovascular bundles) are not harmed even if they come into direct contact with the piezosurgery instruments.

Fig 1: Piezosurgery Unit



The action of piezoelectric device can be summarized by the following points:

Micrometric Cutting: Precise bone cutting accompanied by high tactile sensitivity.

Selective Cutting: Bone cutting without the risk of damaging adjacent soft tissues.

Asepsis: Sterile water

Cavitation Effect: For maximum intra operative visibility and high predictability.

Minimum surgical stress: Excellent tissue healing.¹⁰

Clinical Applications in Periodontics

Bone grafting

Autogenous bone procured using manual or motor driven instruments may not

be suitable for grafting because of the absence of osteocytes and predominance of non-vital bone. The Piezosurgery inserts used for bone harvesting produces a vibration with a width of 60 to 210µm in oscillation controlled module. The use of ultrasonic vibration makes micrometric bone cuts resulting in controlled osteotomies in mobilizing block graft in contrast to rotary burs or reciprocation saws. Stubinger et al in his analysis reported increase in levels of bone morphogenic protein (BMP-4) and transforming growth factor (2 proteins) in the bone harvested.⁶ The osteotomy makes a narrow cut and reduce bone damage and best results can be obtained in terms of bone regeneration.

Periodontal surgery assisted orthodontics

Here small vertical bone incisions were made between the teeth which allowed more expedient orthodontic movement. The corticotomy performed by piezosurgical saw reduced the treatment time by 60 to 70 % with accepted degrees of pain and discomfort. Another alternative technique to corticotomies was proposed by Sebaoun et al in which piezocision, minimally invasive flapless procedure combining micro incision, piezoelectric incision and selective tunneling showed better results compared to the earlier techniques used.

Routine Scaling and root planing

The piezosurgery device with a vibrating tip used for removal of debris ,calculus and stains uses cavitation effect and microstreaming, which disrupts the bacterial cell wall. The inserts (Figure 2a, b &c) used are placed vertically parallel to the long axis of the tooth and is moved

continuously providing better calculus removal and patient comfort.

Curettage of Pockets

Piezosurgery device can be used for debriding the epithelial lining of the pocket wall resulting in microcauterization. Piezosurgery device can be used for efficient removal of root calculus and residual soft tissue compared to manual instruments.

Fig 2a, b &c: Inserts



BLUNT INSERT TIPS

Blunt insert tips are used for preparing the soft tissue.
For example, for elevating Schneider's Membrane or for lateralizing nerves.
In periodontology, these tips are used for root planing.



SMOOTHING INSERT TIPS

The smoothing insert tips have diamond surfaces enabling precise and controlled work on the bone structures.
Smoothing insert tips are used in osteotomy when it is necessary to prepare difficult and delicate structures.
For example, those preparing for a sinus window or access to a nerve.
In osteotomy, smoothing insert tips are used to obtain the final bone shape.



Sinus lift procedure in implant surgery

The piezoelectric device used for sinus lift procedure comprises of handpiece fitted with the insert and irrigation fluid which removes debris from the cutting area. Piezoelectric osteotomies cuts mineralized tissue without damage to the scheinderman membrane allowing easy separation and is raised with piezoelectric elevators (Figure 3) without perforation and the space between the bone and membrane filled by new graft. There is no risk of injury to the adjacent structures and effect of cavitation cleans the working area improving the visibility.

Fig 3: Inverted cone tip for sinus lift procedure



Ridge split procedure for implant placement

Classic ridge split procedures are time consuming and requires technical skill. Rotating saws which are used will damage soft tissues such as tongue, cheek and the vertical incisions require more effort and care. But with Piezoelectric surgery, the split crest procedure used is technically less sensitive and horizontal and vertical incision is made without damaging the adjacent structures.

Other procedures

Osteoplasty, Osteotomy and crown lengthening requires careful removal of bone without damaging the adjacent structures and by using piezosurgery device, positive architecture is created for better flap closure and bone support.

Advantages of Piezosurgery

1. Precise cutting and safety⁷

The device enables hard tissue incision with superior precision for safe cutting action with minimum bone loss.

2. Greater control of surgical device⁸

The piezosurgery hand piece operates with ultrasonic frequency which is safe providing greater control of surgical device and enhanced operator sensitivity.

3. Bleeding- free surgical site

There is minimal bleeding of bone tissue and this provides good visibility of the operating site. The reason is due to the cavitation effect creating bubbles leading to implosion which generate shock waves causing micro-coagulation.⁹

4. Selective cutting and specificity to the surgical site⁸

Reduces the risk of damage to the soft tissue including arteries, nerves and risk of perforation to the sinus membrane is eliminated.

5. Faster bone regeneration and healing process⁸

Oxygen molecules released during cutting have antiseptic effect and ultrasound vibration stimulates cells metabolism. Lack of necrosis accelerates bone regeneration.

6. Decrease in post-operative pain⁷

Since the cutting action is less invasive producing less collateral damage which results in better healing.

7. Reduced traumatic stress.

Less noise is produced in comparison with the conventional motor driven devices so fear and psychological stress is reduced.⁹

8. No risk of emphysema⁴

The risk of subcutaneous emphysema is reduced due to aerosol effect that the ultrasonic device produce unlike the effect of air water spray generated with rotary instruments.

Disadvantages

1. High cost of the instrument. Ultrasonic osteotomy equipment is more expensive than conventional osteotomes.
2. Increased operating time. Cutting very dense bone will take upto 4 times longer than with a rotary bur.
3. Increase in tip breakage.

Recent advances

- Fiber Optic Piezo Ultrasonic unit are available on market today.
- Most powerful unit that is currently available with 16.5 watts of power at the tip.
- External irrigation with no worry of crystallization of saline during sterilization that can ruin hand piece.
- Titanium Nitride Coated bone cutting tips that increase cutting efficiency and life of tips.

Conclusion

Piezosurgery is an innovative osseous surgical technique in field of dentistry compared to the traditional methods that uses manual or rotary instruments. Piezosurgery ensures the predictability, less post operative pain and increased patient's compliance. It offers minimal risk of injury to the soft tissues, bloodless surgical field and, faster healing. So the use of piezosurgical device is not only limited to the field of dental surgery, but far beyond the horizon, in more complex cases and in all interdisciplinary problems pertaining in the effect of medical and dental sciences.

References

1. Hema Seshan, Kranti Konuganti, Sameer Zope. Piezosurgery in periodontology and oral implantology. *J Indian Soc Periodontol* 13: 155-56.
2. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. *J. Oral Surg* 1980; 38: 613-16.

3. Vercellotti T. Technological characteristics and clinical indications of piezoelectric bone surgery. *Minerva Stomatologica* 2004;53:5.
4. Puneet B, Vijay Prasad, K P. Ashok, Swetha S, Gupta G, Rao A . Piezosurgery: a novel approach in periodontics and oral implantology. *Dental Impact* 2014;6:20-3.
5. Laurence J. Piezosurgery: an increasing role in dental hard tissue surgery. *Aus Dent Prac* 2007;54-56.
6. Stubinger S, Kuttenger J, Filippi A Sader R, Zeilhofer HF. Intra oral Piezosurgery: Preliminary results of a new technique. *J Oral Maxillofac Surg* 2000; 63: 1283-87.
7. Escoda-francoli J Rodriguez rodrigueza berini aytes L et,al .application of ultrasound in bone surgery. Two case reports. *Med Oral Patol Cir Bucal* 2010; 15:902-05.
8. Schlee M, Stienemann M, Bratu E et al. Piezosurgery:basics and possibilities. *Implant Dent* 2006;12;334-40.
9. Stubinger S, Landes C,Seitz O,et al. ultrasonic bone cutting in oral surgery:a review of 60 cases *Ultraschall Med* 2008;29:66-7.
10. Esha Agarwal, Sujata Surendra Masamatti, Ashish Kumar. Escalating Role of Piezosurgery in Dental Therapeutics. *J Clin Diagnos Res.* 2014; 8: ZE08-11.

RADICULAR CYST : A REVIEW

*Dr. Faiz Aboobacker, *Dr. Indu Sundaram, *Dr. Hiba Ummer, **Dr. Anoop U R,

Dr. Rajeesh Muhammed P K,*Dr. Swapna Honwad

Abstract

Radicular cysts are the most common cystic lesions in the jaws. They generally result due to pulpal infection following dental caries, which induces the epithelial residues in the periodontal ligament to give rise to the cyst. This review is to highlight the pathogenesis of radicular cysts, their clinical features, histopathology and treatment aspects.

Key words: Radicular cyst, Rushton bodies, Cholesterol clefts

Corresponding Author: Dr. Indu Sundaram

** Post Graduate Student, **Professor & Head, *** Reader, ****Senior Lecturer, Department of Department of Oral Pathology & Microbiology, KMCT Dental College, Manassery P.O., Kozhikode, Kerala*

Introduction

A radicular cyst is generally defined as a cyst arising from epithelial residues (Cell rests of Malassez) in the periodontal ligament as a consequence of inflammation, usually following the death of dental pulp.¹ They are the most common cystic lesions encountered in the jaws. They are most usually found at the apices of the involved teeth, however they may also be found on the lateral aspects of the roots in relation to lateral accessory root canals. Quite often a radicular cyst may remain behind in the jaws; even after removal of the offending tooth and this is referred to as a residual cyst.^{2,3,4} They are most commonly associated with permanent teeth and are rare in the primary teeth.⁵

Epidemiology

Radicular cysts are the most common of all jaw cysts and comprise about 52% to

68% of all the cysts affecting the human jaws.³ Actual prevalence of cysts is only about 15% of all apical periodontitis lesion.^{3,4} Their prevalence is highest among patients in their third decade of life, and higher among men than women.⁴

Pathogenesis

Radicular cysts arise from the epithelial residues in the periodontal ligament as a result of inflammation. They generally result due to pulpal infection following dental caries. Bacteria from the gingival sulci or periodontal pockets have been suggested to reach the root canals of these carious teeth through severed periodontal blood vessels.⁶ Pulpal infection can also occur through exposed dentinal tubules at the cervical root surface, due to gaps in the cemental coating.⁷ Microbes have also been claimed to 'seed' in the necrotic pulp via the blood circulation (anachoresis).⁸ Initially, the tooth pulp

becomes infected and necrotic by an autogenous oral microflora. The endodontic environment provides a selective habitat for the establishment of a mixed, predominantly anaerobic microbial colonization. Collectively, this habitat-adapted polymicrobial community residing in the root canal has several biological and pathogenic properties, such as antigenicity, mitogenic activity, chemotaxis, enzymatic histolysis, and activation of host cells. The microbial invaders in the root canal can advance, or their products can egress, into the peri apex.

Fig 1: H & E stained radicular cyst under 10 X showing arcading pattern

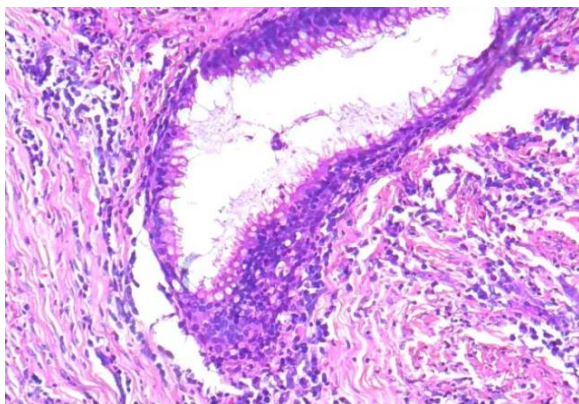
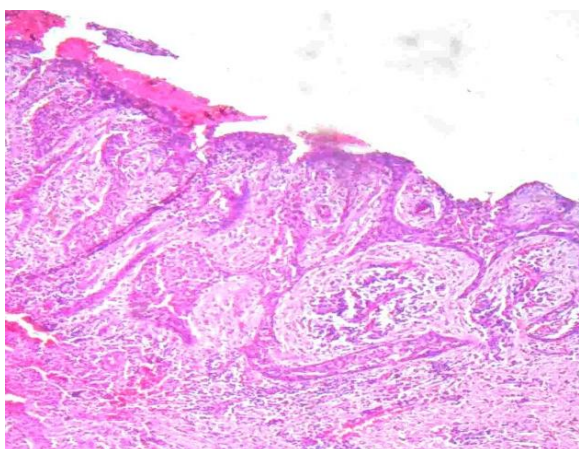


Figure 2 : H & E stained radicular cyst under 40 X showing metaplastic mucous cells in surface layer of stratified squamous ciliated epithelial lining



In response, the host mounts an array of defences consisting of several classes of cells, intercellular messengers, antibodies, and effector molecules. The microbial factors and host defense forces encounter, clash with, and destroy much of the periapical tissue, resulting in the formation of various categories of apical periodontitis lesions.⁷ Periapical cysts are a direct sequel to chronic apical periodontitis, but not every chronic lesion develops into a cyst. There are two distinct categories of periapical cysts, namely, those containing cavities completely enclosed in epithelial lining, and those containing epithelium-lined cavities that are open to the root canals. The latter was originally described as 'bay cysts' and has been newly designated as 'periapical pocket cysts'. More than half of the cystic lesions are true apical cysts, and the remainder are apical pocket cysts.³

Pathogenesis of true cysts

The periapical true cyst may be defined as a chronic inflammatory lesion at the periapex that contains an epithelium-lined, closed pathological cavity. The pathogenesis of true cysts has been described by various authors.^{7,8,9} An apical cyst can arise as a result of direct sequale to apical granuloma, although a granuloma need not always develop into a cyst. Due to still unknown reasons, Only a small fraction (<10%) of the periapical lesions advance into true radicular cysts¹⁰. The pathogenesis of the true cyst has been described in three phases^{3,4,11}. During the first phase, the dormant cell rests of malassez begin to proliferate as a direct effect of inflammation, probably under the influence of bacterial antigens.^{3,4,12} Epidermal growth factors, cell

mediators and metabolites that are released by various cells residing in the periapical lesion. during the second phase, an epithelium-lined cavity comes into existence. There are two main theories regarding the formation of the cyst cavity.^{3,4,12,13}

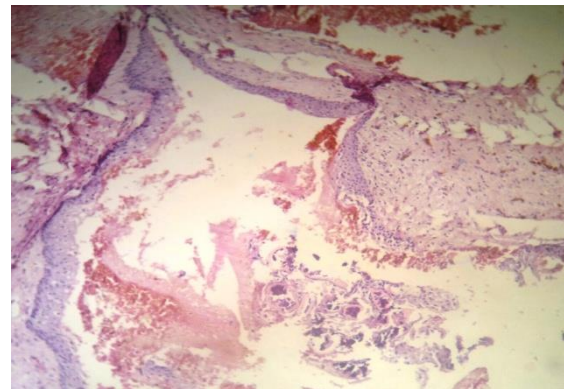
1. The '*nutritional deficiency theory*' is based on the assumption that the central cells of the epithelial strands become removed from their source of nutrition and undergo necrosis and liquefactive degeneration, the accumulating products in turn attract neutrophilic granulocytes into the necrotic area. Such microcavities containing degenerating epithelial cells, infiltrating mobile cells and tissue fluid coalesce to form the cyst cavity lined by stratified epithelium.

2. The '*abscess theory*' postulates that the proliferating epithelium lines an abscess cavity formed by tissue necrosis and lysis because of the innate nature of the epithelial cells to cover exposed connective tissue surfaces. During the third phase the cyst grows, but whose exact mechanism is still unknown. It is generally believed to be by osmosis. The presence of necrotic tissue in the cyst lumen attracts neutrophilic granulocytes, which extravasate and transmigrate through the epithelial lining in to the cyst cavity where they perish. The lytic products of the dying cells in the cyst lumen release a greater number of molecules. As a result, the osmotic pressure of the cyst fluid rises to a level higher than that of the tissue fluid. The latter diffuses into the cyst cavity so as to raise the intra luminal hydrostatic pressure well above the capillary pressure. The increased intra cyst

pressure may lead to bone resorption and expansion of the cyst .⁴

However, the fact that an apical pocket cyst with lumen open to the necrotic root canal can become larger suggests against osmotic pressure as a potential factor in the development of radicular cysts. Further, there is increasing evidence in support of a molecular mechanism for cyst expansion. The t-lymphocytes and macrophages in the cyst wall may provide a continuous source of bone resorptive metabolites and cytokines. The presence of effector molecules such as matrix metalloproteinase-1 and -2 have also been reported in the cyst walls.^{12,14}

Figure 3: H & E stained slide showing hyaline bodies in the lumen of a radicular cyst

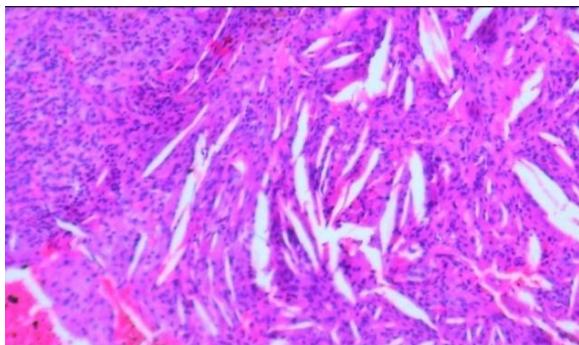


Pathogenesis of pocket cysts

The periapical pocket cyst contains an epithelium-lined pathological cavity that is open to the root canal of the affected tooth. As mentioned previously, such lesions were originally described as 'bay cysts'. It has been postulated that biologically, a pocket cyst constitutes an extension of the infected root canal space into the periapex. The micro luminal space becomes enclosed

in a stratified squamous epithelium that grows and forms an epithelial collar around the root tip. The epithelial collar forms an 'epithelial attachment to the root surface so as to seal off the infected root canal and the micro-cystic lumen from the periapical milieu and the rest of the body. The presence of microorganisms at the apical foramen attracts neutrophilic granulocytes by chemotaxis into the micro lumen. However, the pouch like lumen biologically outside the body milieu acts as a 'Death trap' to the externalized neutrophils. As the necrotic tissue and microbial products accumulate, the sac-like lumen enlarges to accommodate the debris, forming a voluminous diverticulum of the root canal space into the periapical area.⁴ It has been pointed out that from the pathogenic, structural, tissue dynamic, host-benefit and protection stand points, the epithelium-lined pouch-like extension of the root canal space of such lesions has much in common with a marginal periodontal pocket.¹¹

Figure 4: H & E stained slide of radicular cyst under 40 x showing cholesterol cleft spaces



Clinical presentation

Most of the radicular cysts are symptomless and are discovered when periapical radiographs are taken for teeth

with non-vital pulps. Patient often complains of slowly enlarging swellings. At first the enlargement is bony hard but as the cyst increases in size, the covering bone becomes very thin despite sub periosteal bone deposition and the swelling then exhibits egg shell crackling or oil can bottoming or 'springiness'. Only when the cyst has completely eroded the bone, there will be fluctuation. In the maxilla there may be buccal or Palatal enlargement whereas in the mandible it is usually labial or buccal and only rarely lingual.⁴ Pain and infection are other clinical features of some radicular cysts. It is often said that radicular cysts are painless unless infected. Some patients with these lesions, however, complain of pain although no evidence of infection is found clinically and no evidence of acute inflammation is seen histologically after the cyst has been removed. Likewise, some patients have clinically infected and histologically inflamed cysts which are not painful.^{10,15,16} A sine qua non for the diagnosis of a radicular cyst is the related presence of a tooth with a non-vital pulp. Occasionally, a sinus may lead from the cyst cavity to the oral mucosa. quite often, more than one radicular cyst may be found in a patient.⁴

Radiological features

Radiographically most radicular cysts appear as round or pear-shaped unilocular radiolucent lesions in the periapical region. The cysts may displace adjacent teeth or cause mild root resorption. Radiographically, a difference between a granuloma and a cyst is impossible, although some say that if the lesion larger than 2 cm is more likely to be a cyst.^{4,15,16}

Pathological features

The gross specimens may be spherical or ovoid intact cystic masses, but often they are irregular and collapsed. The walls vary from extremely thin to a thickness of about 5 mm. The inner surface may be smooth or corrugated. Yellow mural nodules of cholesterol may project into the cavity. The fluid contents are usually brown resulting from the breakdown of blood and when cholesterol crystals are present they impart a shimmering gold or straw Colour.⁴

Microscopic features

Almost all radicular cysts are histopathologically lined wholly or in part by non-keratinized stratified squamous epithelium. These linings may be, discontinuous in part and range in thickness from one to 50 cell layers. The majority are between six and 20 cell layers thick.

The epithelial linings may be proliferating and show arcading with an intense associated inflammatory process or be quiescent and fairly regular with a certain degree of differentiation. The inflammatory cell infiltrate in the proliferating epithelial linings consists predominantly of Polymorphonuclear leucocytes whereas the adjacent fibrous capsule is infiltrated mainly by chronic inflammatory cells.⁴ In approximately 10 per cent of periapical cysts, hyaline bodies (often referred to as Rushton's hyaline bodies) are found in the epithelial linings. Rushton bodies occur almost exclusively within odontogenic cysts.¹⁷ Such bodies within the epithelial lining are characterized by a glassy pink (hyalinized) appearance.

The origin of such bodies is believed to be related to previous hemorrhage within

the inflamed cyst wall.^{18, 19} They may show up in examination of the gross specimen as small, white, dome-shaped swellings measuring up to 0.1 mm on the epithelial surface and protruding into the cyst cavity.⁴ In microscopic sections, they appear as eosinophilic, linear, straight or curved or hairpin shaped, circular or polycyclic forms, often with a granular core and sometimes concentrically laminated. They are found almost always within the epithelial lining and only rarely in the fibrous capsule.^{4,20}

Metaplastic changes, in the form of mucous cells or ciliated cells, are frequently found in the epithelial linings of radicular cyst. They may be present in the surface layer of the stratified squamous epithelial lining, either as a continuous row or as scattered cells, and they may be found associated with ciliated epithelium.

Treatment

The treatment options for radicular cyst can be conventional nonsurgical root canal therapy when lesion is localized or surgical treatment like enucleation, marsupialisation or decompression when lesion is large.²¹ The choice of treatment may be determined by the factors such as the extension of the lesion, relation with noble structures, origin, and the clinical characteristics of the lesion, and cooperation and systemic condition of the patient.^{22, 23}

The treatments of these cysts are still under discussion and many professionals option for a conservative treatment by means of endodontic technique.²⁴ However in large lesions the endodontic treatment alone is not efficient and it should be associated to a decompression or a marsupialization or even to enucleation.^{25, 26}

References

1. Nainani P, Sidhu GK. Radicular Cyst – An Update with emphasis on Pathogenesis. *J Adv Med Dent Sci Res* 2014;2:97-01.
2. Taylor E. *Dorland's Illustrated Medical Dictionary*, 27th edn. Philadelphia: W.B. Saunders Co., 1988. pg3
3. Nair PNR. Non-microbial etiology: periapical cysts sustain post-treatment apical Periodontitis. *Endodontic Topics* 2003;6: 96-13.
4. Shear M. *Cysts of the Oral Regions*, 3 edition, Boston, Wright, 1992 .pp. 136-70.
5. Lustman J, Shear M. Radicular cysts arising from deciduous teeth: Review of the literature and report of 23 cases. *Int J Oral Surg* 1985;14:153-61.
6. Grossman LI. Origin of microorganisms in traumatized, pulpless, sound teeth. *J Dent Res* 1967 46:551-53.
7. Nair PNR. Pathogenesis of Apical Periodontitis and the Causes of Endodontic Failures. *Crit Rev Oral Biol Med* (2004);15:348-81.
8. Allard U, Nord CE, Sjöberg L, Strömberg T. Experimental infections with *Staphylococcus aureus*, *Streptococcus sanguis*, *Pseudomonas aeruginosa*, and *Bacteroides fragilis* in the jaws of dogs. *Oral Surg Oral Med Oral Pathol* 1979 ;48:454-62.
9. Nair PNR. New perspectives on radicular cyst: do they heal? *Int Endod J* 1988; 31: 155-60.5,7.
10. Bhaskar SN. Periapical lesion - types, incidence and clinical features. *Oral Surg Oral Med Oral Pathol* 1966; 21: 657-71.
11. Nair PNR, Pajarola G, Schroeder HE. Types and incidence of human periapical lesions obtained with extracted teeth. *Oral Surg Oral Med Oral Pathol* 1996; 81: 93-102.
12. Takahashi K. Microbiological, pathological, inflammatory, immunological and molecular biological aspects of periradicular disease. *Int Endod J* 1998;31:311-25.
13. Cohen S, Burns RC. Pathways of the pulp, 8th edition, Harcourt Asia Co., India, 2002.pp.457-500.
14. Marton IJ, Kiss C. Protective and destructive immune reactions in apical Periodontitis. *Oral Microbial Immunol* 2000; 15 : 139-50.
15. Cawson RA, Odell EW, Porter S .*Cawson`s essentials of oral pathology and oral medicine*.7th ed, Churchill Livingstone, Edinburgh,2002.pp. 102-14.
16. Regezi JA, Sciubba JJ, Jordan RCK. *Oral Pathology: clinical pathologic correlations*. 4th ed, WB Saunders, St Louis, 2003.pp.241-54
17. Jacob, S. Rushton bodies or hyaline bodies in radicular cysts: a morphologic curiosity. *Indian Journal of Pathology & Microbiology*, 53, 846–47.
18. Neville BW, Damm DD, Allen CM, Bouquot JE. *Oral and maxillofacial pathology*, 2nd edition, Philadelphia, W.B. Saunders; 2002.pp. 107-36.

19. Rajendran R, Sivapathasundaram B. In *Shafer's Text-book of Oral pathology*, 5th edition, Reed-Elsevier India Private Limited. 2006. pp. 376-80.
20. Mathews JB. *Hyaline and foreign bodies in cyst walls*. In: Browne RM, editor. *Investigative pathology of the odontogenic cysts*. Boca Raton, Florida CRC Press; 1991. p. 191-10.
21. Ribeiro Paulo Domingos, Gonçalves Eduardo S., Neto Eduardo S. *Surgical approaches of extensive periapical cyst. Considerations about surgical technique*. *Salusvita Bauru* 2004; 23: 317-328
22. Michael Mh, Gary LL. Conservative treatment of persistent periradicular lesions using aspiration and irrigation. *J Endod* 1990;16:182-6.
23. Neaverth EJ, Burg HA. Decompression of large periapical cystic lesions. *J Endod* 1982;8:175-82.
24. Hoen M.M. Conservative Treatment of Persistent Periradicular Lesions Using Aspiration and Irrigation. *J Endod* 1990; 16: 182-6.
25. Danin J. et al. *Outcomes of periradicular surgery in cases with apical pathosis and untreated canals*. *Oral Surgery and Oral Medicine and Oral Pathology and Oral Radiol. Endodontic* 1999; 87:227-32.
26. Rees. J.S. Conservative Management of a large maxillary cyst. *Int Endod J* 1997; 30: 64-7.

AWARDS AND ACHIEVEMENTS



Dr. Indu Sundaram
 3rd year PG Student (Oral Pathology)
 Best Paper - Original Research
 12th State Conference KSOMP,
 Kothamangalam, March 2015

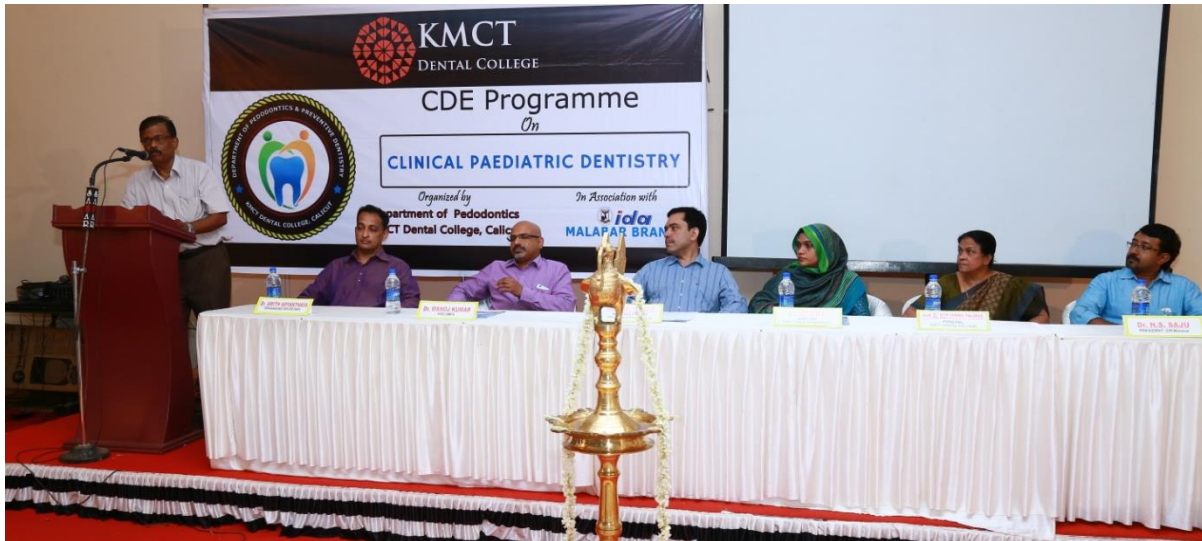


Dr. Rahul C S
 3rd year PG Student (Orthodontics)
 First Runner-Most promising Senior
 Postgraduate Student in Dentistry at D+ve,
 Season 2, State Level Talent Hunt, Palakkad,
 May 2015

A CDE on comprehensive evaluation and treatment planning of dentofacial deformities – KOSMECT 15 organized by Prof. Dr. Manoj Kumar K P (*Organizing Chairman*) and Prof. Dr. Benny Joseph (*Organizing Secretary*), Department of Oral and Maxillofacial Surgery in association with AOMSI Kerala State on 26th April at KMCT Medical College, Manassery. The Speakers for the programme were Dr. Varghese Mani, Dr. Sherry Peter, and Dr. Maria John Kuriakose.



A CDE on Clinical Paediatric Dentistry for Post Graduate students, Interns and General Practitioners was organized by Prof. Dr. E Ramakrishnan (*Organizing Chairman*) and Dr. Amit Adyanthaya (*Organizing Secretary*), Department of Pediatric Dentistry in association with IDA Malabar Branch on 7th June at KMCT Dental College, Manassery. The Guest Speaker for the programme was Dr. Madhu S, Associate Professor, Govt. Dental College, Kottayam.



Speakers from left:
 Dr. E. Ramakrishnan
 Dr. Amit Adyanthaya
 Dr. Madhu S
 Dr. Dhanya Krishnan
 Dr. Akhilesh R A
 Dr. Aneesha N K