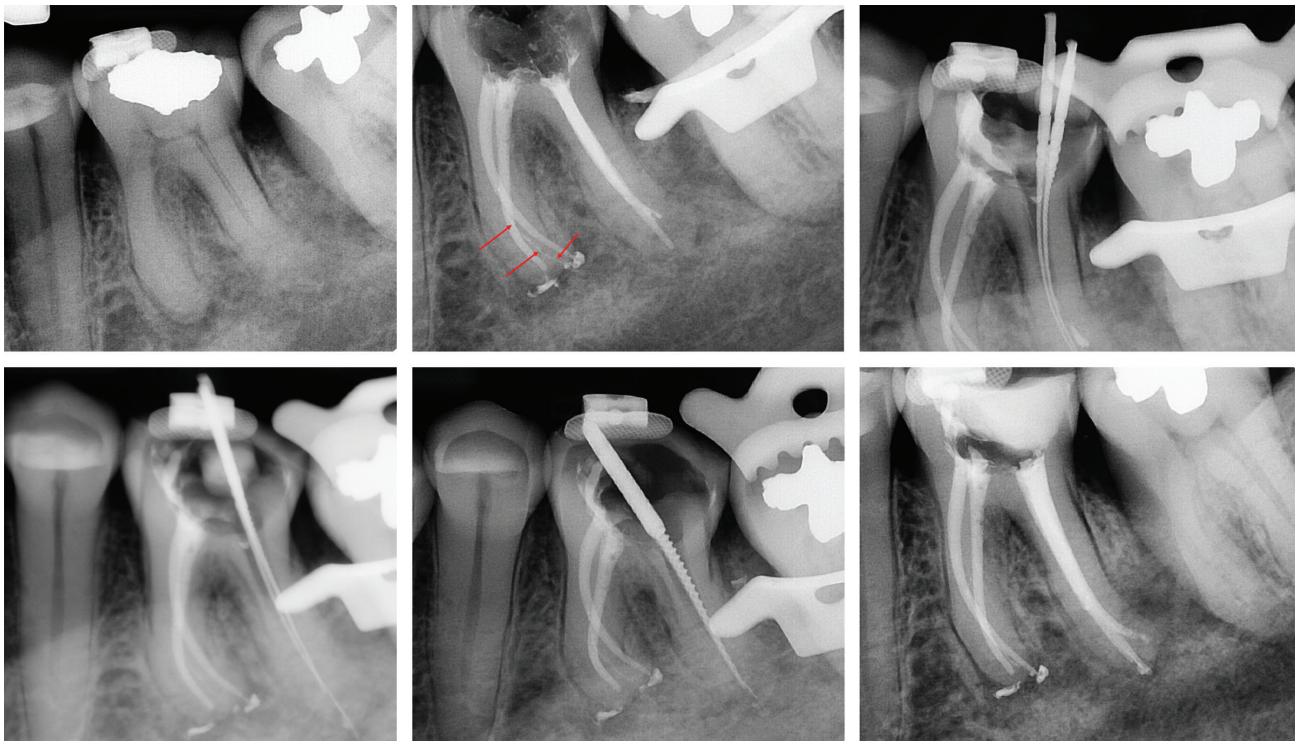
Endodontic Society of the Philippines

ESP Journal

December 2020 · Volume 13, Number 1
ISSN 2094-3903



Official Journal of the Endodontic Society of the Philippines

CONTENTS

1 Subcutaneous Emphysema - Identification, Management, and Prevention: A Case Report

Randolph Todd and Christina Boyd

6 Managing Anatomic Complexities in the Revision of Previous Root Canal Treatment

Alex B. Yee and James L. Gutmann

10 Diagnosis and Clinical Management of Radix Entomolaris

Michelle S. Santos, Young Min Jung, Grace Ellen S. Dey and Iluminada L. Viloria

16 Mineral Trioxide Aggregate Pulpotomy for Apexogenesis of an Immature Permanent Molar

Fredrick Ikhabi Weboko, Benjamin Simiyu Nyongesa, Mercy Naswa Makhanu, Michelle S. Santos, Katrina G. De Luna, Grace Ellen S. Dey and Iluminada L. Viloria

22 Practice Guidelines During COVID-19 FOR ENDODONTISTS AND GENERAL DENTISTS

ABOUT THE ENDODONTIC SOCIETY OF THE PHILIPPINES (ESP) JOURNAL:

THE ESP JOURNAL GUIDELINES FOR AUTHORS:

The ESP Journal calls for interested Endodontic specialists or specialists from other branches of dentistry, general dentists, academicians, researchers, and dental students, who would like to submit papers that would be relevant in the practice, research, and development of Endodontics in the global setting.

The ESP Journal is a refereed journal. All submissions undergo initial review by one member of the editorial board and if approved, will be advanced to the rest of the editorial board for further peer-review.

The ESP Journal provides detailed information about the review and publication process.

I. Authorship, Copyright, and Permissions

- *The ESP Journal* defines "authors" as those individuals who have been involved in the preparation of a manuscript and not all individuals who may have been involved in the project or program the manuscript discusses. The latter individuals should be acknowledged in an "Acknowledgments" section. For manuscripts with co-authors, the order would be: the first name of author to appear is the main author of the manuscript, followed by co-author/s who have contributed in the preparation of the paper itself.
- All submissions to *The ESP Journal* must be an original work of the author/s listed and must not have been previously published in another journal. An author submitting a manuscript that includes material that has been reproduced or adapted from a copyrighted source is responsible for obtaining any necessary permission from the copyright owner and acknowledging accordingly in the manuscript that such permission was obtained.
- "Authorized Reprinted Articles" pertain to those papers that have been published in another journal and has granted *The ESP Journal* the permission to re-publish said articles in verbatim. Proper acknowledgement of the original authors and publishing journal should be present in the paper.
- *The ESP Journal* highly observes "writing ethics". Any mode of plagiarism in a submitted article will not be tolerated and such articles will be rejected by the editorial board.

II. Manuscript Format Considerations

All submissions to *The ESP Journal* should be in Microsoft Word file. Additional format considerations are as follows:

- Text should be one font, font size, and font color.
- Paragraphs should be left aligned, not indented, and single-spaced, with one line of space between paragraphs.
- Tables and figures should be positioned at the appropriate places within the body of the manuscript.
- HTML formats are not acceptable, and *The ESP Journal* does not support other web enhancements, including such formats as multimedia (sound/video).

III. Manuscript Structure Considerations

A. Organization of Original Research Manuscripts:

I. Title:
The title should have no abbreviations. It is important that the title is attention-catching and is reflective of the content and topic.

II. Authors Information:
The entry for author information should be: full name, title, and institutional affiliations (Position, Name of Institution, Department/College, City, Country).

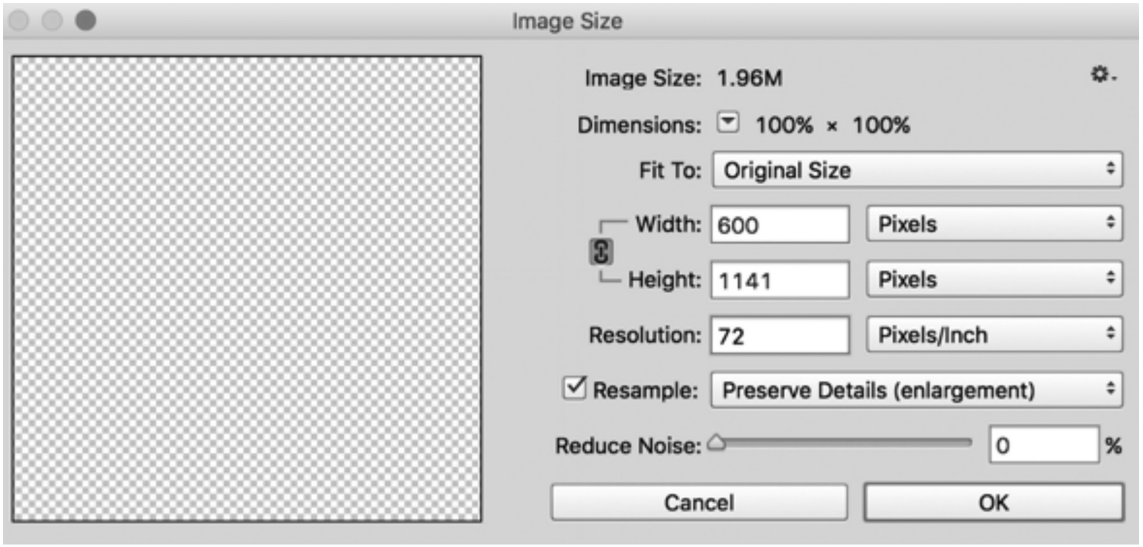
III. Abstract:
The abstract is a concise description of the problem, hypothesis, methods, results, and conclusion.
It should be no more than 250 words and is in bold format. 2-3 keywords may follow the abstract.

IV. Introduction:
This section should entice readers by describing the need for bridging the gap of a particular knowledge.
A few relevant review of literature and historical background of the problem covers this section.

V. Materials and Methods:
Materials and methods should all be described in paragraph form. No bullets are accepted.

VI. Results:

Relevant Figures and Tables that would clearly reflect on possible conclusions are in this section.
Each figures and table should have brief descriptions. Figure/Image formats if using Photoshop should be:



VII. Discussion:

This section discusses the current study's result with previous studies and how it can affect the purpose of the study. More importantly, conclusions are drawn in this section.

VIII. Acknowledgments

IX. References:

Reference style follows the following format:

- For published journal articles:
  Author/s (Surname, First and middle Initials). Title. Journal/Publication Year; Volume No: page/s.
  Example: Gutmann JL, Primus CM, Regan JD, Hill G, Woodmansey KF, Tay FR. Biocompatibility of a mineral trioxide aggregate-based root canal sealer - ProRoot® ES (Endo Sealer). Int J Endod Rehabil 2015;1:3-11.
- For published online articles:
  Author/s (Surname, First and middle Initials). Title. Journal/Publication Year; Volume No: page/s; Link.
  Example: Primus CM, Gutmann JL, Yapp R, Tay FR. Physical properties of new generation tricalcium silicate dental materials. Bioceram Dev Appl 2014;4:76, 2014; http://dx.doi.org/10.4172/2090-5025.

B. Original Case Reports:

I. Title (same as in Section A)
II. Introduction
III. Case History
IV. Materials and Methods
V. Discussion
VI. Conclusion
VII. Acknowledgments
VIII. References

IV. Submission Procedure

Submissions are to be emailed to espjournal@yahoo.com. Acceptance of article will be notified to the main author through email. Unless the author has complied and has satisfied all members of *The ESP Journal* editorial board before the cut-off date for the upcoming issue, the article will be considered "pending" and will not be published on the said upcoming issue.

Subcutaneous Emphysema - Identification, Management, and Prevention: A Case Report

Randolph Todd, DDS

Christina Boyd, DDS

Abstract

Endodontic infections are of bacterial origin (1). The spread of the infection is a function of (a) the patient's physical and immunological resistance and (b) the virulence of the infecting organism (2). Once a physical barrier like bone surrounding an infection is perforated, the muscle attachment, as well as the arrangement of the fasciae, will determine if the infection will spread or be contained. Potential spaces between the fasciae and the underlying structures exist. These spaces can quickly become a thoroughfare through which infections spread (2).

The pressure exerted by the bacterial infections is not the only way that these pathways can be opened. Trauma, vigorous coughing, habitual performance of the Valsalva maneuver, surgical procedures, and iatrogenic misdirected compressed air are amongst other possible etiologies (3, 4). When the fascial planes open via compressed air, a rapidly developing condition called subcutaneous emphysema (SE) develops. SE is defined as the abnormal presence of air in the tissue spaces (5).

In most cases, when this condition is related to dental treatment, it is transient and with proper management, resolves after a few days. However, it is a frightening and unpleasant event for both the patient and the doctor and requires immediate attention to avoid serious complications (6, 7).

The purpose of this case report is to review the pathways that SE follows and how to rapidly manage this condition. Changes in technique, equipment, preoperative evaluations and post treatment management can reduce patient risk and protect patients from SE and its consequences.

Keywords: subcutaneous emphysema, dental air polishers, fascial planes, crepitus, rapid swelling, dental emergencies

Significance: The significance of this case report is to provide a review of the pathways that subcutaneous emphysema follow and how to rapidly manage this condition. Changes in technique, equipment, preoperative evaluations and post treatment management can reduce patient risk and protect them from its consequences.

Introduction

Swelling of the facial region is a common emergency in the dental office. Effective treatment is dependant on proper diagnosis. Endodontic infections are of bacterial origin (1). The spread of the infection is a function of the patient's physical and immunological resistance as well as the virulence of the infecting organism (2). In many cases, once the bone surrounding the infection is perforated, the muscle attachment, as well as the arrangement of the fasciae will determine if the infection will spread or be contained (20). Potential spaces that exist between the fasciae and the underlying structures are not isolated compartments. These spaces can quickly become a thoroughfare through which infections spread (2).

In many cases, the inflammation creates enough intra-tissue pressure to dissect thru these fascial planes. Although rare, bacterial infections are not the only way that these delicate pathways can be opened. Trauma, vigorous coughing, habitual performance of the Valsalva maneuver, surgical procedures and iatrogenic misdirected compressed air are amongst

Fascial Space Subtype	Fascial Space Subtype Components
Fascial spaces of the face	Canine, buccal, parotid, infratemporal, masticatory space Masseteric Pterygomandibular Temporal
Suprahyoid fascial spaces	Sublingual, submental, submandibular, lateral pharyngeal, peritonsillar
Infrahyoid fascial spaces	Pre-tracheal
Fascial spaces of the neck	Retropharyngeal, danger, carotid sheath

Figure 1: Fascial Spaces

other possible etiologies (3, 4). When the fascial planes open via compressed air a rapidly developing condition called subcutaneous emphysema (SE) develops. SE is defined as the abnormal presence of air in tissue spaces (5). It was previously described as pneumomediastinum. Laenec, back in 1827, coined the term "inter-lobar emphysema" (6, 7). SE can occur during dental extractions, periodontal, and restorative procedures. As noted in the literature, patients seem to be more at risk if there is pre-existing periodontal disease (8). Other issues that can be a factor in this condition include air extruded through endodontic perforations, the use of air-driven syringes to dry canals, and the misuse of rubber dams – or not using a rubber dam.

In most cases, when this condition is related to dental treatment, it is transient and with proper management, resolves after a few days. However, it is a frightening and unpleasant event for both the patient and the doctor and requires immediate attention to avoid serious complications.

"There are 16 fascial spaces of the head and neck region divided into four subtypes (Fig. 1). These four subtypes are the fascial spaces of the face, suprahyoid spaces, infrahyoid spaces, and the spaces of the neck" (4). Infections or air can pass through fascial spaces of the face, to the suprahyoid space, to the infrahyoid space, to the deep spaces of the neck. The health risks of the infection increase as it approaches the deep spaces of the neck. Dire consequences are possible due to this intimate relationship.

A review of the literature by McKensie and Rosenberg reveals that from 1993 to 2008 only 32 cases were reported relating cutaneous emphysema to dental or surgical procedures, wherein "sixteen of the 32 cases were linked to air-driven handpieces. Only five cases (15%) resulted in significant complications (7). It should be noted that despite the infrequent occurrence, iatrogenic SE can have serious and potentially life-threatening consequences" (8). The purpose of this case report is to review the pathways of SE and how to rapidly manage this condition.

Case Report

A 49-year-old male patient was referred for an emergency evaluation. He had spontaneously developed an acute facial swelling following a routine dental prophylaxis. The swelling appeared to involve the left buccal space. No prior pain or swelling was reported. His dentist was unable to determine the etiology and referred him to his periodontist for further evaluation. Within an hour, the swelling had spread to the left canine and buccal spaces. A periodontal etiology for the swelling was ruled out and the patient was immediately referred for an endodontic consultation.

A careful review of the patient's medical and dental history was completed. His medical history was unremarkable. The dental history includes previous root canal treatment and crowns on the maxillary left first and second molar, and an impacted maxillary left 3rd molar. The remaining teeth in the maxillary and mandibular left quadrants had been moderately restored. The patient denied pain, dysphagia, or dyspnea. Extra-orally, the swelling was not warm or erythematous. Upon light palpation, crepitus could be felt in the buccal space. Although there was swelling present extra-orally in the left buccal, canine, and infraorbital spaces, intra-oral swelling was not detected. The probing depths in the region were normal. Significant mobility was not detected. Tooth #15 had more pain on palpation and percussion when compared to tooth #14. All other teeth in the maxillary and mandibular left quadrants tested normal to palpation, percussion, and thermal testing.

Radiographically (Fig. 2), tooth #14 is restored with a crown, had prior RCT and exhibits a normal PDL and lamina dura. Tooth #15 is restored with a crown. The mesial margin of the crown rests on a composite. There is an apical radiolucency and resorption. Normal crestal bone was noted and confirmed on a CBCT. The left maxillary sinus was clear with no evidence of mucositis. Additionally, the CBCT revealed a classic "soap bubble" pattern within multiple fascial spaces (Fig. 3). Note that it even extends into the submandibular space.

A differential diagnosis included a) soft tissue infection b) angioedema c) allergic response d) hematoma and e) dental abscess. All would have presented with a rapid development but this case presented with minimal if any bleeding, erythema, pain or warmth to the touch. According to Hayduk et al., the finding of "crepitus" (a popping sound when palpated) is a pathognomonic sign of SE (9). Although a MDCT (multi-detector computed tomography) was not available for further confirmation, the CBCT radiographic presentation was consistent with the diagnosis of SE (10). Further investigation disclosed the use of an air polisher during the patient's prophylaxis. A CBC blood test was reserved in the event that any drainage developed. Based on the patient's history and a clinical and radiographic exam, the primary diagnosis was SE (11). This affected the submandibular,

Tooth #15

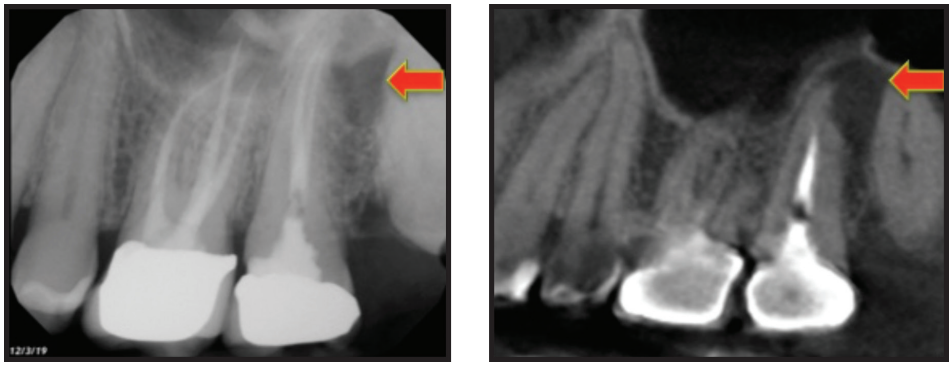


Figure 2: Apical periodontitis observed and confirmed on CBCT (note apical resorption on CBCT)

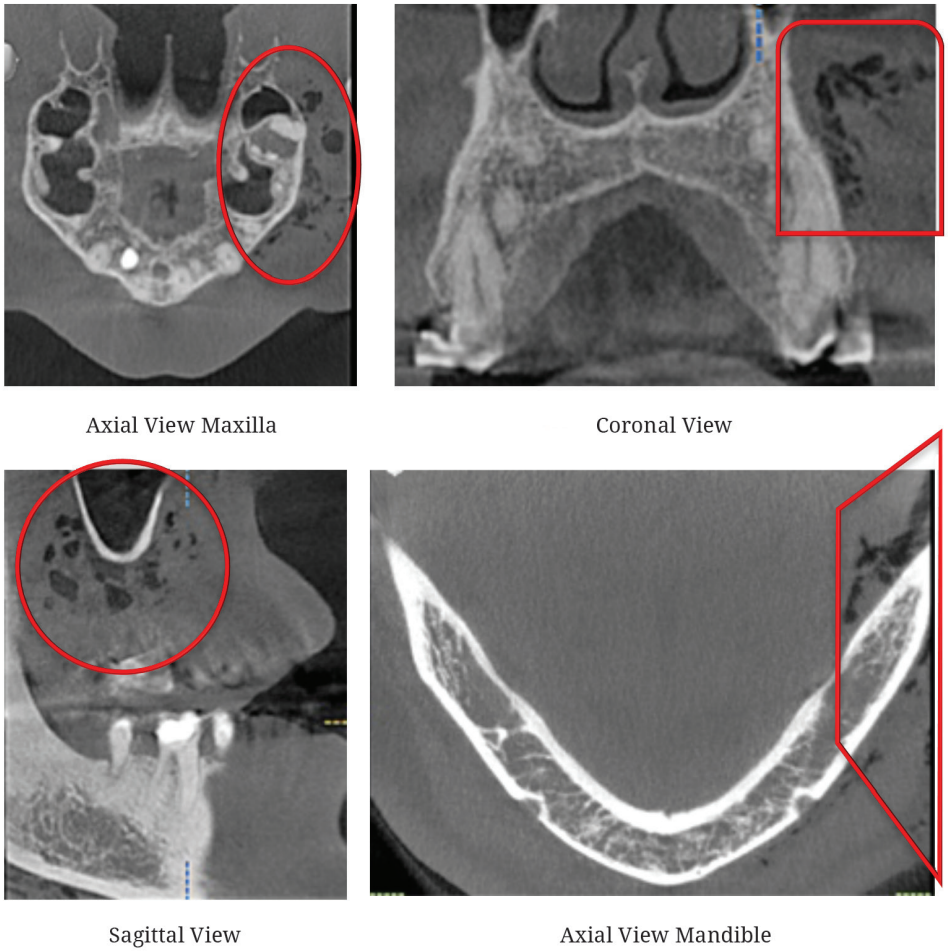


Figure 3: Left Buccal & Infraorbital Space – soap bubble pattern

buccal, and canine spaces on the patient's left side. A secondary diagnosis of previous RCT with symptomatic apical periodontitis was established for tooth #15. Despite the normal periodontal soundings, it is suspected that the compressed air from the polisher entered the subcutaneous tissues along the distal defect on tooth #15.

The patient was prescribed a prophylactic antibiotic to guard against secondary infection (Amoxicillin 875mg BID for 7 days) and was monitored closely. Steroids were not prescribed at this time. Eighteen hours later, the patient was contacted and although he mentioned the facial swelling was slightly worse, he denied any pain, difficulty breathing, or swallowing. He was monitored the following day and the swelling had decreased. He continued to deny any pain, difficulty breathing, or swallowing. The patient completed the course of antibiotics and all clinical signs and symptoms subsided. The risk of further migration of air into subcutaneous connective tissue spaces appeared eliminated. Concern for conditions such as a) pneumomediastinum b) pneumothorax c) pleural effusion d) arrhythmias e) electrocardiogram alterations f) periorbital infusions g) seizures or h) brain ischemia appear unlikely (12, 13, 14).

Discussion

SE, at times, is not a preventable condition. It can be a byproduct of blunt force trauma (motor vehicle accidents), abuse or even infections with gas-forming bacteria. On occasion, when related to dental procedures, it can be an accidental consequence of modern technology or a function of an unrecognized structural weakness in natural anatomy (lack of attached periodontal tissue).

On the other hand, iatrogenic SE can occur from high-speed air driven handpieces, "blow-drying" of root canals, and clearing of restorative preparations or surgical fields with compressed air (15, 16, 17). The use of an air polisher in combination with an abrasive powder has also been documented to cause SE (18). It has been suggested that the combination of an air polisher with an abrasive powder can alter the speed and trajectory of the particles. This can increase the abrasive potential of their impact on the adjacent intact mucosa (19).

Changes of equipment, pre-treatment assessment of the periodontal conditions and reduction of air pressure may reduce patient risk of SE. The equipment selected for a procedure frequently determines the direction of the airflow. Alternative handpieces that offer a rear exhaust feature reduces the risk of SE by redirecting the air from the surgical site.

During root canal treatment, canals can be effectively dried using an aspirating technique followed by a few paper points. This would eliminate the risk of compressed air traveling through the root and into the periapical area. Similarly, when clearing a surgical field, a low pressure "Stropko" syringe should be used to reduce the risk of spreading and tearing exposed fascial planes (Stropko units reduces air pressure from 50 psi to 10 psi). Prevention of SE is clearly paramount but, in the event, that it develops, rapid diagnosis and early intervention is equally important.

A comprehensive history, both medical and dental, facilitates the process of diagnosis. It may identify those prone to oral infections (i.e. diabetics, HIV, immuno-compromised etc.). SE usually presents itself as a rapidly spreading swelling. It is differentiated from other swellings by a unique (crepitus) finding through palpation. Supportive tests like a CBCT or MDCT and at times a blood test will help confirm or rule out the diagnosis. Identifying the causative agent is essential. Infection and further trauma are potential secondary consequences to SE. Prophylactic broad-spectrum antibiotics and steroids are frequently considered when treating this condition however, there is no clear consensus on their use (20). Complications such as fear, anxiety and pain may be very real and require case-by-case management.

Close monitoring is critical. Watch for a distortion in vision, brain function, discharge, respiratory distress, or cardiac distress. This will enable a rapid response if the SE extends into deeper fascial planes. Introduction of air and or bacteria into the pleural or mediastinal space can cause airway obstruction and death. A medical consultation is frequently sought if rapid resolution does not follow. A review of the literature by Lee et al, from 1987 to 2018 revealed 6 cases of SE (19). Despite the low risk, the consequences are significant. Changes in technique, equipment, preoperative evaluations and post treatment management can reduce patient risk and protect patients from SE and its consequences.

References

1. Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. Oral Surg Oral Med Oral Pathol 1965; 20: 340-9.
2. Battrum DE and Gutmann JL. Implications, prevention and management of subcutaneous emphysema during endodontic treatment. Endod Dent Traumatol 1995; 11(3): 109-14.
3. Al-Qudah A, Amin F and Hassona Y. Periorbital emphysema during endodontic retreat-ment of an upper central incisor: A case report. British Dental Journal 2013; 215(9): 259-261.
4. Pocket Dentistry/Internet Dr. Zezo 2016.
5. Tenore G, Palaia G, Ciolfi C, Mohsen M, Battisti A and Romeo U. Subcutaneous emphysema during root canal therapy: endodontic accident by sodium hypochlorite. AnnStomatol (Roma) 2018; 8(3): 117-122.
6. Patel N, Lazow SK and Berger J. Cervico-facial subcutaneous emphysema: Case report and Review of literature. J Oral Maxillofac Surg 2010; 68(8): 1976-82.
7. McKenzie WS and Rosenberg M. Iatrogenic subcutaneous emphysema of dental and sur-gical origin: a literature review. J of Oral Surg 2009; 67: 1265-1268.
8. Wong P, Palacios S and Kashtwari D. Managing Subcutaneous emphysema following dental procedures. Decisions in Dentistry CE course 2017.
9. Hayduk S, Bennett CR and Monheim LM. Subcutaneous Emphysema after Operative Dentistry: Report of Case. Journal of the American Dental Assoc 1970; 80(6): 1362.
10. Eleazer PD and Eleazer KR. Air pressures developed beyond the apex from drying root canals with pressurized air. J Endod 1998; 24(12): 833-6.
11. Goth L and Nagy T. Acatalasemia and Diabetes mellitus. Arch Biochem Biophys 2012; 525: 195-200.
12. Gulati A, Baldwin A, Intosh IM and Krishnan A. Pneumomediastinum, bilateral pneu-mothorax, pleural effusion, and surgical emphysema after routine apicectomy caused by vomiting. J Oral Maxillofac Surg 2008; 46(2): 136-7.

13. Magni G, Imperiale C, Rosa G and Favaro R. Non-fatal cerebral air embolism after den-tal surgery. Anesth Analg 2008; 106(1): 249-51.
14. Hülsmann M and Hahn W. Complications during root canal irrigation - literature review and case reports. Int Endod J 2000; 33(3): 186-93.
15. Bradford CE, Eleazer PD, Downs KE and Scheetz JP. Apical pressure developed by drying root canals with pressurized air. J Endod 1998; 24(12): 833-36.
16. Lambrianidis T. Management of Fractured Endodontic Instruments: A Clinical Guide. Springer Nature 2018.
17. Heyman SN and Babayof I. Emphysematous complications in dentistry, 1960-1993: An illustrative case and review of the literature. Quintessence Int 1995; 26(8): 535-43.
18. Alonso V, Garcia-Caballero L, Couto I, Diniz M, Diz P and Limeres L. Subcutaneous emphysema related to air-powder tooth polishing: A report of three cases. Australian Dental Journal 2017; 62 (4).
19. Lee ST, Subu MG and Kwon TG. Emphysema following air-power abrasive treatment for peri-implantitis, Maxillofacial Plastic and Reconstructive Surgery 2018; 40: 12.
20. Laskin DM. Anatomic considerations in diagnosis and treatment of odontogenic infections. J Am Dent Assoc. 1964; 69: 308-16.

About the Authors

Randolph Todd, DDS
Diplomate, American Board of Endodontists
International Lecturer, Cone Beam Technology
Past President, College of Diplomates of the American Board of Endodontics
Past Editor, Journal of the American Analgesia Society
Scientific Reviewer, Journal of Endodontics
Member, National Dental Practice-Based Research Network

Christina Boyd, DDS
Diplomate, American Board of Endodontists
Past Adjunct Clinical Instructor, New York University, College of Dentistry, Post-graduate Endodontics Department

Managing Anatomic Complexities in the Revision of Previous Root Canal Treatment

Alex B. Yee, DDS

James L. Gutmann, DDS, Cert Endo, PhD, FACD, FICD, FADI, FAAHD, FDSRCSEd, Dip ABE

Abstract

Revision of previous root canal procedures is common in today's specialty practice of Endodontics. Most often seen are patients having teeth with missed canals, canals with broken instruments, canals filled short of ideal that have persistent periapical pathosis, persistence of microbial populations including biofilms, anatomical challenges, coronal leakage, and so forth.[1-5] This case report will address techniques and their rationale, used to remove and revise a previously completed root canal procedure when anatomical and technical complexities are present.

Case Report

A 63-year-old female patient was referred to the endodontic department at Nova Southeastern University College of Dental Medicine for evaluation of the mandibular left first molar (#36). The referring clinician noted a sinus tract present on the buccal mucosa of this tooth three months prior, however, when the patient presented at the Dental College no sinus tract was present. A medical history of retroperitoneal fibrosis (a disease involving the buildup of fibrous tissue in the retroperitoneum) was reported for which the patient was taking an immunosuppressant drug daily [Mycophenolate mofetil, also known as MMF or CellCept, which is classified as a reversible inhibitor of inosine monophosphate dehydrogenase (IMPDH). This drug is an immunosuppressant often combined with drugs such as a cyclosporine and corticosteroids to prevent organ rejection after hepatic, renal, and cardiac transplants], to control her disease process.

The patient reported that the tooth was previously painful to cold 6 months prior, and has consistently been painful to chewing for the past few months. Clinical examination revealed large occlusal amalgam restorations on the mandibular molars, with a composite occlusal restoration on the second premolar. Periodontal probing depth was 5mm along the distobuccal of #36 and normal physiologic mobility and response to palpation on all teeth was noted. Tooth 36 responded painfully to percussion but without a response to cold. Radiographic examination showed periapical radiolucencies around the mesial and distal roots of #36; extensive pulp space calcifications were noted, and a pulpal diagnosis of necrosis and a periapical diagnosis of symptomatic apical periodontitis was made (Fig. 1). Non-surgical root canal treatment was recommended.

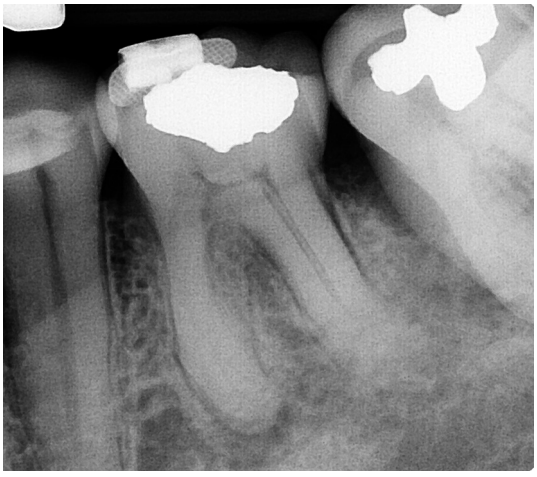


Figure 1: Periapical radiograph of tooth 36 showing large radiopaque occlusal restorations consistent with amalgam. Tooth 36 has a reduced pulp chamber, with calcified mesial canals and no readily distinguishable canal in the apical third of the distal canal. Chronic periapical osteitis is present along with a periapical radiolucency on the mesial roots.

Primary root canal procedures were performed using contemporary techniques and materials, including: 8.25%

NaOCl, electronic apex locator (ZXII, J. Morita Corp, Tokyo, Japan), Vortex Blue Rotary files (Dentsply, Maillefer, Switzerland) to a final apical size of 35/.04, followed by placement calcium hydroxide (Multi-Cal, Pulpdent, Watertown, MA) using the EndoActivator (Dentsply Maillefer, Ballaigues, Switzerland). The access was closed with cotton pellets and Cavit-G (3-M ESPE, Seefeld, Germany). One week later the patient returned for completion of the treatment using 35/.04 master gutta-percha cones (Dentsply, Maillefer, Switzerland) lightly coated with AH-Plus Root Canal Sealer (Dentsply, Maillefer, Switzerland) and warm vertical compaction. The final radiograph indicated adequate obturation of the mesial canals (even a middle-mesial canal was filled with sealer - arrows); however, the distal canal showed tracings of sealer and gutta-percha partially into an additional canal branching in the apical third of the root (Fig. 2). Given the fact that the pulp was necrotic and radiolucency was present around the distal root, the choice was made to revise the filling in the distal canal and attempt to negotiate the distal buccal branch of the distal canal.

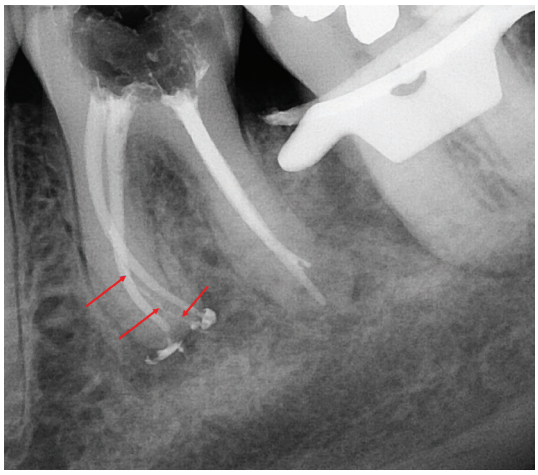


Figure 2: Postoperative periapical radiograph of tooth 36. The distal canal shows tracings of sealer and gutta-percha into an additional canal branching in the apical third. Note the filling of a small middle-mesial canal with root canal sealer (arrow). This canal is more distinctly visible in Figure 6.

Revision procedures began using an SX orifice opener from the ProTaper System (Dentsply, Maillefer, Ballaigues, Switzerland) in a gentle gliding motion with light apical pressure to engage and remove the coronal portion of gutta-percha. A 40/.06 rotary instrument (EdgeEndo, Albuquerque, New Mexico) was used at 500 rpm to generate frictional heat and remove the middle portion of gutta-percha. Due to its long engagement zone, a D3 retreatment file (Dentsply, Maillefer, Ballaigues, Switzerland) at 500 rpm and 2 NcM torque was used to engage the apical portion of the gutta percha and auger the material out the canal. Subsequently, negotiation of the distobuccal canal was attempted with a 10 k-file (Dentsply, Maillefer, Ballaigues, Switzerland). A working length radiograph was taken that indicated there was residual gutta percha present at the beginning of the distobuccal split, which was unable to be visualized under the dental operating microscope (Fig. 3).

A small amount (1cc) of Chloroform was introduced into the

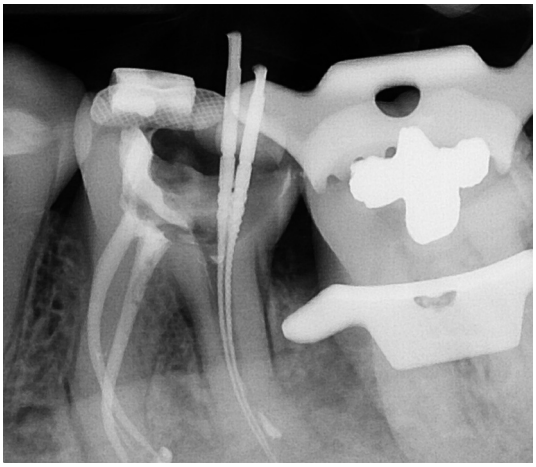


Figure 3: A periapical radiograph of tooth 36 demonstrating removal of gutta-percha from the coronal and middle portion of the distolingual canal, and residual gutta-percha in the distobuccal canal. The anatomical complexity of the curvature prevented visualization of the remaining gutta-percha in the deep split.

distal canal to facilitate the dissolution of the gutta-percha and facilitate penetration for removal. A size 25 k-file (Dentsply Maillefer, Ballaigues, Switzerland) with a sharp 45 degree bend in the apical 2mm was introduced and rotated circumferentially around the buccal side of the canal with minimal apical pressure. The file was used with small oscillating and lightly probing motions in the canal space. The operator relied on tactile sensation to indicate whether the tip of the file contacted dentin or softened gutta-percha. This size file provided sufficient rigidity to withstand unsuccessful scouting attempts, while the 45 degree bend allowed the file to follow the anatomy of the distobuccal canal. The softened gutta-percha was eventually engaged by the 25 k-file, dissolved in chloroform, and wicked out of the canal with sterile paper points. A radiograph was taken to confirm successful removal of gutta-percha occupying the distobuccal canal (Fig. 4).

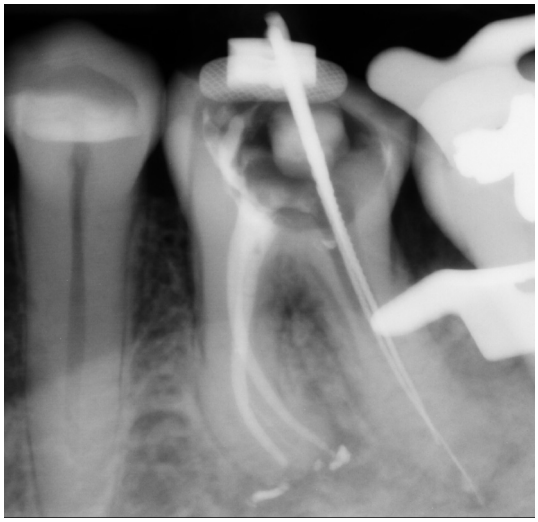


Figure 4: Periapical radiograph demonstrating successful removal of the residual gutta-percha in the distobuccal canal.

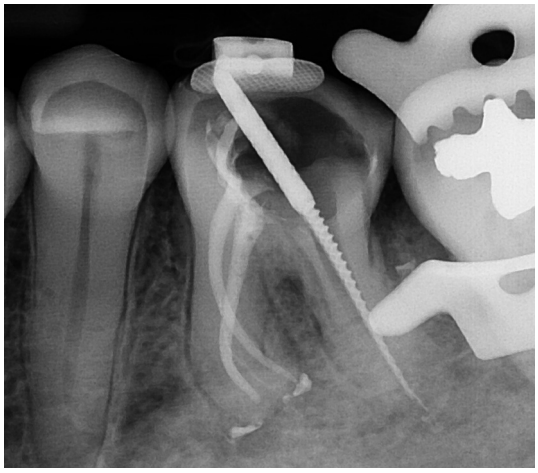


Figure 5: Periapical radiograph confirming the size 35 GuttaCore® verifier has seated at the proper length.

A pre-bent 10 k-file, followed by a 15 k-file, was taken to length in the distobuccal canal. An attempt to shape this canal with rotary instruments was unsuccessful due to the complexity of the deep split and therefore, hand files and copious irrigation with sodium hypochlorite and EDTA were used to clean and disinfect the distobuccal canal beyond the split. Activation of the solutions with the EndoActivator (Dentsply Maillefer, Ballaigues, Switzerland) allowed fluid movement into the distobuccal canal to further enhance its disinfection. A size 35 verifier (GuttaCore® System - Dentsply Maillefer, Ballaigues, Switzerland) was placed passively in distobuccal canal and a radiograph taken to confirm working length (Fig. 5). Care was taken to confirm that no obstructions and canal irregularities would interfere with the seating of the GuttaCore® filling material. The distobuccal and distolingual canals were obturated using GuttaCore®, which was selected as the obturation material of choice due to its ease of handling, high viscosity and material flow. The thermosoftened material's viscosity allows one to predictably capture the complex anatomy in the apical third. Due to the wide buccal lingual nature of the canal, a size 40 plugger was used in a sweeping motion to create space for additional warm gutta-percha to be placed in the coronal portion of the shared canal space. A final postoperative radiograph demonstrated successful completion of the revision procedure (Fig. 6).

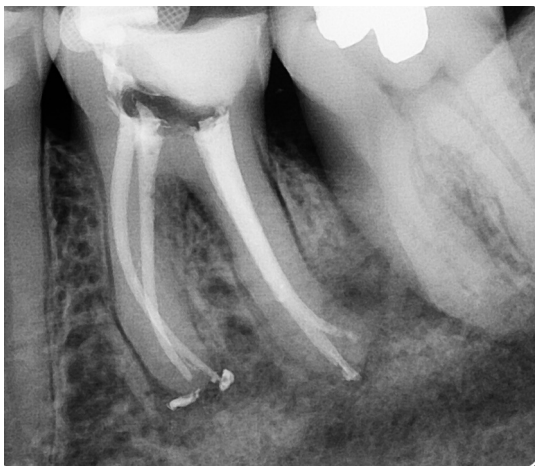


Figure 6: Final post obturation radiograph demonstrating the complex anatomy of the distobuccal and distolingual canals filled by the GuttaCore®.

Discussion

Root canal anatomy and its variabilities pose a wide range of challenges in the revision of previously unsuccessful procedures. Initially the concept of revision vs. retreatment must be considered, as the use of the term retreatment does not imply to redo and make better, whereas revision does.[6] The term revision is widely used by physicians, globally and should be considered within the scope of Endodontics as the preferred term, as we always strive to make the procedure and its outcome "better". The phrases used in contemporary Endodontics of "retreating gutta-percha", retreating silver cones", or "retreating paste fills" and so forth are archaic in nature and may imply that the procedure was done incorrectly in the first place. Likewise, as indicated these phrases say absolutely nothing about enhancing the root canal environment for a successful outcome. In this case report, using revision instead of retreatment makes it clear that the clinician was trying to make the previously completed procedures better with the intent of enhancing successful outcomes. Hence, the concept of retreatment should be abandoned and the terminology of "revision" should be embraced by the contemporary endodontic community in the provision of these types of procedures.

With enhanced knowledge regarding root canal anatomy[7,8] anticipation and management of complexities have been clarified and detailed. Furthermore, many techniques have been proffered in which to remove previous filling materials, given advances in instrument technologies and their applications.[9-12] As can be seen in this case report, a multitude of techniques along with a wide variety of manufacturer's instruments were used to accomplish the revision procedure. For example, the use of small amounts of chloroform and a specifically bent K-file in the apical 2-3mm was essential in application to remove the material blocking the divergent canal for cleaning and disinfection. Likewise, the use of more aggressive instruments in the wider part of the canal to remove the filling material efficiently was indicated. Finally the use of a flowable filling material along with a sealer through the use of a core-carrier obturation was highly favored over other methods of canal filling, given this anatomical complexity. This multi-dimensional approach emphasizes the importance of being familiar or experienced with more than just one technique to achieve success when faced with plethora of unanticipated challenges in the provision of root canal revision procedures.

While social media presents the dental profession with a lot of "so-called" spectacular cases of curved roots, accessory canals, teeth with 6-7 canals, or irregular root formations, and so forth, the ultimate success will be determined by proper restoration, health of the periodontium, patient monitoring and assessment of healing.[13,14] This patient will be carefully monitored for healing and symptom-free function, along with the proper restoration of the tooth.

References

1. Olcay K, Antaoglu H, Belli S. Evaluation of related factors in the failure of endodontically treated teeth: a cross-sectional study. J Endod 2018;44:38-45.
2. Prada I, Micó-Muñoz P, Giner-Lluesma T, Micó-Martinez P, Collado-Castellano N, Manzano-Saiz A. Influence of microbiology on endodontic failure. Literature review. Med Oral Patol Oral Cir Bucal 2019;24(3):e364-e372.
3. Kim Y, Lee D, Kim DV, Kim SY. Analysis of cause of endodontic failure of C-shaped root canals. Scanning 2018;25:2516832.
4. Neelakantan P, Romero M, Vera J Daood U, Khan AU, Yan A, Cheung GSP. Biofilms in endodontics – current status and future directions. Int J Mol Sci 2017;188). pii: E1748.
5. Siqueira JF Jr, Rôças IDN, Marceliano-Alves MF, Pérez AR, Ricucci D. Unprepared root canal surface areas: causes, clinical implications, and therapeutic strategies. Braz Oral Res 2018;32(suppl 1):e65.
6. Helfer A. To revise or retreat – your choice. J Endod 2002;28(12):799.
7. Versiani M, Basrani B, Sousa-Neto MD (editors). The Root Canal Anatomy in Permanent Dentition. New York, NY, Springer Int Publishing, 2018.
8. Pablo OV, Estevez R, Hellborn C, Cohenca N. Root anatomy and canal configuration of the permanent mandibular first molar: Clinical implications and recommendations. Quintessence Int 2012;43(1):15-27.
9. Migliau G, Pepla E, Laith MD, Besharat K, Livio Gallottini MD. Annali di Stomatologia. Resolution of endodontic issues linked to complex anatomy 2014;5(1):34-40.
10. Tang L, Sun TQ, Gao XJ, Zhou XD, Huang DM. Tooth anatomy risk factors influencing root canal working length accessibility. Int J Oral Sci 2011;3(3):135-40.
11. Agrawal P, Ramanna PK, Arora S, Sivarajan S, Jayan A, Sangeetha KM. Evaluation of efficacy of different instrumention for removal of gutta-percha and sealers in endodontic retreatment: an in vitro study. J Contemp Dent Pract 2019;20(11):1269-1273.
12. Wright CR, Glickman GN, Jalali P, Umorin M. Effectiveness of gutta-percha/sealer removal during retreatment of extracted human molars using the GentleWave system. J Endod 2019;45(6):808-812. Erratum in: J Endod 2019.
13. Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. Int Endod J 1995;28:12–18.
14. Ng YL, Mann V, Gulabivala K. A prospective study of the factors affecting outcomes of nonsurgical root canal treatment: part 1: periapical health. Int Endod J 2011;44:583–609.

About the Authors

Dr. Alex B. Yee is a second-year endodontic resident at Nova Southeastern University College of Dental Medicine, Davie, Florida, USA.

Dr. James L. Gutmann is Professor, Chair and Postgraduate Program Director in the Department of Endodontics at Nova Southeastern University College of Dental Medicine, Davie, Florida, USA.

Diagnosis and Clinical Management of Radix Entomolaris

Michelle S. Santos, DDM, Young Min Jung, DMD

Grace Ellen S. Dey, DMD, MScD, Iluminada L. Viloria, DMD, PhD

Abstract

One predictor of success of endodontic therapy is the knowledge of root canal anatomy and the possible aberrations that exist. An example of such anomaly in mandibular molars is the presence of an extra distolingual root, known as *radix entomolaris* (RE). The presence of an extra root may pose a challenge during root canal therapy due to its orifice inclination and root canal curvature. Having a thorough understanding of its existence, i.e., detection, negotiation and obturation, can mean better treatment outcome. This case report will discuss clinical and radiographic diagnosis including recommendation for management of RE.

Introduction

The primary goal of endodontic therapy is to eliminate the disease and to prevent the tooth from becoming re-infected. This is made possible by chemo-mechanical cleaning and shaping of the root canal system followed by hermetic sealing with an obturating material (1, 2). Thus, thorough knowledge of root canal morphology is imperative in order to successfully perform endodontic treatment (2).

Mandibular first molar is the earliest posterior tooth to erupt in the permanent dentition. This tooth is most of the time extensively restored or badly carious and may often require root canal treatment (3), of particular interest with mandibular molars are the anatomical variations that exist, such as the presence of radix entomolaris (RE). It is one of the anatomical variant found in permanent mandibular molars and was first described by Carabelli (4). It is characterized by the presence of an additional or extra third root, which is typically found disto-lingually (5). The presence of RE is associated with certain ethnic groups. In African populations, a maximum frequency of 3% is found (6), while in Eurasian and Indian populations the frequency is less than 5% (7). Various studies have shown that populations of Asians have a prevalence of RE of 5.8% to more than 30% (8-10).

Depending on the classification of the RE, a good clinical and preoperative radiographic assessment will lead one to suspect the presence of such an anomaly.

Case Report

A 13-year-old male, Filipino patient was referred to the Postgraduate Department of Endodontics and Periodontics, at the University of the East College of Dentistry due to pain coming from a mandibular right first molar tooth 46. Upon clinical examination, a deep Class II disto-occlusal cavity with probable pulpal involvement was evident.

History of present illness revealed that tooth 46 was initially sensitive to cold. This sensitivity later on progressed to sharp pain triggered by food impaction on the now evident cavity on the said tooth.

Patient does not routinely visit a dentist. Hence, the cavity on the tooth was left to progress until such time that pain has already advanced to a spontaneous, lingering type that required the use of analgesic for pain relief. Patient's medical history was non-contributory.

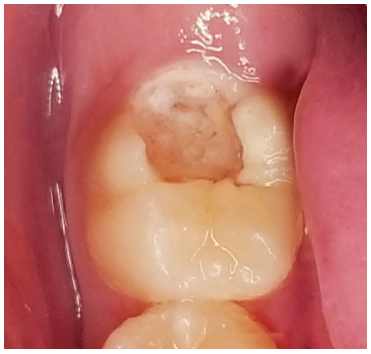


Figure 1: Pre-operative clinical appearance of tooth 46 with a large, saucer-shaped disto-occlusal caries with possible pulpal involvement.

Upon clinical examination, tooth presents with a large, saucer-shaped disto-occlusal caries with possible pulpal involvement (Fig. 1). Cold test elicited a hyper-reactive response and lingering type of pain on the tooth. Percussion was positive. Mobility and pocket probing depths were within normal limits. On radiographic examination, apart from a Class II DO deep caries with distal pulp horn involvement, ill-defined periapical radiolucency was seen on both roots. Furthermore, the presence of a distinct distolingual root was noted (Fig. 2). A pulpal diagnosis of Symptomatic Irreversible Pulpitis and a periapical diagnosis of Symptomatic Apical Periodontitis was made. Non-surgical root canal treatment was the treatment recommended.

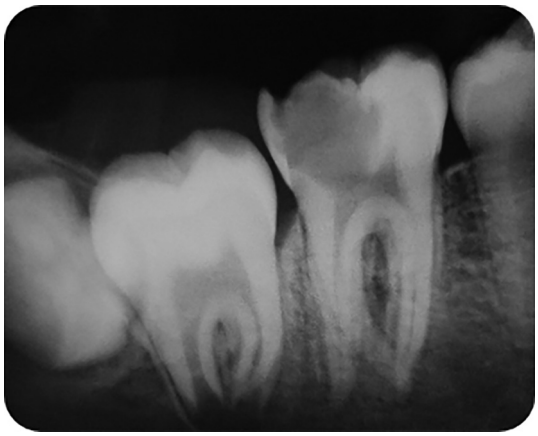


Figure 2: Pre-operative straight-on radiograph of tooth 46 showing a distinct distolingual root (RE).

After obtaining a signed informed consent from the patient's mother, local anesthesia via inferior alveolar nerve block was administered using 1 carpule of 2% Lidocaine with 1:100,000 Epinephrine (New Stetic S.A., Colombia).

Caries removal was carried out and tooth was placed out of occlusion. Composite build-up on the outermost part of the distal aspect was done using Filtek™ P60 (3M™ Espe, USA). The dentin part and bulk of the distal wall was restored with everX Posterior™ fiber reinforced composite (FRC) (GC Corp., Japan). FRC and conventional composite resin afford the best combination against microleakage and provide increased compressive strength (11).

From this point onwards, loupe was used throughout the procedure for improved visualization and magnification. Rubber dam assembly, access cavity preparation and location of the orifices were then performed. Patency and scouting of the internal anatomy of the canals was checked with a size 8 M-Access™ (Dentsply Maillefer, Switzerland). Apical patency is necessary in order to prevent blockage of dentin debris during root canal therapy. It also ensures thorough cleansing of the most apical region by allowing the flow of irrigant and eventually the accessibility of the sealer (12). It was at this point in the procedure that the presence of another canal on the distal (middle distal canal) was detected. SX file of Protaper Gold™ (Denstply Maillefer, Switzerland) was used to enlarge the orifices on distobuccal and the middle distal. Size 10 M-Access™ (Dentsply Maillefer, Switzerland) with apical binding was used as the Initial Apical File on all canals. Working length determination was done using Root ZX® II apex locator (J. Morita, USA) and confirmed with a radiograph. Upon establishing the working length, a mechanical glide path preparation was created using ProGlider® (Dentsply Maillefer, Switzerland). WaveOne® Gold Primary (25/.07) (Dentsply Maillefer, Switzerland) for the MB, ML, DB and middle distal (Mid D) canals and WaveOne® Gold Small (20/.07) for the DL canal at 350 rpm, 2 N·cm on reciprocation motion were selected for the final shaping size using X-Smart® Plus Endo motor (Dentsply Maillefer, Switzerland) (Fig. 3a). Copious irrigation of the canals with 2.5% NaOCl after each file use and lubrication with 15% EDTA RC-Prep® (Premier, USA) was done during canal preparation. A file summary of the rotary shaping files selected for root canal instrumentation is depicted on Figure 3b.

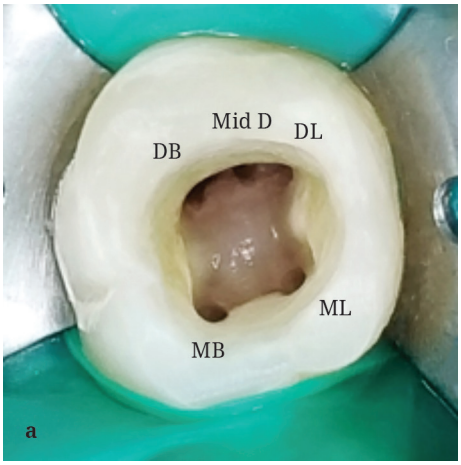


Figure 3a: Clinical appearance of tooth 46 after biomechanical preparation. Note the five canals present and the trapezoidal-shaped access cavity.

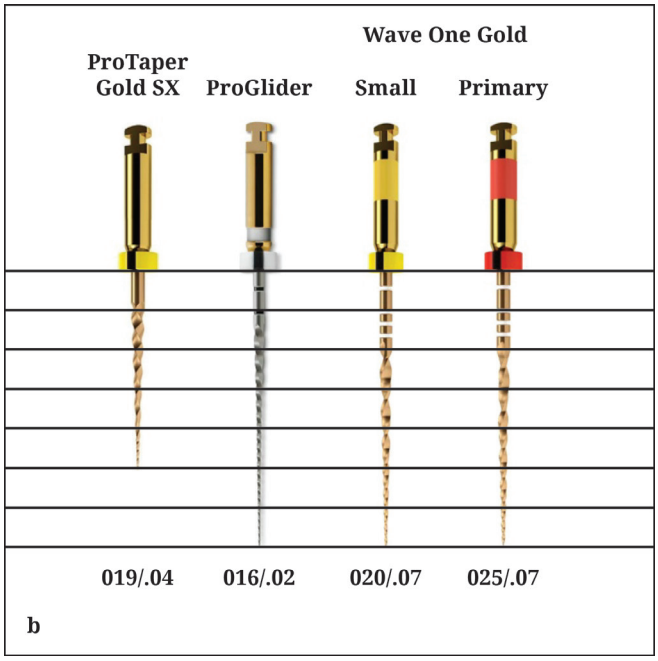


Figure 3b: Rotary shaping files used for the root canal instrumentation.

After canal preparation, apical gauging was employed with the use of NiTi hand files to determine the size of the apical constriction. A radiograph of the master apical files in place was then taken (Fig. 4).

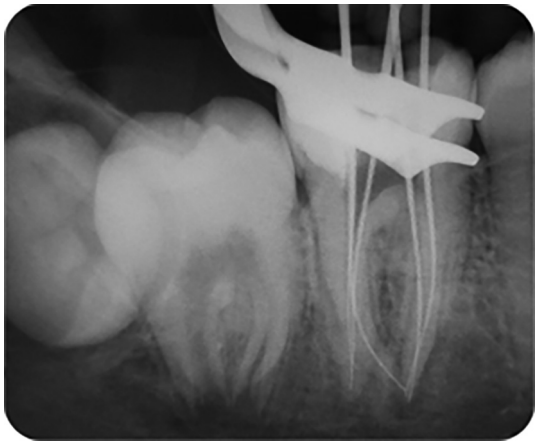


Figure 4: Master apical files of mesiobuccal, mesiolingual, distobuccal, middle distal, and distolingual canals.

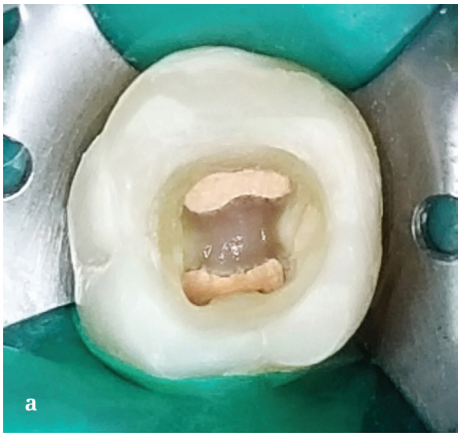


Figure 5a: Clinical appearance of cut gutta percha.

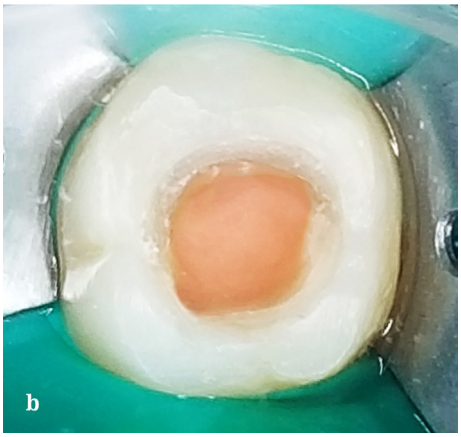


Figure 5b: Clinical appearance of Fuji VII GIC intraorifice seal.

Once the criteria for obturation were met, selection of master cone with the correct working length and tug back were established after which a radiograph was taken. Final irrigation of 17% aqueous EDTA solution (Pulpdent® Corp., USA) was used and agitated for one minute after which, canals were flushed with distilled water. Final rinse followed with 2.5% NaOCl. Canals were then dried with paper points and obturated via lateral compaction technique using AH Plus® root canal sealer (Dentsply Maillefer, USA) and .02 SS finger spreaders (Mani, Japan). Radiograph was taken to verify the quality of obturation. Gutta percha cones were cut 1 mm apical to the cervical line (Fig. 5a). Glass Ionomer Cement (GIC) Fuji VII Pink (GC Corp., Japan) was placed to serve as intraorifice barrier (Fig. 5b). GIC is not dependent on light exposure for setting, which is limited in root canals (13, 14). It also has reduced microleakage when placed under composite restoration (15). Full cuspal coverage direct onlay was the final restoration chosen using SureFil® SDR® flow+ (Dentsply Sirona, USA) bulk fill composite followed by Filtek™ Z250 composite (3M™ Espe, USA). SureFil® SDR® flow+ (Dentsply Sirona, USA) was selected for ease of placement as well as it demonstrates better internal adaptation than conventional composites (16). A clinical photograph and final radiograph after root canal treatment were taken to verify good marginal seal of the restoration (Fig. 6 and 7).

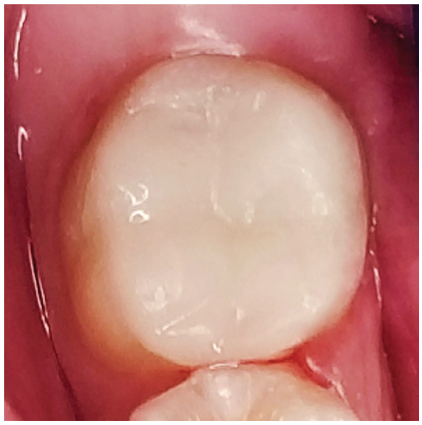


Figure 6: Clinical photograph of tooth 46 with direct composite onlay showing full cuspal coverage.

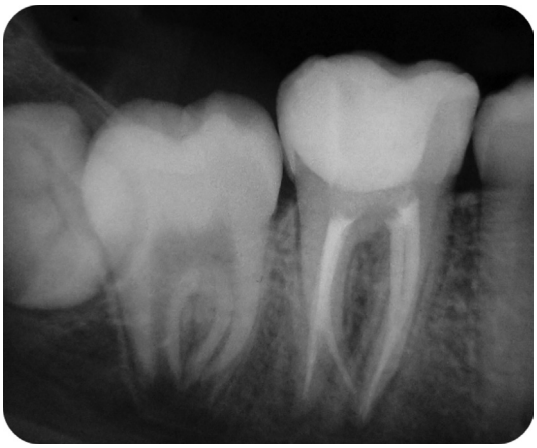


Figure 7: Radiographic appearance of tooth 46 after completion of root canal treatment and final restoration.

Discussion

Successful treatment outcome with any endodontic therapy depends on proper diagnosis, adequate chemo-mechanical preparation, three-dimensional obturation and a good coronal restoration.

RE can be discovered by careful clinical examination in which there are certain occasions that the presence of an additional cusp (tuberculum paramolare) or a cervical convexity can be noted by probing (5). Thereafter, a thorough evaluation of diagnostic imaging available is conducted. Images gathered for clinical assessment can be in the form of conventional two-dimensional (2D) imaging which is the periapical radiograph or the newer three-dimensional (3D) imaging system, which is the Cone Beam Computed Tomography (CBCT). CBCT in endodontics is an innovative technique that offers an excellent representation of the complexities of the root canal system and its neighboring anatomical structures in multiple planes, thereby providing the clinician with accurate data to assist with endodontic diagnosis and treatment planning. Although CBCT is part of the new standard of care in endodontics, it is not to be used routinely for endodontic management, if sufficient data can be obtained from the 2D radiography (17). Moreover, when using CBCT, the effective radiation dose is higher than conventional 2D radiography, which poses a risk especially to children as they are more radiosensitive (18). Hence, the standard 2D intraoral radiography was utilized to manage this case.

In a study by Wang et al. in 2011, RE can be analyzed radiographically by the presence of a double or extra root outline and classified into 3 types depending on the degree of overlap between the distobuccal and the distolingual roots: type i, slight overlapped image; type ii, moderate overlapped image of RE; type iii, severe overlapped image of RE (19). In this case, RE was visible on a straight-on shot as the 2 distal roots are separated, thus radiographically classifying this case as type i. If the case would have been a type ii or iii, at least 2 radiographic exposures need to be taken, a straight on and a 25 degrees horizontal shift to aid in diagnosis. De Moor et al., on the other hand, utilized the classification of REs proposed by Ribeiro & Consolaro in 1997, which is based on their morphologic feature in a buccolingual orientation: type I, straight root; type II, coronal third curved and straight continuation to the apex going towards the lingual; type III, curvature in the coronal third and buccal, especially mesiobuccal curvature from the middle to apical third of the root (20, 21). In this case, it was established that the RE was a type III during the scouting of the canal. This is in agreement with the in vitro study done by Wang et al. on mandibular molars whereby almost all the Type III REs were detected mostly in type i images. In addition, the shape of the access cavity should be modified from the triangular to trapezoidal to create a straight line access in locating the RE (19). When mandibular molars present with variations in their root and root canal morphology, such as the presence of a canal in between the DB and the DL, it is alternately termed as the middle distal, distal, and third distal canal (22).

A severe inclination of the root or curvature of the canal, specifically on the apical third portion of the root (as in a type III RE), can lead to shaping irregularities such as creation of a ledge, canal transportation, and loss of canal length (23). Schneider, in 1971, proposed a method of measuring canal curvature (24). This entailed that the first line be drawn from the orifice, parallel to the long axis of the canal. A second line was drawn from the apical foramen to intersect with the first line at the point where the canal began to leave the long axis of the canal. The acute angle formed was defined as the degree of root curvature (25, 26). In this case, the RE had an angle of 37 degrees which is categorized as severe based on Schneider's classification (Fig. 8). In a systematic review conducted by Hartmann et al. in 2019, on different methods for measuring root canal curvature, using 2D and 3D images, there is lack of agreement on the ideal technique to measure it as each method has its own potential clinical and research application (26).

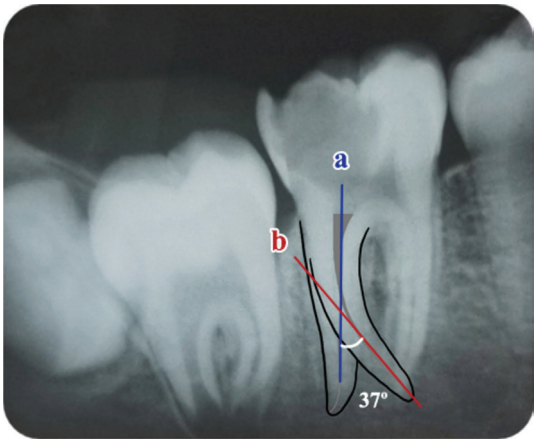


Figure 8: Radiograph with the prescribed lines and angle showing the degree of canal curvature obtained using Schneider's method.

Anatomical complexities present, enhanced instrument safety and reduced shaping time were the criteria used during the file selection for this case. WaveOne® Gold (WOG), a reciprocating single file rotary system, was utilized for the biomechanical preparation (BMP). Its movement is designed to reduce the likelihood of torsional fracture (27). The improved cross-section, size, and geometry has rendered the file more flexible (28). Moreover, the heat treatment of files, from M-wire to Gold-wire technology, upgraded the file's flexibility compared with its predecessors, the Nickel Titanium (NiTi) and M-wire alloy (29). The WOG is configured as an off-centered parallelogram with two 85-degree active cutting edges with alternate one or two point contact with the canal wall which minimizes taper lock and provides additional space around the instrument for better debris removal (30) (Fig. 9a). The tip is roundly tapered and semi-active to improve its passage into any secured canal with a reproducible glide path (Fig. 9b) (30). In addition, the improved features ensure that the instrument remains centered on the longitudinal axis of the root canal (31), even for severely curved cases.

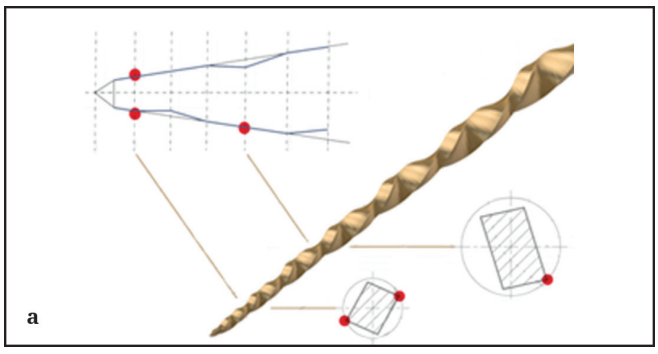


Figure 9a: Parallelogram-shaped cross-sectional design of the WaveOne® Gold instrument demonstrating one or two edges in contact with the canal wall *(https://www.endoruddle.com/WaveOned)*.

Figure 9b: WaveOne® Gold roundly tapered, semi-active tip design *(https://www.endoruddle.com/WaveOned)*.

In this case report, it was emphasized how diagnosing the presence of RE clinically and in the preoperative radiograph has implications with the course of the endodontic treatment (23). Taking a series of straight on and angled radiographs to get a better impression of the roots should be done to aid in diagnosis. Careful radiographic diagnosis plays a pivotal role for a successful endodontic treatment. Multiple radiographs recorded at several angulations reveal the basic information regarding the anatomy of a tooth and can thus help to detect any unusual anatomy such as extra canals/roots (21). CBCT should only be used as an adjunct imaging modality to aid in diagnosis and when benefits far outweigh the risk for a given case. Moreover, the use of magnification and illumination, such as loupes and the dental operating microscope, has been considered a requirement in the standard of care in endodontics. It has aided endodontists in a number of ways: by providing visualization of the root canal system in fine detail; distinguishing the floor and dentin; locating small canal orifices; and observing complex anatomical situation (32).

Inability to detect its presence may lead to a missed canal, which is a common cause of failure in endodontics. Due to the orientation of this canal, outline of the access cavity needs to be modified to a trapezoidal form. Awareness of its presence allows one to anticipate its location during access and minimize errors such as gouging, ledge formation and perforation. Instrument separation is also a possibility when negotiating this canal due to the severe curvature that presents either on the coronal or on the middle to apical third portion. This is prevented by making sure that coronal pre-flaring and glide path preparation has been established prior to use of rotary instruments. Countless studies have evaluated the causes of breakage of NiTi instruments and have concluded that a noticeable reduction in the breakage rate of rotary instruments can be attained when their use is preceded by initial manual enlargement and the creation of a “glide path”, which is a smooth passageway along which the NiTi instruments can easily slip and slide to reach the working length (33).

Knowledge of root canal morphology and variances coupled with thorough clinical assessment, radiographic interpretation, technical skills and proper armamentarium are essentials for a successful treatment outcome.

References

1. Arora A, Arya A, Chauhan L and Thapak G. Radix Entomolaris: A Case Report with Clinical Implication. Int J Clin Pediatr Dent 2018; 11(6): 536-538.
2. Vertucci FJ. Root Anatomy of the Human Permanent Teeth. Oral Surg Oral Med Oral Path 1984; 58(5): 589-598.
3. Hargreaves KM, Berman LH. Cohen’s Pathways of the Pulp. 11th Edition, Elsevier Health Sciences; 2016.
4. Carabelli G. Systematisches Handbuch der Zahnheilkunde. 2nd ed. Vienna: Braumuller und Seidel; 1844. 114.
5. Tu MG, Huang HL, Hsue SS, Hsu JT, Chen SY, Jou MJ, et al. Detection of permanent three-rooted mandibular first molar by cone-beam computed tomography imaging in Taiwanese individuals. J Endod 2009; 35: 503-7.
6. Sperber GH, Moreau JL. Study of the number of roots and canals in Senegalese first permanent mandibular molars. Int Endod J 1998; 31: 112–6.
7. Ferraz J, Pécora JD. Three-rooted mandibular molars in patients of Mongolian, Caucasian and Negro origin. Braz Dent J. 1993; 3(2): 113-7.
8. Song JS, Choi HJ, Jung IY, et al. The prevalence and morphologic classification of distolingual roots in the mandibular molars in a Korean population. J Endod 2010; 36: 653–7.
9. Chen YC, Lee YY, Pai SF, Yang SF. The morphologic characteristics of the distolingual roots of mandibular first molars in a Taiwanese population. J Endod 2009; 35: 643–5.
10. Gu Y, Lu Q, Wang H, et al. Root canal morphology of permanent three-rooted mandibular first molars: part I—pulp floor and root canal system. J Endod 2010; 36: 990–4.
11. Garoushi SK, Hatem M, Lassila LVJ, and Vallittu PK. The effect of short fiber composite base on microleakage and load-bearing capacity of posterior restorations. Acta Biomater Odontol Scand 2015; 1(1): 6-12.
12. Khatavkar RA, Hegde VS. Importance of patency in endodontics. Endodontology 2010; 22: 85-91.
13. Yamauchi S, Shipper G, Buttke T, Yamauchi M, and Trope M. Effect of orifice plugs on periapical inflammation in dogs. Journal of Endodontics 2006; 32: 524-6.
14. Schwartz RS. Adhesive Dentistry and Endodontics. Part 2: Bonding in the root canal system - The promise and the problems: A review. Journal of Endodontics 2006; 32: 1125-34.
15. Taha NA, Palamara JE, Messer HH. Assessment of laminate technique using glass ionomer and resin composite for restoration of root filled teeth. Journal of Dentistry 2012; 40: 617-23.
16. Van Ende A, De Munck J, Van Landuyt KL, Poitevin A, Peumans M, and Van Meerbeek B. Bulk-filling of high C-factor posterior cavities: effect on adhesion to cavity-bottom dentin. Dental Mater. 2013; 29: 269–277.

17. The Impact of Cone Beam Computed Tomography in Endodontics: A New Era in Diagnosis and Treatment. Endodontics: Colleagues for Excellence. 2018; 1-8.
18. AAE/AAOMR Joint Position Statement – Use of Cone Beam Computed Tomography in Endodontics. 2015 / 2016; 1-6.
19. Wang Q, Yu G, Zhou X, Peters OA, Zheng Q, and Huang D. Evaluation of X-Ray Projection Angulation for Successful Radix Entomolaris Diagnosis in Mandibular First Molars In Vitro. Journal of Endodontics 2011; 37(8): 1063–1068.
20. De Moor RJ, Deroose CA, Calberson FL. The Radix Entomolaris in mandibular first molars: an endodontic challenge. International Endodontic Journal. 2004; 37(11): 789–799.
21. Ribeiro FC, Consolaro A. Importancia clinica y antropologica de la raiz distolingual en los molares inferiores permamentes. Endodoncia. 1997; 15: 72–8.
22. Albuquerque DV, Kottoor J, and Velmurugan N. A New Anatomically Based Nomenclature for the Roots and Root Canals – Part 2: Mandibular Molars. International Journal of Dentistry 2012; doi: 10/1155/2012/814789. 1-9.
23. Calberson FL, De Moor RJ, and Deroose C. The Radix Entomolaris and Paramolaris: Clinical Approach in Endodontics. Journal of Endodontics 2007; 33 (1): 58-63.
24. Schneider SW. A comparison of canal preparations in straight and curved root canals. Oral Surg Oral Med Oral Pathol 1971; 32:271–5.
25. Plotino G, Grande NM, Cordaro M, Testarelli L, Gambarini G. A Review of Cyclic Fatigue Testing of Nickel-Titanium Rotary Instruments. JOE 2009; 35 (11): 1469-1476.
26. Hartmann RC, Fensterseifer M, Peters OA, de Figueiredo JAP, Gomes MS, & Rossi-Fedele G. Methods for measurement of root canal curvature: a systematic and critical review 2019; 52(2).
27. Bürklein S, Flüch S, and Schäfer E. Shaping ability of reciprocating single-file systems in severely curved canals: WaveOne and Reciproc versus WaveOne Gold and Reciproc blue. Odontology 2018; doi: 10.1007/s10266-018-0364-3.
28. Grande NM, Ahmed HM, Cohen S, Bukiet F, and Plotino G. Current Assessment of Reciprocation in Endodontic Preparation: A Comprehensive Review – Part I: Historic Perspectives and Current Applications. Journal of Endodontics 2015: 41(11); 1778-1784.
29. West J. Endodontic update 2006. J Esthet Restor Dent 2006; 18: 280-300. 34.
30. Webber J. Shaping canals with confidence: WaveOne GOLD single-file reciprocating system 2015. Roots (reprinted) International Dentistry-African Edition: 6(3): 6-17.
31. Gavini G, Santos MD, Caldeira CL, Machado MEL, Freire LG, Iglecias EF et al. Nickel-titanium instruments in endodontics: a concise review of the state of the art. Braz. Oral Res. 2018; 32 (suppl): e67: 44-65.
32. Shetty S, Tejaswi S. Magnification – An Endodontic Review. Journal of Advanced Clinical and Research Insights 2018; 5 (6): 178-182.
33. Cantatore G, Berutti E, Castelluci A. The Pathfiles: A New Series of Nickel Titanium Instruments for Mechanical Pre-flaring and creating glide path. https:// www.zerodonto.com/en/category/endodontics/ 2010.

Conflict of Interest
The authors had full freedom of investigation and there were no potential conflict of interest.

About the Authors
Michelle S. Santos, DDM
Third year Endodontic Resident, Postgraduate Endodontics Program, University of the East, College of Dentistry, Manila, Philippines
Active member, Endodontic Society of the Philippines

Young Min Jung, DMD
Third year Endodontic Resident, Postgraduate Endodontics Program, University of the East, College of Dentistry, Manila, Philippines

Grace Ellen S. Dey, DMD MScD FADI FICD
Associate Professor, Postgraduate Endodontics Program, College of Dentistry, University of the East, Manila, Philippines
Fellow, Philippine Board of Endodontics
Fellow, Academy of Dentistry International
Fellow, International College of Dentists
Secretary, Endodontic Society of the Philippines

Iluminada L. Viloria, DMD PhD FADI FICD
Professor and Chair, Postgraduate Endodontics Program, College of Dentistry, University of the East, Manila, Philippines
Diplomate, Philippine Board of Endodontics
Fellow, Academy of Dentistry International
Fellow, International College of Dentists
Past President, Endodontic Society of the Philippines

Mineral Trioxide Aggregate Pulpotomy for Apexogenesis of an Immature Permanent Molar

Fredrick Ikhabi Weboko, BDS, MScD, Benjamin Simiyu Nyongesa, BDS, MScD,

Mercy Naswa Makhanu, BDS, MScD, Michelle S. Santos, DDM,

Katrina G. De Luna, DMD, MScD, Grace Ellen S. Dey, DMD, MScD, Iluminada L. Viloria, DMD, PhD

Abstract

All restorative treatment procedures in immature permanent teeth aim at maintaining pulp vitality so that normal root development can continue. When pulpal exposure occurs in immature permanent teeth, treatment options available include conventional pulpotomy and partial pulpotomy. Once the inflamed pulp tissue has been surgically removed, the remaining vital tissue is dressed with a suitable material to promote healing and ensure continued root development. Mineral trioxide aggregate (MTA) is a tri-calcium silicate-based material that has demonstrated the ability to stimulate tissue regeneration as well as induce a good pulp response. The success rate for pulpotomy procedures is highly dependent on the status of the pulp prior to initiating treatment. However, the lack of an accurate diagnostic tool for clinically assessing the degree of pulpal inflammation makes treatment planning difficult. Therefore, proper diagnosis and clinical judgment are paramount. To guide treatment approaches, the terms reversible and irreversible pulpitis are used. It is worth noting that these terms have no absolute diagnostic basis but reflect the best clinical judgment. This case report presents a case of an immature permanent molar with irreversible pulpitis managed with MTA pulpotomy.

Keywords: pulpotomy, apexogenesis, MTA

Introduction

One of the challenges to the integrity of the developing tooth is dental caries. Irreversible pulpal damage and necrosis, secondary to dental caries can result in the arrest of the normal root development. Once there is disturbance in its development, the long-term prognosis for tooth retention is equally affected. During treatment, the main goal is to maintain pulp vitality in order to have continued normal root growth [1].

Pulpotomy is a vital pulp therapy procedure in which the infected coronal pulp is surgically excised. After achieving hemostasis, the vital radicular pulp is left intact. This procedure is an alternative to direct pulp capping in young permanent teeth with pulpal exposure secondary to dental caries. For pulpotomy to be considered a treatment modality, the inflammation ought to be restricted to the coronal pulp [2]. All the carious dentin and the entire coronal pulp are eliminated prior to dressing with a suitable material [2, 3].

After its invention in the mid 90's, Mineral Trioxide Aggregate (MTA) is increasingly finding favor as a dressing material for pulpotomy procedures in immature permanent teeth. Results from a clinical case series showed high success rates when MTA was used as a pulp capping agent [2, 4]. Furthermore, clinical outcome studies showed that pulp capping with MTA gave significantly better results than with calcium hydroxide [5, 7].

Apexogenesis is a vital pulp therapy procedure performed to encourage continued physiologic development and formation of the root end [6]. The remaining radicular pulp must be vital and capable of sustaining continued development of the root. Pulp capping can be used to treat small exposures, whereas with more extensive pulpal exposures, partial pulpotomy (Cvek pulpotomy) or conventional pulpotomy are the treatment of choice. With both pulpotomy techniques, the remaining pulp can be capped with a hard set calcium hydroxide or, preferably, MTA [6, 7, 8]. This report presents a case of an immature permanent molar with irreversible pulpitis successfully managed with MTA pulpotomy.

Case Report

A 16-year-old female student presented to the Postgraduate Department of Endodontics and Periodontics, at the University of the East College of Dentistry with pain on her lower right quadrant.

Two years prior to consultation, the patient began experiencing occasional sensitivity upon taking cold drinks. With time, the sensitivity increased in intensity and duration. About one year prior to consultation, she began experiencing mild pain that was aggravated by cold stimuli. Six months after which, pain had moderately intensified coupled with food impaction on the cavitated occlusal surface resulting to further discomfort. One week prior to consultation, she experienced severe pain that was aggravated by chewing food on the right side. She had taken 500 mg Mefenamic acid to relieve the pain. The medical history was non-contributory.

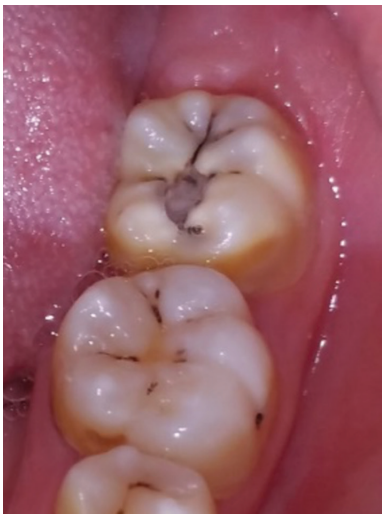


Figure 1: Pre-operative photograph of tooth 47

Upon examination, tooth 47 had a large carious lesion on the occlusal surface. The gingiva around it was normal and the probing depths within normal limits (Fig. 1). The tooth had an exaggerated painful lingering response to cold test. An intraoral periapical radiograph taken revealed a large radiolucent area in the crown extending to the pulp chamber, intact lamina dura and uniform periodontal ligament space. The roots had wide open apices with thin root dentin walls (Fig. 2).

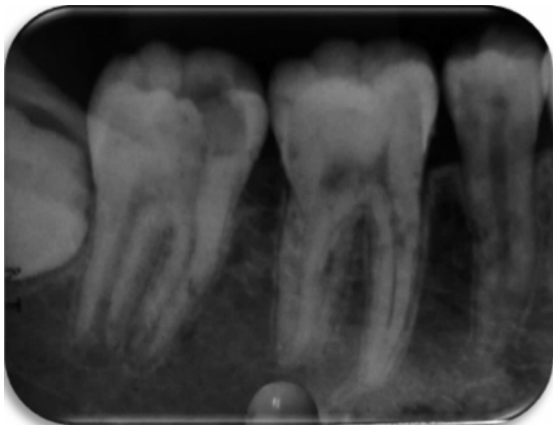


Figure 2: Pre-operative radiograph of tooth 47

After considering the clinical and radiographic findings, the diagnosis made was Symptomatic Irreversible Pulpitis with Normal Apical Tissues [AAE 2013].

For the treatment, anaesthesia was achieved using 2% Lidocaine with 1: 100,000 epinephrine. After rubber dam isolation, caries removal with the use of a highspeed handpiece with a round diamond bur ensued resulting into a large carious exposure of the pulp. This was followed by performance of conventional pulpotomy using a sharp spoon excavator and application of pressure over the amputated pulp to achieve haemostasis using a sterile cotton pellet dampened with normal saline (Fig. 3a). A 1.25% sodium hypochlorite solution was utilized for disinfection. MTA (Dentsply Sirona) mixed to a sandy consistency was delivered over the amputated pulp (Fig. 3b). Placement of a dampened sterile cotton pellet over the MTA was then followed by a layer of Fermin (Detax GmbH-Germany) to serve as provisional restoration. A radiograph was taken to ensure good adaptation of the MTA and Fermin (Fig. 4). The patient was then scheduled after one week for the second visit.

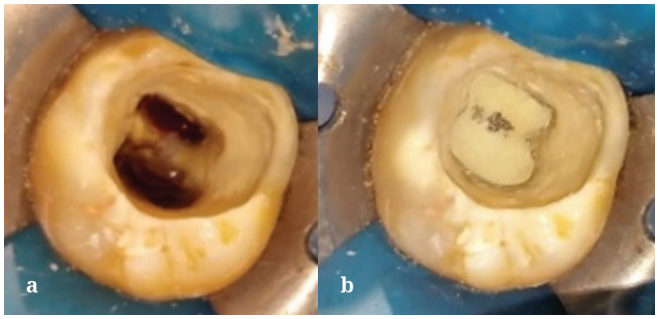


Figure 3a: Conventional Pulpotomy where entire coronal pulp amputated and haemostasis achieved by applying pressure using a sterile cotton pellet dampened with normal saline. Figure 3b: Freshly mixed white MTA was gently placed over the amputated pulp.

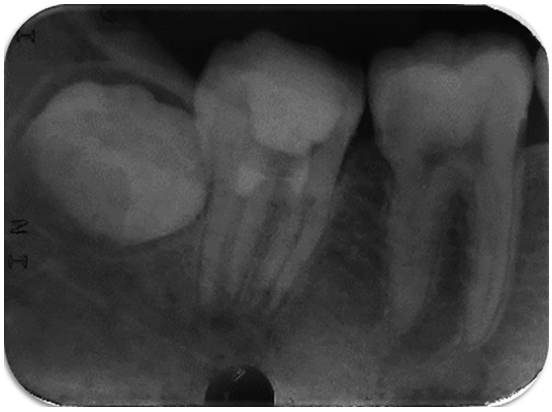


Figure 4: Radiograph confirming MTA over amputated pulp and Fermin temporary restoration

During the second visit, an endodontic explorer was utilized to inspect whether the MTA has completely set. Once verified, Glass Ionomer Cement (GIC) (Fuji VII GC Dental, Japan) was packed over the hard set MTA (Fig. 5a) and filled with composite restoration DiaFil (DiaDent International-Korea). A radiograph was taken to confirm good marginal adaptation (Fig. 5b).

Maintenance of good oral hygiene and recall every six months or whenever necessary were recommended to the patient in case of symptoms or any other complaint.

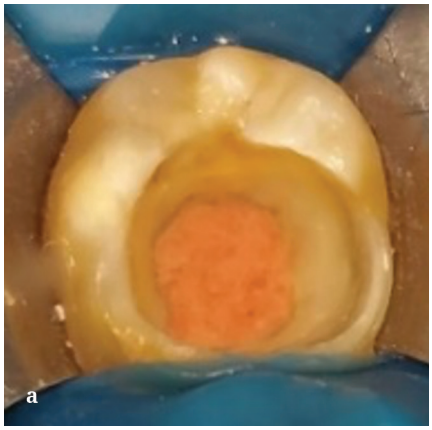


Figure 5a: Fuji VII GIC placed over the hard set MTA.

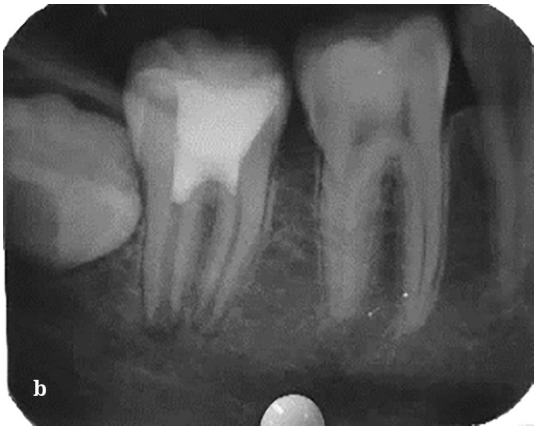


Figure 5b: An intraoral periapical radiograph revealed tooth 47 fully restored with MTA, GIC and direct composite onlay showing good marginal adaptation.

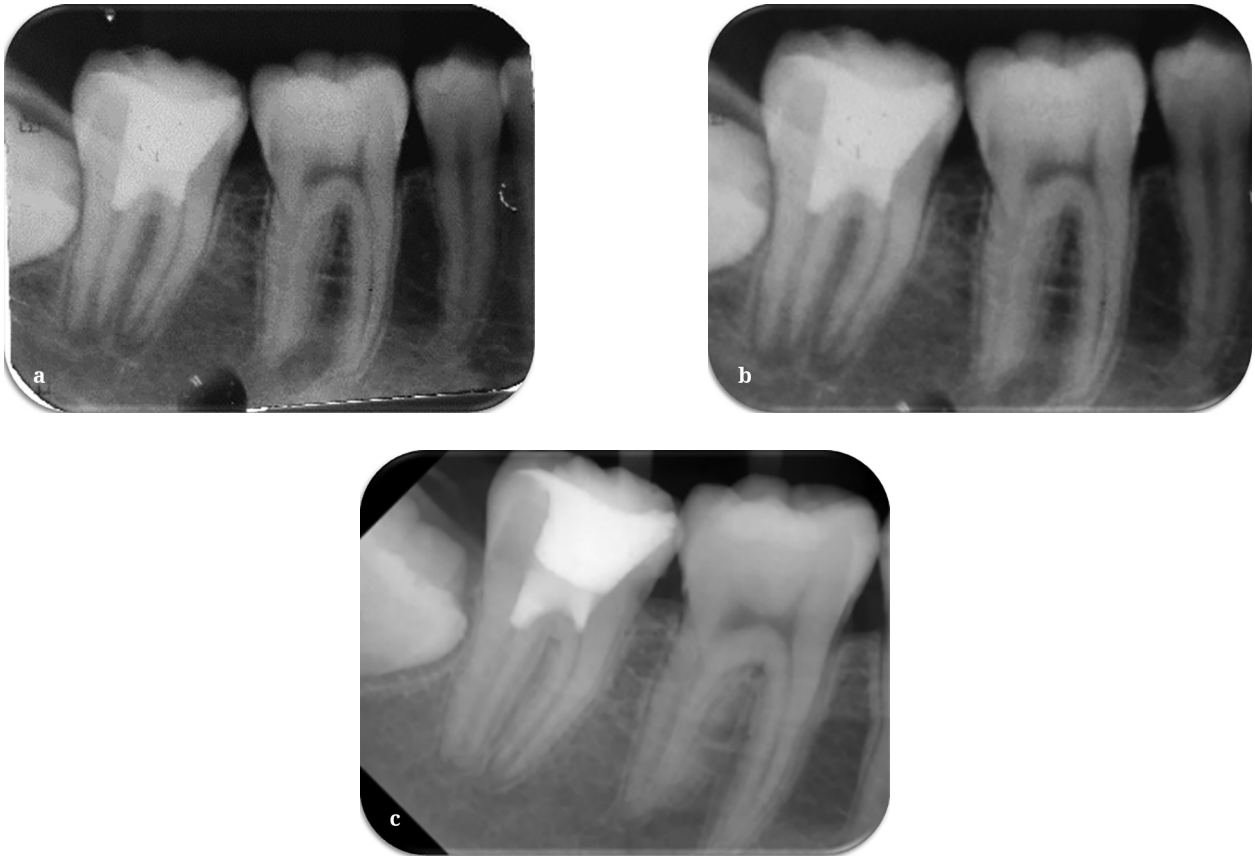


Figure 6: Tooth 47 (a) At six-month recall, radiograph showing no visible changes pertaining to apical growth and increase in radicular dentin thickness. (b) Radiograph taken after one-year recall revealing slight increase in radicular dentin thickness and continued apical growth. (c) A three-year review radiograph presenting apical maturation and increased radicular dentin thickness. The canal spaces were clearly visible radiographically with no signs of calcification nor periapical radiolucency. Throughout, the tooth remained asymptomatic.

Discussion

The primary goal of apexogenesis is to maintain pulp vitality, thus allow dentin formation and root-end closure [7].

The duration required to produce a thicker root varies between 1 and 2 years, depending on the degree of root development at the time of the procedure. It is recommended that patient should be recalled at 6-month intervals to determine the extent of apical maturation [8]. In the current case, the patient was reviewed at 6 months, 1 year and 3 years (Fig. 6. a, b, c). During each recall, signs and symptoms were monitored and radiographs were taken to determine periapical status and check for increased radicular dentin thickness. In cases of pulp capping and partial pulpotomy, pulp vitality tests can be performed during recall visits unlike

in conventional pulpotomy. The ability to perform vitality tests in vital pulp therapy procedures is seen as an advantage because absence of symptoms usually does not indicate absence of disease. However, should the pulp become necrotic at some future date, the canals may not be negotiable and surgery would be indicated [8, 9, 10].

After performing pulpotomy and dressing with MTA, a temporary restoration was placed with at least 4 mm thickness to provide a tight seal and avoid contamination before the next appointment. Well-placed temporary restorations have been shown to improve the success of the outcome [11]. Moreover, further bacterial recontamination was prevented with a tight coronal seal achieved by placing GIC over the hard set MTA and a composite restoration. The radiograph confirmed the good marginal adaptation. The remaining radicular pulp therefore had the capacity to maintain vitality and facilitate continued root formation. The surviving primary odontoblasts were responsible for forming dentin and increasing the thickness of the root wall hence making it less prone to fracture [7].

The presence of microorganism has been shown to be a significant inhibiting factor for the healing of pulp exposures [12]. Calcium hydroxide has long been considered the standard therapeutic pulpotomy agent for apexogenesis procedures in immature permanent teeth. However, it has low strength and high solubility [13]. Thus, if microleakage occurs around the restoration, the calcium hydroxide porous bridge at the pulpotomy site does not offer protection from bacterial contamination [14]. On the other hand, MTA remains stable and resists microleakage after setting [15]. For the present case, MTA was the material of choice selected for dressing the vital radicular pulp. Studies have reported exceptional physiochemical and biological properties of MTA that is, good sealing ability [16], hydroxyapatite formation [17] and biocompatibility [18]. MTA has demonstrated the ability to induce hard tissue formation in cases of pulp capping and pulpotomy [19, 20, 21].

Two studies comparing the outcome of pulpotomies in immature permanent teeth, performed with Calcium hydroxide and MTA concluded that there was no significant difference between the two [7, 36]. However, MTA has been considered superior to Calcium hydroxide in clinical and radiographic aspects. This has been attributed to superior biocompatibility of MTA [22]. The difference between MTA and Calcium hydroxide could have been reduced by the improved success in immature permanent teeth caused by the rich blood supply that results in greater resistance to infection [23].

Proper case selection is key for successful vital pulp therapy procedures. The condition of the pulp plays a decisive role in the outcome. However, determination of the actual status of the pulp remains a challenging task to any clinician. The degree of pulpal bleeding after exposure has been thought to reflect the severity of pulpal inflammation. Profuse bleeding that is difficult to control indicates severe inflammation [24].

The "time to stop bleeding" has been used as a cutoff point to distinguish between the reversible and irreversible status of the pulp. Bleeding that cannot be stopped within 5 to10 minutes has been said to be severely inflamed, and pulpectomy is recommended [2, 25]. However, one study showed that the time to stop bleeding has no effect on treatment outcomes [21]. Therefore, even for cases with irreversible pulpitis, vital pulp therapy remains a treatment option granted that all of the irreversibly inflamed tissues are removed by partial or conventional pulpotomy [1, 26].

Several studies have reported lack of good correlation between clinical symptoms and the exact histological status of the pulp [27, 28]. Pain may denote possible pulpal damage, however it cannot be used to foretell the degree and severity of the damage. Even though pain is one of the cardinal signs of inflammation, no studies have shown that there is a correlation between the pain intensity and the extent of tissue damage. In actual fact, teeth with pulpitis are on many occasions clinically asymptomatic [29].

In a study of the diagnosis of the pulp, it was concluded that scientific evidence available was not sufficient to assess the reliability of clinical signs, symptoms or pulp sensibility tests to determine reversible or irreversible pulpal inflammation [30]. Pulp sensibility tests assess the function of sensory nerves to heat, cold or electric current. These tests do not check the degree and severity of pulpal inflammation but they can detect pulpal injury. It has been shown that there is no good correlation between the responses elicited by the sensory nerves and the degree of pupal inflammation [31]. Thus to assess the histological status of the pulp, pulp sensibility tests cannot be used reliably. Pulse oximetry and laser Doppler flowmetry on the other hand, are the most accurate methods for determining pulp vitality [32].

A number of solutions and methods have been recommended to achieve pulpal hemostasis. These include the use of 30% hydrogen peroxide, sodium hypochlorite, ferric sulphate, 2% chlorhexidine, Mixture of Tetracycline, Acid and Detergent (MTAD) and lastly, the application of direct pressure with cotton pellets soaked in sterile water or saline which was the method carried out in the current case. More recently, lasers have also been employed to achieve pulpal hemostasis [33].

Key variables for vital pulp therapy include complete caries control, visible hemostasis, verified MTA setting and placement of bonded composite [4]. Krakow et al. described criteria for vital therapy success in immature teeth with vital pulp. These include continued root formation, completion of root apex, maintenance of pulp vitality and stimulation of a new layer of dentin at the orifice of the canal [34]. In the current case, there was continued root formation and apical maturation as seen at three-year recall. Furthermore, throughout the follow-up period the tooth remained asymptomatic, and there was no periapical radiolucency observed on the recall radiographs taken. One recent study reported a success rate of 91% following MTA pulpotomy for treatment of immature permanent teeth with irreversible pulpitis [35].

Conclusion

The present case report showed that even in immature permanent teeth with clinical signs of irreversible pulpitis, MTA pulpotomy may provide a predictable option for management provided case selection, treatment planning and execution are done appropriately.

Note: This case report won 1st place in the Postgraduate Program in the College of Dentistry Clinical Case category during the 2019 University of the East Research Poster presentation. This was also presented during the 2019 Oral Case and Research presentation of the Philippine Dental Association Luzon Mega Convention and President's mid-year review.

References

1. Shabahang S. Treatment Options. Apexogenesis and Apexification. J. Endod 2013; 39: S26-S29.
2. Witherspoon DE, Small JC, Harris GZ. Mineral trioxide aggregate pulpotomies: a case series outcomes assessment. J Am Dent Assoc 2006; 137(5): 610-618.
3. Ghoddusi J, Forghani M, Parisay I. New approches in vital pulp therapy in permanent teeth. Iran Endod J 2014; 9(1): 15-22.
4. Chen, Y., Chen, X., Zhang, Y. et al. Materials for pulpotomy in immature permanent teeth: a systematic review and meta-analysis. BMC Oral Health 2019; 19: 227.
5. Mente J, Geletneky B, Ohle M, et al. Mineral trioxide aggregate or calcium hydroxide direct pulp capping: an analysis of the clinical treatment outcome. J Endod 2010; 36(5): 806-813.
6. Hargreaves KM, Berman LH. Cohen's Pathways of the Pulp. 11th Edition, Elsevier Health Sciences 2016.3.
7. El-Meligy OAS, Avery DR. Comparison of mineral trioxide aggregate and calcium hydroxide as pulpotomy agents in young permanent teeth (apexogenesis). Pediatr Dent 2006; 28(5): 399.
8. Nosrat, A., Seifi, A., & Asgary, S. Pulpotomy in caries-exposed immature permanent molars using calcium-enriched mixture cement or mineral trioxide aggregate: A randomized clinical trial. International Journal of Paediatric Dentistry 2013; 23(1): 56–63.
9. Seo R, Maki K, Hidaka A, Higuchi M, et al. Long term radiographic study of bilateral second premolars with immature root treated by apexogenesis and apexification. J Clin Pediatr Dent 2005; 29(4): 313.
10. Robertson A, Andreasen FM, Andreasen JO, Noren JG. Longterm prognosis of crown fractured permanent incisors: the effect of stage of root development and associated luxation injury. Int J Paediatr Dent 2000; 10(3): 191-9. 7
11. Beach CW, Calhoun JC, Bramwell D, Hutter JW, Miller GA. Clinical evaluation of bacterial leakage of endodontic temporary filling materials. Journal of Endodontics 1996; 22: 459^62.
12. Aeinehchi M, Eslami B, Ghanbariha M, Saffar AS. Mineral trioxide aggregate (MTA) and calcium hydroxide as pulp-capping agents in human teeth: a preliminary report. Int Endod J 2003; 36: 225-231.
13. Walton RE, Torabinejad M. Principles and Practice of Endodontics, WB Saunders. Management of Incompletely Formed Roots 2002; ed 3: 388-404.
14. Bakland LK. Management of traumatically injured pulps in immature teeth using MTA. J Calif Dent Assoc 2000; 28: 855-858.
15. Torabinejad M, Higa RK, McKendry DJ, Pitt Ford IR. Dye leakage of four root-end filling materials: effect of blood contamination. J Endod 1994; 20: 159–63.
16. Parirokh M, Torabinejad M. Mineral Trioxide Aggregate: A comprehensive literature review – part I: chemical, physical and antibacterial properties. J Endod 2010; 36(1): 16-27.
17. Torabinejad M, Hong CU, Pitt Ford TR, Kettering JD. Cytotoxicity of four root-end filling materials. J Endod 1995; 21: 489–92.
18. Parirokh M, Torabinejad M. Mineral Trioxide Aggregate: A comprehensive literature review – Part III: Clinical applications, drawbacks, and mechanism of action. J Endod 2010; 36(3): 400-413.
19. Dominguez MS, Witherspoon DE, Gutmann JL, Opperman LA. Histological and scanning electron microscopy assessment of various vital pulp-therapy materials. J Endod 2003; 29: 324–33.
20. Linsuwanont, P., Wimonsutthikul, K., Pothimoke, U., & Santiwong, B. Treatment Outcomes of Mineral Trioxide Aggregate Pulpotomy in Vital Permanent Teeth with Carious Pulp Exposure: The Retrospective Study. Journal of Endodontics, 2017; 43(2): 225–230.
21. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review—part I: chemical, physical, and antibacterial properties. J Endod 2010; 36: 16–27.
22. Camp JH, Fuks AB. Pediatric endodontics: endodontic treatment for the primary and young permanent dentition. In: Cohen S, Hargreaves KM, editors. Pathways of the pulp. St. Louis: Mosby Elsevie; 2006: 9 th ed: p. 834–59.
23. Matsuo T, Nakanishi H, Shimizu H, Ebisu S. A clinical study of direct pulp capping applied to carious-exposed pulps. J Endod 1996; 22: 551–6.
24. Bogen G, Kim JS, Bakland LK. Direct pulp capping with mineral trioxide aggregate: an observational study. J Am Dent Assoc 2008; 1 39: 305–15.
25. Eghbal MJ, Asgary S, Baglue RA, Parirokh M, Ghoddusi J. MTA pulpotomy of human permanent molars with irreversible pulpitis. Aust Endod J 2009; 35(1): 4-8.
26. Garfunkel A, Sela J, Ulmansky M. Dental pulp pathosis: clinicopathologic correlations based on 109 cases. Oral Surg Oral Med Oral Pathol 1973; 35: 110–7.
27. Dummer PM, Hicks R, Huws D. Clinical signs and symptoms in pulp disease. Int Endod J 1980; 13: 27–35.
28. Michaelson PL, Holland GR. Is pulpitis painful? Int Endod J 2002; 35: 829–32.

29. Mejare IA, Axelson S, Davison T et al. Diagnosis of the condition of the dental pulp: a systematic review. Int Endod J 2012; 45: 597–613.
30. N€arhi M, Yamamoto H, Ngassapa D. Function of intradental nociceptors in normal and inflamed teeth. In: Shimono M, Maeda T, Suda H, Takahashi K, eds. Dentin/pulp complex. Tokyo: Quintessence; 1996. pp. 136–40.
31. Mainkar A, Kim SG. Diagnostic accuracy of 5 dental pulp tests: a systematic review and meta-analysis. J Endod 2018; 44: 694–702.
32. Witherspoon DE. Vital pulp therapy with new materials: new directions and treatment perspectives— permanent teeth. J Endod 2008; 34(Suppl): S25–28.
33. Krakow AA, Berk H, Gron P. Therapeutic induction of root formation in the exposed incompletely formed tooth with vital pulp. OOO 1977; 43: 755-765.
34. Peng C, Zhao Y, Yang Y, Qin M. Mineral trioxide aggragate pulpotomy for the treatment of immature permanent teeth with irreversible pulpitis: a preliminary clinical study. Chinese Journal of Stomatology 2015 Dec; 50(12): 715-719.
35. Özgür B, Uysal S, Güngör HC. Partial Pulpotomy in immature permanent molars after carious exposures using different hemorrhage control and capping materials. Pediatr Dent. 2017; 39: 364–70.

Conflicts of Interest
The authors deny any conflicts of interest related to the study.

Acknowledgements
The authors would like to thank Dr. Jay Hansel Tabije, Dr. Mariusse Chars R. Esquillo, Dr. Ian Adrian Manaloto and Dr. Ma. Lourdes Pacaldo for their invaluable inputs during the oral poster presentation.

About the Authors
Fredrick Ikhabi Weboko, BDS MScD
Endodontic Resident, Postgraduate Endodontics Program, College of Dentistry, University of the East, Manila, Philippines

Benjamin Simiyu Nyongesa, BDS MScD
Endodontic Resident, Postgraduate Endodontics Program, College of Dentistry, University of the East, Manila, Philippines

Mercy Naswa Makhanu, BDS MScD
Endodontic Resident, Postgraduate Periodontics Program, College of Dentistry, University of the East, Manila, Philippines

Michelle S. Santos, DDM
Third year Endodontic Resident, Postgraduate Endodontics Program, College of Dentistry, University of the East, Manila, Philippines
Active member, Endodontic Society of the Philippines

Katrina G. De Luna, DMD MScD FICD
Associate Professor, Postgraduate Endodontics Program, College of Dentistry, University of the East, Manila, Philippines
Fellow, Philippine Board of Endodontics
Fellow, International College of Dentists
Assistant Treasurer, Endodontic Society of the Philippines

Grace Ellen S. Dey, DMD MScD FADI FICD
Associate Professor, Postgraduate Endodontics Program, College of Dentistry, University of the East, Manila, Philippines
Fellow, Philippine Board of Endodontics
Fellow, Academy of Dentistry International
Fellow, International College of Dentists
Secretary, Endodontic Society of the Philippines

Iluminada L. Viloria, DMD PhD FADI FICD
Professor and Chair, Postgraduate Endodontics Program, College of Dentistry, University of the East, Manila, Philippines
Diplomate, Philippine Board of Endodontics
Fellow, Academy of Dentistry International
Fellow, International College of Dentists
Past President, Endodontic Society of the Philippines

Practice Guidelines During COVID-19

FOR ENDODONTISTS AND GENERAL DENTISTS

Prepared by the

Philippine Board of Endodontics

for the

Endodontic Society of the Philippines

Introduction

In the midst of these uncertain times brought about by the COVID-19 pandemic, we continue to reassure everyone that we are dedicated in establishing the utmost safety standards for endodontists, general dentists, staff, and patients.

It is imperative that strict guidelines for health and infection control be practiced, not only to contain the disease and accomplish our moral obligation to help stop it, but more so to eventually have a healthier and safer environment for everyone.

Preparing Your Office and Your Team

- Brief all dentists and staff on your new infection control protocol
- Make sure your dentists and staff fully understand the new guidelines. They should undergo training, know the risks and take extra precaution during this time of the pandemic.

PREPARING YOUR OFFICE

If dentists and staff exhibit COVID-19-like symptoms such as fever, cough, sore throat and muscle aches, they should not report for work and should contact a medical doctor/DOH.

DOH COVID-19 HOTLINE

OPEN TO ALL CALLERS NATIONWIDE:

(02) 894-COVID

(02) 894-26843

FOR PLDT, SMART, SUN, AND TNT SUBSCRIBERS:

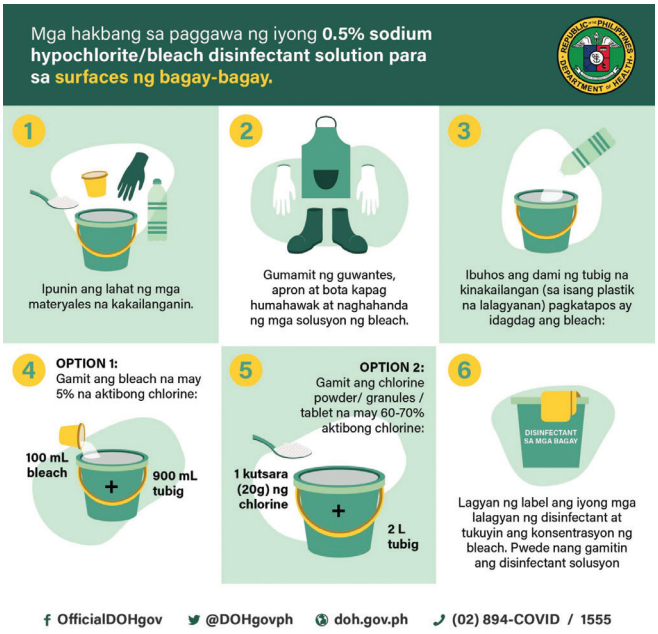
1555

We're working to have the 1555 hotline accessible for all.

OfficialDOHgov @DOHgovph doh.gov.ph (02) 894-COVID

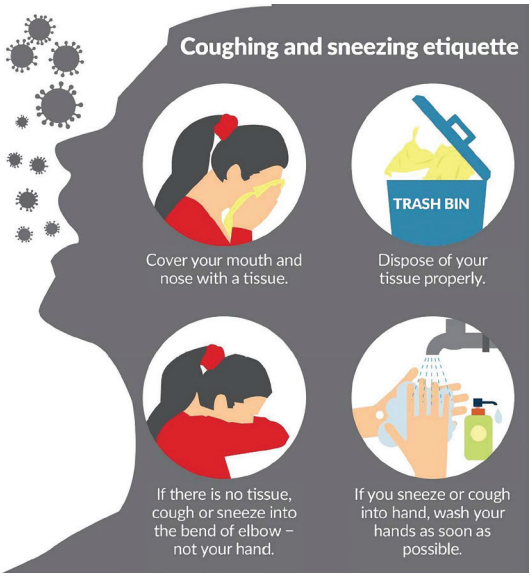
- Dentists and staff should monitor their body temperature twice a day using a non-contact infrared thermometer
- Dentists and staff who are
  - older than 65 years
  - have pre-existing, medically compromised condition
  - pregnant

  are of higher risk of contracting COVID-19. Extra precaution must be taken and if possible, they should be assigned to less critical duties
- Clean and disinfect the whole office with 0.5% sodium hypochlorite solution, 70% isopropyl or ethyl alcohol or benzalkonium chloride (lysol) solution (non-aerosol)



- Wipe surfaces such as knobs, cabinet handles, light switches, countertops, monitors, keyboards and phones
- Wipe reception counter areas and all hard surfaces
- Have alcohol-based hand cleaners (70% isopropyl or ethyl alcohol) readily available on reception counters and around the office
- Provide tissue paper and trash bin (preferably contactless) at the reception area
- Print signages on entry requirements such as:
  - “No mask, No entry”
  - proper respiratory hygiene, cough etiquette
  - social distancing

  and place them at the reception area
- Remove magazines, pens, toys, coffee/tea/water stations or decor that can potentially be contaminated
- Physical arrangement in the reception area should allow social distancing of 2 meters or 6 feet apart
- You may provide a shoe bath of 1 part hypochlorite solution to 10 parts water in a tray at the entrance of the office



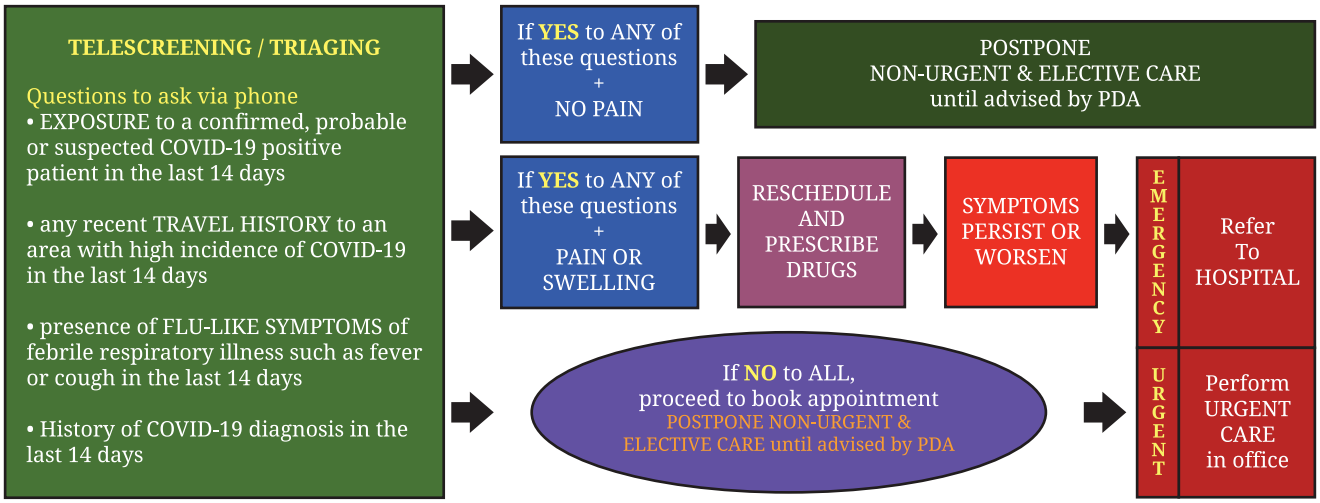
Booking Schedule

- To observe social distancing in the office
  - Schedule appointments and discourage walk-ins
  - Allow a minimum of 30-minute interval between appointments to facilitate proper disinfection (reception area and operatory) and social distancing
- If patient arrives early or has an emergency, ask them to wait in the car or somewhere nearby until advised to come in via text message or phone call
- Walk-in patients can be rescheduled or can be asked to wait until schedule permits

Telescreening / Triaging

- Initial screening via telephone to identify patients with suspected or possible COVID-19 infection can be performed remotely at the time of scheduling appointments
- Use the telescreening/triaging algorithm to serve as a guide whether the patient can receive treatment or not
- Prior to dental treatment, recovered patients from COVID-19
  - Must be asymptomatic
  - Tested negative twice for Covid-19 after a 14-day strict home quarantine

  *per DOH protocol released April 16 2020, please check with DOH for updates
- Confirmed COVID-19 patients (symptomatic or asymptomatic) needing emergency or urgent dental care must be treated in a negative pressure facility (i.e. hospital) to prevent transmission of the disease



EMERGENCY vs URGENT CARE

EMERGENCY CARE

- Uncontrolled bleeding
- Cellulitis or a diffuse soft soft tissue infection with intra-oral or extra-oral swelling that potentially compromise the patient's airway
- Trauma involving facial bones, potentially compromising the patient's airway

URGENT DENTAL CARE

- Severe dental pain from pulpal inflammation
- Pericoronitis or third-molar pain
- Surgical post-operative osteitis, dry socket dressing changes
- Abscess or localized bacterial infection resulting in localized pain and swelling
- Tooth fracture resulting in pain or causing soft tissue trauma
- Dental trauma with avulsion, luxation
- Dental treatment required prior to critical medical procedures
- Final crown/bridge cementation if the temporary restoration is lost, broken or causing gingival irritation
- Biopsy of abnormal tissue

OTHER URGENT DENTAL CARE

- Extensive dental caries or defective restorations causing pain (Manage with interim restorative techniques when possible (silver diamine flouride, glass ionomers)
- Suture removal
- Denture adjustment on radiation/oncology patients
- Replacing temporary filling on endo access openings in patients experiencing pain
- Snipping or adjustment of orthodontic wire or appliances piercing or ulcerating the oral mucosa

American Dental Association (ADA) Interim Guidelines for Minimizing Risk of COVID-19 Transmission

ENDODONTIC MANAGEMENT

PHARMACOLOGIC MANAGEMENT		
	GENERIC / Example of Brands	**DOSAGE**
PAIN (Painkillers)	**Paracetamol** *Biogesic, Calpol, Tylenol, Panadol*	1000 mg every 6 to 8 hours; 325-500 mg every 6 to 8 hours if in combination with Ibuprofen
	Ketorolac Tromethamine *Toradol, Marolac, Ketomed, Remopain*	10 mg every 6 hours
	Mefenamic Acid *Ponstan, Dolfenal, Mefenax, Gardan*	500 mg every 8 hours
	Ibuprofen *Advil, Medicol*	400-600 mg every 6-8 hours
SWELLING (Antibiotics)	**Amoxicillin 500 mg/ Clavulanic Acid 125 mg** *Augmentin, AmoClav*	500 mg every 12 hours / 5 days
	Clindamycin *Dalacin-C, Dalamed, Clindal*	300 mg every 6 hours / 5 days (if allergic to Amoxicillin)

DIAGNOSIS	URGENT TREATMENT
Pain Only **IRREVERSIBLE PULPITIS/ APICAL PERIODONTITIS**	Full pulpotomy Painkillers as needed
Pain and Swelling **ACUTE APICAL ABSCESS**	With intra-oral swelling: Incision and Drainage, Antibiotics + Painkillers as needed With extra-oral swelling: Antibiotics + Painkillers; Possible referral to OMS
TOOTH FRACTURE resulting in pain	Vital Pulp Therapy Painkillers as needed
AVULSION / LUXATION	If tooth not replanted, replant and follow IADT guidelines as best as possible Painkillers as needed
CELLULITIS or diffuse soft tissue infection **with intra-oral or extra-oral swelling; TRAUMA** involving facial bone, potentially **compromising patient's airway**	Refer to OMS / Hospital ER

Adapted from Journal of Endodontic / American Association of Endodontists and the International Federation of Endodontic Associations / Indian Endodontic Society

Patients who have cough, fever, sore throat or shortness of breath must be rescheduled

- Only one companion will be allowed to accompany patients. They will undergo screening for signs and symptoms of COVID-19 (body temperature checked and COVID-19 questionnaire answered)
- Companions should not fall in the high risk category of contracting COVID-19 such as
  - have a pre-existing, medically compromised condition
  - pregnancy
  - elderly
- Companion should be prohibited in the dental operatories and should only be allowed in the reception area
- Instruct patients to brush their teeth prior to their appointment

On the Day of the Appointment

RECEPTION AREA

- Patient and companion must wear masks upon entry into the office
  Provide them with masks if they do not have one
- Take their temperature preferably with a non-contact infrared thermometer
- Patient or companion with a temperature of 38.0°C and above (as prescribed by DOH) will need to be rescheduled and refused entry to protect the other patients and dental staff
- You may opt to provide a plastic bag for the patient's belongings before entering the operatory
- You may give the patient booties/shoe covers to put on
- Patient and companion must fill-in and sign a COVID-19 questionnaire
- Receptionist should wear surgical mask and headcap

SAMPLE COVID-19 QUESTIONNAIRE

Dear Patient and Companion,

In light of the COVID-19 pandemic, kindly answer the following questions to determine whether we can perform any treatment or defer at a later date for your safety as well as our dental team.

This is in compliance with the recommendation of the Department of Health.

Please be reminded that under Republic Act No. 11332, non-cooperation of persons who should report notifiable diseases such as the COVID-19, is prohibited.

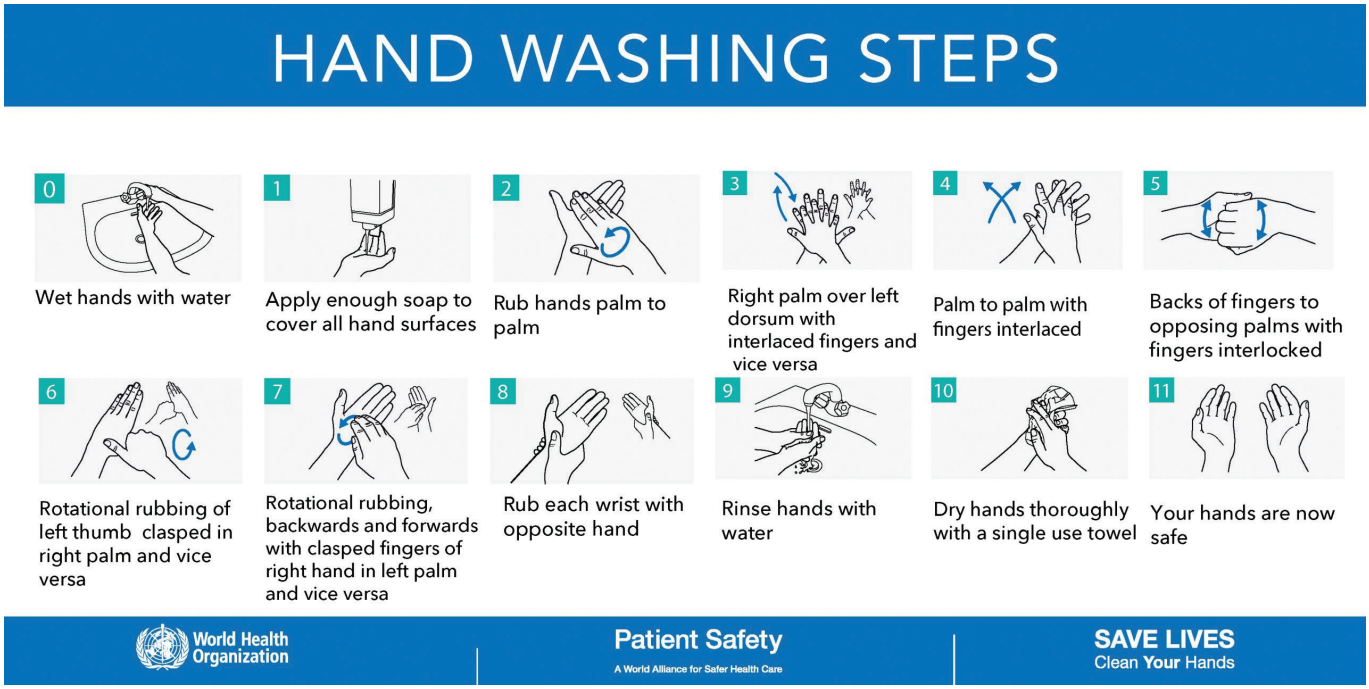
Thank you for your understanding in these difficult times.

Date:		
	PATIENT	**COMPANION**
Name:		
Age:		
Address:		
Contact Number:		
Body Temperature:		
	Please encircle below	Please encircle below
1. Have you **TRAVELLED** to any country within the last 14 days prior to your scheduled appointment?	Yes No	Yes No
• If YES, please specify country(ies) or city(ies) visited.		
• If YES, when did you arrive in the Philippines?		
2. Have you been in close contact with someone who arrived from abroad in the last 14 days?	Yes No	Yes No
3. Have you been in a **red zone area** (cities with high incidence of COVID-19 positive cases) for the past 14 days?	Yes No	Yes No
4. Have you been in close contact with anyone from a **red zone area** within the past 14 days?	Yes No	Yes No
5. Have you attended a **mass gathering**, a **reunion of relatives or friends, parties** within the last 14 days?	Yes No	Yes No
6. Have you been in close contact with a confirmed probable, suspect COVID-19 positive person in the last 14 days?	Yes No	Yes No
7. Have you been in close contact with a recovered COVID-19 person in the last 14 days?	Yes No	Yes No
8. Have you been diagnosed with COVID-19?	Yes No If YES, when? _____	Yes No If YES, when? _____
9. Do you have flu-like symptoms such as fever, cough, runny nose, sore throat, headache, shortness of breath, chills, general malaise, diarrhea?	Yes No	Yes No
10. Have you had any of the mentioned symptoms on #9 within the last 14 days?	Yes No	Yes No
I hereby declare that the above statements are true, accurate and complete.	Signature	Signature

OPERATING AREA

- Provide the patient with Protective Personal Equipment (PPE): goggles/protective eyewear and disposable bib
- Dentists, hygienists and chairside assistants should wash hands with soap and water for at least 20 seconds before donning PPE
- Dry hands thoroughly with disposable paper towels before donning PPE

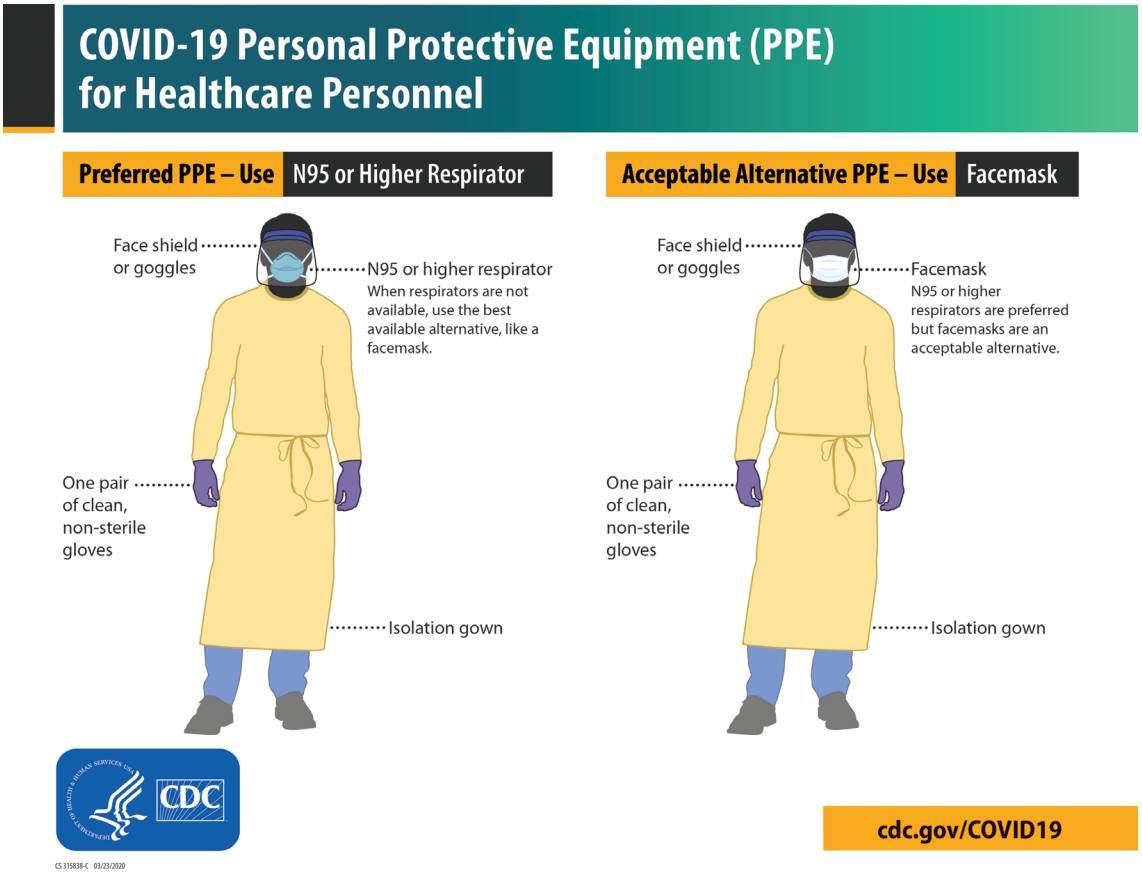
HAND WASHING TECHNIQUE



RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR DENTAL PROCEDURES

- Disposable PPE is recommended. However, due to shortage, alternatives are acceptable
- Minimum Recommended PPEs:
  - Receptionist: **head cap, surgical mask**
  - Dentists/Hygienists/Chairside Assistants: **head cap, eye protection, surgical gown, mask (N95) for aerosol-generating procedure (AGP), gloves**
- Adjunct PPE: booties/surgical shoe cover

PPE (Please note that head cap not in the diagram, but recommended)

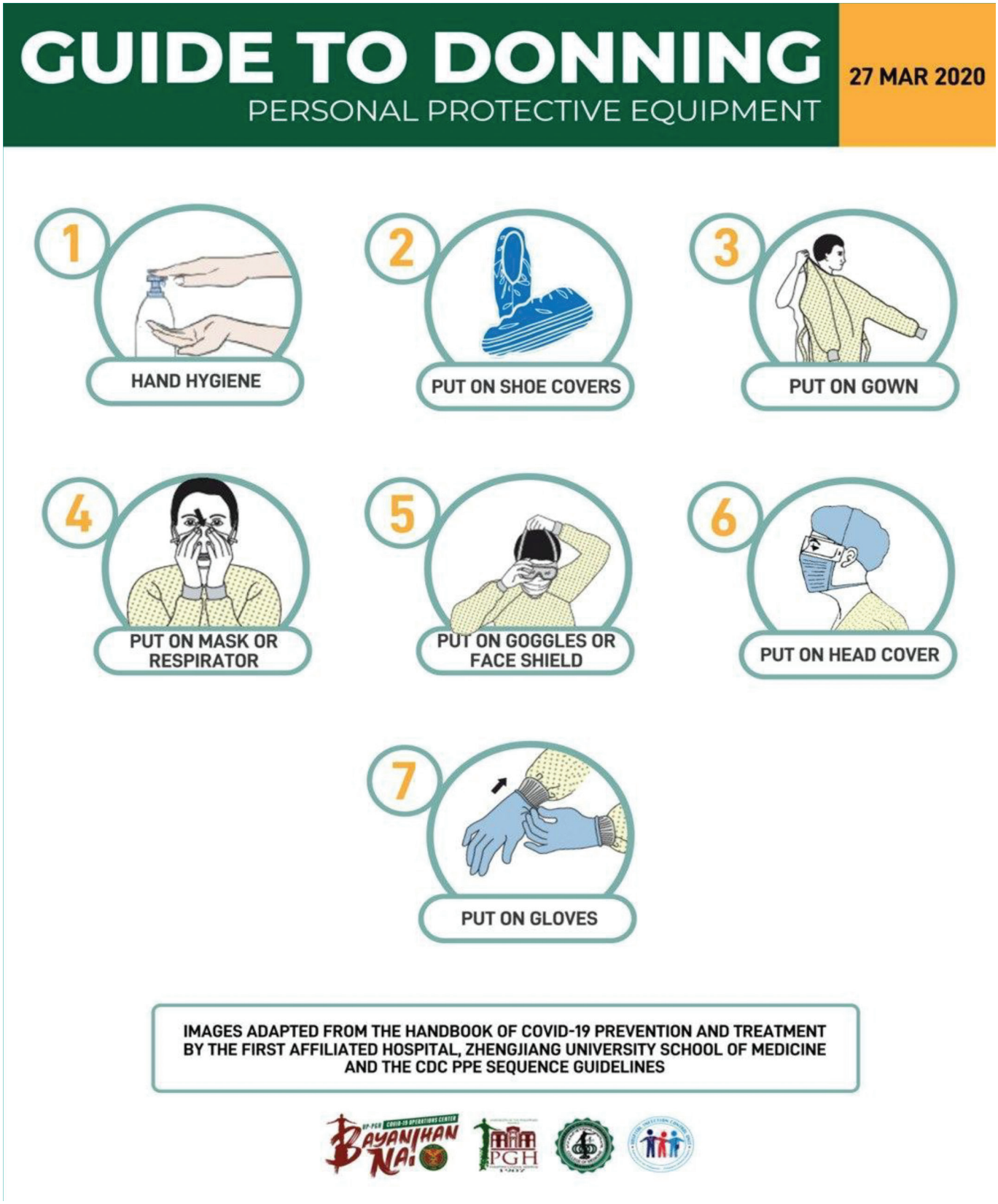


PPE: HEAD CAP, GOWN, EYE PROTECTION, MASK & GLOVES

	PREFERRED	ALTERNATIVE
HEAD CAP	Disposable *Dispose after every patient*	Washable *Change after every patient*
GOWN SURGICAL GOWN: long-sleeved that ties at the back (for ease of donning and doffing which will minimize cross-contamination) *Follow proper donning and doffing procedure (video) (video does not include headcap but it is recommended to have one)	Disposable *Dispose after every patient* *Change if soiled or with blood*	Washable Autoclavable material preferred, Water-repellant, non-woven preferred *Change after every patient* *Change if soiled or with blood* *Properly disinfected and washed accordingly
EYE PROTECTION GOGGLES AND/OR FACE SHIELD	GOGGLES: Place over face and eyes and adjust to fit FACE SHIELD: should cover the entire front (that extends to the chin or below) and sides of the face *Disinfect eye protection after each patient with 0.5% sodium hypochlorite, 70% isopropyl or ethyl alcohol*	
MASK	N95 RESPIRATOR N95 must be properly fitted based on manufacturer's instructions or CDC recommendations *Placing a surgical mask on top of the N95 to prolong its shelf life is recommended *Due to shortage, N95 masks may be reused	SURGICAL MASK *Change after every patient*
GLOVES	Wash hands thoroughly before and after donning gloves Alcohol-based handrub may also be used Gloves should extend over the cuff of the surgical gown Double gloving is recommended *Change gloves after every patient and when torn or heavily contaminated during procedures*	

IMPORTANT: KEEP HANDS AWAY FROM FACE LIMIT SURFACES TOUCHED

PPE: DONNING

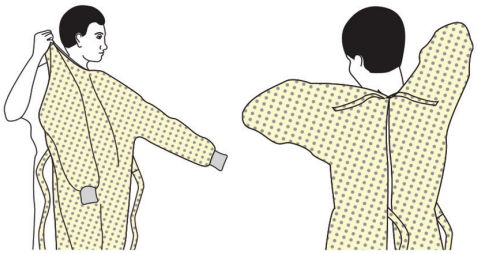

GUIDE TO DONNING
PERSONAL PROTECTIVE EQUIPMENT
27 MAR 2020
1
HAND HYGIENE
2
PUT ON SHOE COVERS
3
PUT ON GOWN
4
PUT ON MASK OR RESPIRATOR
5
PUT ON GOGGLES OR FACE SHIELD
6
PUT ON HEAD COVER
7
PUT ON GLOVES
IMAGES ADAPTED FROM THE HANDBOOK OF COVID-19 PREVENTION AND TREATMENT BY THE FIRST AFFILIATED HOSPITAL, ZHENGJIANG UNIVERSITY SCHOOL OF MEDICINE AND THE CDC PPE SEQUENCE GUIDELINES
BAYANIHAN NA!
PGH

SEQUENCE FOR PUTTING ON PERSONAL PROTECTIVE EQUIPMENT (PPE)

The type of PPE used will vary based on the level of precautions required, such as standard and contact, droplet or airborne infection isolation precautions. The procedure for putting on and removing PPE should be tailored to the specific type of PPE.

1. GOWN

- Fully cover torso from neck to knees, arms to end of wrists, and wrap around the back
- Fasten in back of neck and waist



2. MASK OR RESPIRATOR

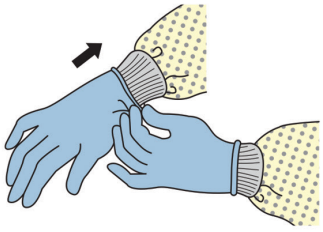
- Secure ties or elastic bands at middle of head and neck
- Fit flexible band to nose bridge
- Fit snug to face and below chin
- Fit-check respirator

3. GOGGLES OR FACE SHIELD

- Place over face and eyes and adjust to fit

4. GLOVES

- Extend to cover wrist of isolation gown



USE SAFE WORK PRACTICES TO PROTECT YOURSELF AND LIMIT THE SPREAD OF CONTAMINATION

- Keep hands away from face
- Limit surfaces touched
- Change gloves when torn or heavily contaminated
- Perform hand hygiene

PPE: DOFFING

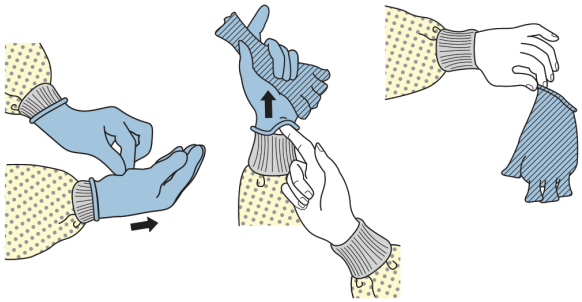
REMINDER:
Remove all PPE before exiting the operatory except for N95 mask
Remove the N95 mask after leaving the operatory

HOW TO SAFELY REMOVE PERSONAL PROTECTIVE EQUIPMENT (PPE) EXAMPLE 1

There are a variety of ways to safely remove PPE without contaminating your clothing, skin, or mucous membranes with potentially infectious materials. Here is one example. **Remove all PPE before exiting the patient room** except a respirator, if worn. Remove the respirator **after** leaving the patient room and closing the door. Remove PPE in the following sequence:

1. GLOVES

- Outside of gloves are contaminated!
- If your hands get contaminated during glove removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Using a gloved hand, grasp the palm area of the other gloved hand and peel off first glove
- Hold removed glove in gloved hand
- Slide fingers of ungloved hand under remaining glove at wrist and peel off second glove over first glove
- Discard gloves in a waste container

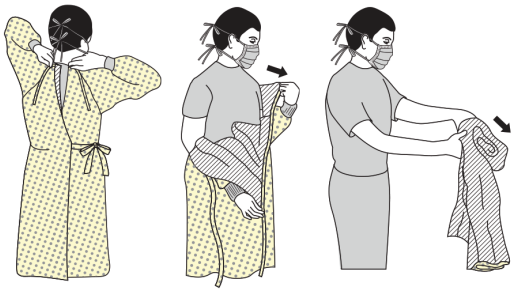


2. GOGGLES OR FACE SHIELD

- Outside of goggles or face shield are contaminated!
- If your hands get contaminated during goggle or face shield removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Remove goggles or face shield from the back by lifting head band or ear pieces
- If the item is reusable, place in designated receptacle for reprocessing. Otherwise, discard in a waste container

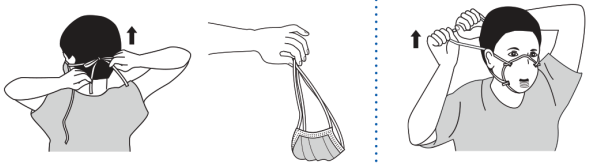
3. GOWN

- Gown front and sleeves are contaminated!
- If your hands get contaminated during gown removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Unfasten gown ties, taking care that sleeves don't contact your body when reaching for ties
- Pull gown away from neck and shoulders, touching inside of gown only
- Turn gown inside out
- Fold or roll into a bundle and discard in a waste container

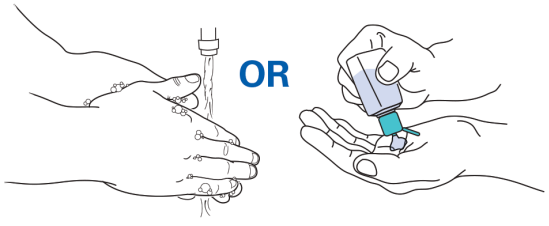


4. MASK OR RESPIRATOR

- Front of mask/respirator is contaminated — DO NOT TOUCH!
- If your hands get contaminated during mask/respirator removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Grasp bottom ties or elastics of the mask/respirator, then the ones at the top, and remove without touching the front
- Discard in a waste container



5. WASH HANDS OR USE AN ALCOHOL-BASED HAND SANITIZER IMMEDIATELY AFTER REMOVING ALL PPE



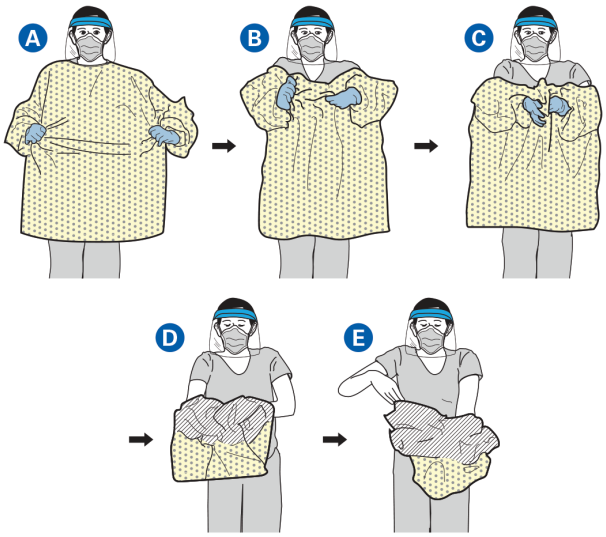
PERFORM HAND HYGIENE BETWEEN STEPS IF HANDS BECOME CONTAMINATED AND IMMEDIATELY AFTER REMOVING ALL PPE

HOW TO SAFELY REMOVE PERSONAL PROTECTIVE EQUIPMENT (PPE) EXAMPLE 2

Here is another way to safely remove PPE without contaminating your clothing, skin, or mucous membranes with potentially infectious materials. **Remove all PPE before exiting the patient room** except a respirator, if worn. Remove the respirator **after** leaving the patient room and closing the door. Remove PPE in the following sequence:

1. GOWN AND GLOVES

- Gown front and sleeves and the outside of gloves are contaminated!
- If your hands get contaminated during gown or glove removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Grasp the gown in the front and pull away from your body so that the ties break, touching outside of gown only with gloved hands
- While removing the gown, fold or roll the gown inside-out into a bundle
- As you are removing the gown, peel off your gloves at the same time, only touching the inside of the gloves and gown with your bare hands. Place the gown and gloves into a waste container

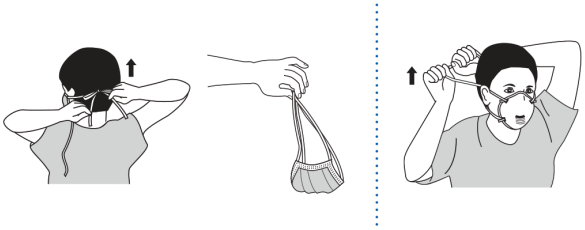


2. GOGGLES OR FACE SHIELD

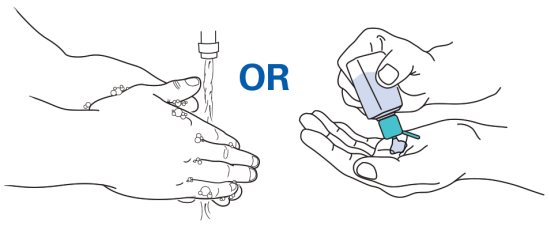
- Outside of goggles or face shield are contaminated!
- If your hands get contaminated during goggle or face shield removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Remove goggles or face shield from the back by lifting head band and without touching the front of the goggles or face shield
- If the item is reusable, place in designated receptacle for reprocessing. Otherwise, discard in a waste container

3. MASK OR RESPIRATOR

- Front of mask/respirator is contaminated — DO NOT TOUCH!
- If your hands get contaminated during mask/respirator removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Grasp bottom ties or elastics of the mask/respirator, then the ones at the top, and remove without touching the front
- Discard in a waste container



4. WASH HANDS OR USE AN ALCOHOL-BASED HAND SANITIZER IMMEDIATELY AFTER REMOVING ALL PPE



PERFORM HAND HYGIENE BETWEEN STEPS IF HANDS BECOME CONTAMINATED AND IMMEDIATELY AFTER REMOVING ALL PPE

DENTAL TREATMENT

TREATMENT MODIFICATIONS	
Use a pre-procedural antimicrobial mouth rinse	1.0% hydrogen peroxide (1 part 3% solution diluted with 2 parts water) 0.2% Povidone (1% Povidone-Iodine Solution diluted with 1 part water)
Radiographs	Extraoral imaging (panoramic radiography, CBCT) preferred to avoid gag or cough reflex that may occur with intraoral imaging When intraoral imaging is mandated, sensors should be double barriered to prevent perforation and cross contamination
Rubber Dam	**STANDARD OF CARE FOR NON-SURGICAL ENDODONTIC TREATMENT** Recommended to minimize splatter generation Place the rubber dam so that it covers the nose Place caulking material around tooth to prevent leakage
Sodium hypochlorite solution for endodontic disinfection / irrigation	Due to shortage, sodium hypochlorite irrigant solution may be diluted to 1% concentration to extend the supplies without compromising treatment outcome
Aerosol-generating equipment (ultrasonic instruments, hi-speed handpieces, 3-way syringe)	Avoid or minimize using these instruments Use of hand instruments (scalers, spoon excavators, etc), slow speed or electric handpieces is preferred
High Volume Evacuator	Highly Recommended
Anti-retraction handpieces	Recommended to provide additional protection against cross-contamination
Equipment adjuncts	Extra-oral aerosol suction Air Purifier HEPA Filter

AFTER DENTAL TREATMENT

- Discard disposable PPEs in yellow plastic trash bags
- Clean reusable face shield with soap and water and disinfect with 70% isopropyl or ethyl alcohol or 0.5 % sodium hypochlorite
- Observe standard sterilization and disinfection procedures
- Disinfect handpieces, ultrasonic scalers, 3-way syringes prior to heat sterilization. Clean and disinfect all exposed surfaces of the dental chair & unit, light and dental x-ray equipment, as well as work tops/tables, computer monitor and keyboard with either 70% isopropyl or ethyl alcohol or 0.5% sodium hypochlorite
- Clean the floor of the operatory midday and at the end of the day with low level disinfectant such 3% hydrogen peroxide, 0.5% sodium hypochlorite
- Do not perform disinfectant fogging in the reception area and operatory
- Avoid sweeping with a broom because particles become airborne and can be transferred throughout the office. Use a dry, flat mop instead

END OF THE DAY

- Change from scrub suit to your personal clothing before heading home
- Soiled, used scrub suits and washable gowns:
    - must be packed in a plastic bag before going home
    - must be washed separately from the rest of the household laundry
- As an adjunct to operatory decontamination, ultraviolet (UVC) radiation may be used to disinfect the air and the exposed areas of the operatory
- Upon arriving home, disinfect your shoes, remove and wash personal clothing (wash separately from the rest of the household laundry) and immediately take a shower

WASTE MANAGEMENT

- Disposable PPEs and other hazardous wastes must be discarded and placed in yellow plastic trash bags inside the operatory. This must be tied securely
- Designate an area in your office for waste storage. Segregate infectious waste bags, amalgam wastes, x-ray film lead foils, teeth

and tissues and sharps in color-coded or labeled containers. The containers must be resistant to leakage for non-sharp medical waste and puncture resistant and leakproof for sharp items. The waste containers must be securely stored prior to collection
- Arrange with your building administration or the local government unit for collection

DEALING WITH OFFICE DELIVERIES
- A "No contact delivery" should be imposed
  - Delivered items can be dropped off on a table outside the door of the office
  - Disinfect outer packaging with hypochlorite solution before bringing it into the office
- Arrange for online payments. If unavailable, place cash/check in an envelope and leave on the table

FAQs

1. Would you recommend getting the extra-oral aerosol suction, a UVC lamp, air purifier with HEPA-14 filters and anti-aerosol box for our office?

   These equipment are promising but are still considered adjuncts. To date, there are no current available research on the effectivity of these armamentarium against aerosolization of the SARS-CoV-2. Prior to recommending these equipment that will impact our clinic's infrastructure and finances, we strongly recommend to wait for further development and evidence in the next few months.

2. Would you recommend wearing coveralls/bunny suits as PPE for dentists?

   Current interim ADA/CDC guidelines recommend the use of surgical gowns.

   Coveralls are more difficult to doff without causing cross-contamination as compared to the surgical gown, as inferred from CDC guidelines.

   Video: Doffing PPE: Remove the Coverall (https://www.cdc.gov/vhf/ebola/hcp/ppe-training/n95respirator_coveralls/doffing_12.html)

3. What is my risk during dental treatment?

   SARS-CoV-2 mode of transmission include direct transmission (cough, sneeze and droplet inhalation transmission) and contact transmission (contact with oral, nasal and eye mucous membranes). Additionally, the viral load of these aerosolized droplets from our dental instruments (such as hi-speed handpieces, ultrasonics, etc) may pose an additional threat. These aerosolized droplets can remain suspended in the air for hours and days after. This the reason why use of PPEs is strongly recommended.

4. What is dental triaging?

   Triaging is sorting patients according to the urgency (as in an emergency room) of their need of care.

   It is an important screening procedure preferably done before seeing the patient to identify suspected and possible COVID-19 patients. This will lessen the incidence of exposure and contamination of our dental team and patients from COVID-19.

5. What is an anti-retraction handpiece?

   Anti-retraction dental handpieces have specially designed anti-retractive valves to reduce the backflow of oral bacteria into the tubes of the handpiece and waterlines. This serves as an extra preventive measure for cross-infection.

6. Can we reuse N95 masks? How?

   Ideally, N95 masks should be discarded following use during aerosol generating procedures. Due to shortage of supply, they may be reused. There is no way of determining the maximum number of safe reuses but certain measures may be used to prolong its life.

   The CDC recommends placing a clean surgical mask over the N95 and protecting it further with a face shield when performing aerosol generating procedures. These measures reduce surface contamination of the N95 mask.

   The used N95 mask must then be stored in a clean, breathable container such as a paper bag between uses. Label the container with the user's name to reduce accidental usage of another person's mask. Storage containers should be disposed of or cleaned regularly.

   Watch the video below on how to reuse N95 mask.
   Video: N95 Respirator Limited Reuse During Emergency Situation (https://www.youtube.com/watch?v=Cfw2tvjiCxM)
   Due to shortage, the video above shows using one N95 mask for 5 consecutive days. However, CDC recommends recycling each used

N95 mask every five days to inactivate the possible pathogens on the mask. In which case you will need 5 masks stored in 5 separate paper bags.

Avoid touching the inside of the N95 mask. Visually inspect the mask to determine if its integrity has been compromised. Check the straps, nose bridge and nose foam for degradation, which can affect the quality of the fit and seal.

Discard them when they have been contaminated with blood, respiratory or nasal secretions or other bodily fluids from patients or following close contact with any patient co-infected with an infection.

Be aware of the risks of reusing N95 masks: such as skin irritation, cross contamination, breakdown of respirator fit, breakdown of protective materials/filter and risk of transmission through trapped pathogens or through touch each time the mask is put on or removed.

Another method of prolonging the life of the N95 mask is by decontamination. This should only be practiced when supplies are severely constrained, as advised by the CDC.

Vaporous hydrogen peroxide, ultraviolet germicidal irradiation and moist heat are the most promising decontamination methods. Steam treatment and liquid hydrogen peroxide are promising but with some limitations. Autoclave dry heat, isopropyl alcohol, soap, dry microwave irradiation, bleach and disinfectant wipes causes significant filter degradation. Ethylene oxide is not recommended as it may be harmful to the wearer.

Video: Disinfecting N95 masks for reuse during COVID-19 pandemic (https://www.youtube.com/watch?v=x7tsbMxubPc)

7. Are we required to use rubber dam for restorative procedures?

   Yes, rubber dam isolation is strongly recommended for restorative procedures especially during this COVID-19 pandemic.

   Rubber dam acts as barrier against splatter and minimizes aerosolizing the patient's oral fluids. It also allows for good moisture control which is paramount in placement of restorations.

8. How do we do treatment with multiple chairs with open cubicles? How do we space patients?

   During this crisis, we are advised to limit the number of patients to practice social distancing, allow ample time to sterilize and disinfect the office and lessen incidence of cross contamination.

   We recommend staggering patient appointments and utilizing alternate dental chairs in your operatories. Try to observe 6 feet or 2 meters distance between 2 dentists.

References

1. Department of Health Philippines (DOH) Updates on Novel Coronavirus Disease (COVID-19)
2. Centers for Disease Control and Prevention (CDC) Interim Prevention and Control Guidance for Dental Settings during the COVID-19 Response; Pandemic Planning
3. American Dental Association (ADA) Interim Guidelines for Minimizing Risk of COVID-19 Transmission
4. American Association of Endodontists (AAE) Coronavirus Disease 19 (COVID-19) Implications for Dental Care (Journal of Endodontics)
5. Endodontic And Dental Practice during COVID-19 Pandemic: Position Statement from International Federation of Endodontic Associations (IFEA) and Indian Endodontic Society (IES)
6. Australian Dental Association (ADA) Managing COVID Guidelines
7. Philippine Dental Association (PDA) Update on PDA Recommendations in Compliance to the Enhanced Community Quarantine
8. Association of Philippine Orthodontists (APO) The New Norm in the Orthodontic Office
9. World Health Organization (WHO) Clean Care is Safer Care: Clean Hands Protect Against Infection

Philippine Board of Endodontics (PBE) Diplomates
Dr. Irene Grace Achacoso-Porter (Chairman)
Dr. Maria Cristina Facundo Morales (Secretary)
Dr. Catherine Anne Teo Chia (Treasurer)
Dr. Isabel Campos-Bustos (Member)
Dr. Erlyn Papa Hernandez (Member)