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A case of a missed canal; maxillary 2nd premolar: tooth not to be underestimated
Muhammad Khiratti Bin Mat Zainal, Eason Soo, Dalia Abdullah

Non-healing extraoral cutaneous sinus tract due to pulpal necrosis of 36: a case report
Nurul Ain Ramlan, Eason Soo

Use of bioceramics in managing non-vital maxillary central incisor with an open apex
Afiz Azizi Jawami, Eason Soo

Effects of operative procedures on pulpal health
Noor Hayati Azami

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PRESIDENT’S MESSAGE

Assalamualaikum warahmatullah I wabarakatuh and Salam Sejahtera.

Dearest esteemed dental colleagues and cherished members of Malaysian Endodontic Society.

I would like to take this opportunity to say thank you for the continuous confidence and support to our committee members in ensuring the success of our beloved society. I am blessed for the opportunity to serve as the President for this term 2017-2018 and surrounded by a group of energetic and hard working committee members in ensuring that our yearly events are successful.

In September, we organised a MES Study Club Meeting as special treat to their members given by Assoc. Prof. Dr. Kranthi Raja and Dr. Shekhar Bhatia. MES will continue to serve as a platform to nurture our own world renowned speakers in their fields and for our participants to continue to learn and exchange ideas on the latest developments in endodontics.

This November, we are honoured to bring Dr Marino Sutedjo, Dr Yoshi Terauchi, Dr Mo’hd Hammo, Dr SF Leung, Dr Tan Boon Tik, and Dr Lim Wen Yi. as our keynote speakers for the 30th Malaysian Endodontic Society - SES Annual Scientific Meeting and Annual General Meeting that will be held in Pullman Kuala Lumpur City Centre Hotel and Residences.

We also would like to hear feedback from our members on the update of the MES website and Facebook Page. In time to time, we will continue to improve especially in MES Bulletin. We also hope that more members will be sharing their cases in the bulletin.

This event would not been possible without the strong support in sponsorship of our vendors in endodontics and dental suppliers. They will also display their latest equipment’s and material in the trade exhibition. Please take a visit to their booth and you may find what you are looking for. We would like to take this opportunity to thank them for their continuous contribution and support to MES yearly event.

Lastly, we would like to extend our grateful thank you for all the delegates for your participation and continuous support. We wish you a pleasant and rewarding meeting. Hope to see you in all MES events.

Dr Afzan Adilah Ayoub
President
Malaysian Endodontic Society (2017-2018)
MES SECRETARY’S ANNUAL REPORT 2017/2018

By: Dr Muhamad Azri Md. Saion

Introduction

The 29th Annual General Meeting (AGM) of the Malaysian Endodontic Society was held on Sunday 26th November 2017 at Pullman Kuala Lumpur City Centre Hotel and Residences, 4 Jalan Conlay, Kuala Lumpur, Malaysia. The MES executive Committee members for the year 2017-2018 as listed to the Registrar of Societies (ROS) are as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Afzan Adilah Binti Ayoub</td>
<td>President</td>
</tr>
<tr>
<td>Dr. Siew Kai Ling</td>
<td>Vice President</td>
</tr>
<tr>
<td>Dr. Muhamad Azri Bin Md. Saion</td>
<td>Secretary</td>
</tr>
<tr>
<td>Dr. Wong Lishen</td>
<td>Treasurer</td>
</tr>
<tr>
<td>Dr. Nurul Ain Ramlan</td>
<td>Assistant Secretary</td>
</tr>
<tr>
<td>Dr. Hussein Ali Al-Wakeel</td>
<td>Assistant Treasurer</td>
</tr>
<tr>
<td>Dr. Noor Hayati Azami</td>
<td>Editor</td>
</tr>
<tr>
<td>Assoc. Prof. Dr. Kranthi Raja</td>
<td>Committee member</td>
</tr>
<tr>
<td>Assoc. Prof. Dr. Dahlia Abdullah</td>
<td>Committee member</td>
</tr>
<tr>
<td>Dr. Farah Eziana Hussein</td>
<td>Committee member</td>
</tr>
<tr>
<td>Dr. Shekhar Bhatia</td>
<td>Committee member</td>
</tr>
<tr>
<td>Dr. Abhishek Parolia</td>
<td>Committee member</td>
</tr>
<tr>
<td>Dr. Mohd Rusman Adlan A. Rahman</td>
<td>Committee member</td>
</tr>
<tr>
<td>Dr. Lam Jac Meng</td>
<td>Hon. Auditor I</td>
</tr>
<tr>
<td>Datin Dr. Roza Anon Mohd Ramlee</td>
<td>Hon. Auditor II</td>
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</table>
Committee Meetings

During this 2017-2018 term, committee members discuss regularly via emails and WhatsApp groups starting on the 1st day of tenure (26th November 2017). 5 face-to-face meetings were scheduled at MDA Kelana Jaya either during the weekdays or weekends. Combination of these virtual and face-to-face meetings became more active towards the end of the term discussing matters pertaining to organizing one major event of the new term; the 11th MES-SES Biannual Joint Conference and 30th AGM 2018. Listed below is the table depicting the issues discussed among the committee members.

a. via WhatsApp application

<table>
<thead>
<tr>
<th>Month</th>
<th>Among the issues/topics discussed:</th>
<th>Sender/Initiator</th>
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<tbody>
<tr>
<td>Jan 2018</td>
<td>‘2018 MES Committee group’ was created announcement official MES in FB</td>
<td>Dr. Azri</td>
</tr>
<tr>
<td></td>
<td>Planning on first meeting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Conference, speakers and cost</td>
<td>Dr Afzan</td>
</tr>
<tr>
<td>Feb 2018</td>
<td>Requesting update details from committee members to fill the committee member form for the eROSES</td>
<td>Dr Azri</td>
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<tr>
<td></td>
<td>Proposal of MES rental storage</td>
<td>Dr Afzan</td>
</tr>
<tr>
<td></td>
<td>MES domain website renewal</td>
<td>Dr Mary Soo</td>
</tr>
<tr>
<td>Mar 2018</td>
<td>Price discussion regarding Terauchi file retrieval kit</td>
<td>Dr Afzan</td>
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<tr>
<td></td>
<td>Sponsorship for workshops</td>
<td>Dr Noor Hayati</td>
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<tr>
<td></td>
<td>Confirmation of speakers for MES-SES conference</td>
<td>Dr Afzan</td>
</tr>
<tr>
<td>April 2018</td>
<td>Poster presentation for MES-SES conference</td>
<td>Dr Azri</td>
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<tr>
<td></td>
<td>Planning for MES website</td>
<td>Dr Azri</td>
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<tr>
<td></td>
<td>CPD points, promotion, booths</td>
<td>Dr Afzan</td>
</tr>
<tr>
<td></td>
<td>Speakers for MES-SES conference and AGM confirmation, lecture topic suggestion</td>
<td>Dr Afzan</td>
</tr>
<tr>
<td>May 2018</td>
<td>MES website update</td>
<td>Dr Afzan</td>
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<tr>
<td></td>
<td>MES study club meeting</td>
<td>Dr Afzan</td>
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<tr>
<td></td>
<td>MES committee members to join workshop discussion</td>
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</tr>
<tr>
<td></td>
<td>Conference and workshop fee</td>
<td>Dr Hussein</td>
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<td></td>
<td>Sponsorship for workshops</td>
<td>Dr Ain</td>
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<tr>
<td>Jun 2018</td>
<td>Update MES organization chart</td>
<td>Dr Azri</td>
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<tr>
<td></td>
<td>IFEA membership</td>
<td>Dr Siew Kai Ling</td>
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<tr>
<td></td>
<td>Translation of MES constitution</td>
<td>Dr Azri</td>
</tr>
<tr>
<td>July 2018</td>
<td>Door gifts discussion</td>
<td>Dr Siew Kai Ling</td>
</tr>
<tr>
<td></td>
<td>Workshop poster presentation</td>
<td>Dr Azri</td>
</tr>
<tr>
<td>Aug 2018</td>
<td>MES Study Club discussion</td>
<td>Dr Azfan</td>
</tr>
<tr>
<td></td>
<td>Poster presentation</td>
<td>Dr Azfan</td>
</tr>
<tr>
<td></td>
<td>Conference registration fees</td>
<td>Dr Wong Lishen</td>
</tr>
<tr>
<td>Sept 2018</td>
<td>MES brochures &amp; forms</td>
<td>Dr Noor Hayati</td>
</tr>
<tr>
<td></td>
<td>Student helper and photographer for event</td>
<td>Dr Azri</td>
</tr>
<tr>
<td></td>
<td>Early bird rates for SES membership</td>
<td>Dr Afzan</td>
</tr>
<tr>
<td></td>
<td>Speakers and sponsorship update</td>
<td>Dr Ain</td>
</tr>
<tr>
<td>Date</td>
<td>Venue</td>
<td>Agenda</td>
</tr>
<tr>
<td>------------</td>
<td>----------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Oct 2018</td>
<td></td>
<td>Accommodation and airport transfer for speakers</td>
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<td></td>
<td></td>
<td>Conference fees rate for awaiting graduates</td>
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<tr>
<td></td>
<td></td>
<td>Early bird extension date</td>
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<tr>
<td></td>
<td></td>
<td>Accommodation for committee members</td>
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</tbody>
</table>

b. Meetings

<table>
<thead>
<tr>
<th>Date</th>
<th>Venue</th>
<th>Agenda</th>
<th>Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/2/2018</td>
<td>MDA Kelana Jaya</td>
<td>a) Committee member task</td>
<td>11/14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) 11th MES-SES Biannual Joint Conference and AGM 2018</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) MES Study Club meeting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) MIDEIC table Clinic</td>
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</tr>
<tr>
<td>26/4/2018</td>
<td>MDA Kelana Jaya</td>
<td>a) Confirmation of last minutes</td>
<td>6/14</td>
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<tr>
<td></td>
<td></td>
<td>b) 11th MES-SES Biannual Joint Conference and AGM 2018</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>c) Purchasing of TRFK kit</td>
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<tr>
<td></td>
<td></td>
<td>d) Workshop fee</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) Poster presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f) Venue- payment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>g) Sponsorship and trade booths</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>h) Storage for memorabilia MES</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>i) MES study club meeting</td>
<td></td>
</tr>
<tr>
<td>18/7/2018</td>
<td>MDA Kelana Jaya</td>
<td>a) Confirmation of last minutes</td>
<td>7/14</td>
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<td></td>
<td></td>
<td>b) 11th MES-SES Biannual Joint Conference and AGM 2018</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) E-poster format</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Complimentary registration fees</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) MES study club</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>f) Registration as IFEA member</td>
<td></td>
</tr>
<tr>
<td>23/9/2018</td>
<td>MDA Kelana Jaya</td>
<td>a) Committee member task</td>
<td>11/14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) 11th MES-SES Biannual Joint Conference and AGM 2018</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Email blast</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Workshops and conference</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) Door gifts and speakers’ gifts</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>f) Trade booth</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>g) Volunteering students</td>
<td></td>
</tr>
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<td>3/10/2018</td>
<td>MDA Kelana Jaya</td>
<td>a) Committee member task</td>
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<td></td>
<td></td>
<td>b) 11th MES-SES Biannual Joint Conference and AGM 2018</td>
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<td></td>
<td></td>
<td>c) Email blast</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>d) Workshops and conference</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) Door gifts and speakers’ gifts and certificate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f) Trade booth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>g) Volunteering students</td>
<td></td>
</tr>
</tbody>
</table>
Activities

a) MES Study Club meeting
This activity was held on Sunday, 23rd September 2018 at MDA secretariat office, Kelana Jaya, Petaling Jaya. The two speakers were Assoc. Prof. Dr. Kranthi Raja and Dr. Shekhar Bhatia. Dr. Shekhar as the first speaker gave an hour lecture on glide path and its management. Assoc. Prof. Dr. Kranthi Raja on the other hand talked about clinical application of bioceramics in endodontics.

b) 2017 MES 29th Annual Scientific Conference & AGM
This event was held on Sunday 26th November 2017 at the Pullman Kuala Lumpur City Centre Hotel and Residences, 4 Jalan Conlay, Kuala Lumpur, Malaysia.

The International speakers were Dr. Marga Ree (Netherlands), Professor Dr. Chengfei Zhang (Hong Kong), Dr. Angeline H.C. Lee (Hong Kong), Dr. Dephne Leong (Singapore).

Dr. Angeline Lee started by giving a lecture on challenges in endodontics. She touched on various aspects that may go wrong in the management of endodontic cases and discuss on how to prevent and manage them in appropriate manners. Dr. Dephne Leong spoke on endodontic - orthodontic relationship. Many interesting cases were shared to the audiences.

Dr. Marga Ree gave a 3 hours lecture on dilemma in treatment planning: retreatment vs implant placement and long term follow up traumatized teeth: endodontic and restorative aspect. Lastly, Professor Dr Chengfei Zhang talked about regenerative endodontics and vital pulp therapy.
Both Professor Dr Chengfei Zhang and Dr Angeline H.C. Lee conducted a pre-conference workshop on Saturday 25th November 2017 at the Faculty of Dentistry, Universiti Kebangsaan Malaysia (UKM)

Dr. Marga Ree & Dr Angeline Lee giving their lecture at the 2017-2018 MES Annual Scientific Conference & AGM.

Report prepared by:
Dr Muhamad Azri Md. Saion
MES Secretary 2017/2018
TREASURER’S REPORT

Dear members,

The financial status of the Malaysian Endodontic Society remains positive with profit amount of RM41,812.74 from the events carried out in our financial year while our net assets stand at RM761,092.67.

We are looking forward to organise more seminars and conferences with the help from more volunteers and continuous support from our members in the near future.

Dr Wong Lishen
MES Treasurer 2018
## PERSATUAN ENDODONTIK MALAYSIA
(MALAYSIAN ENDODONTIC SOCIETY)

### REVENUE AND EXPENDITURE STATEMENT
FOR THE MONTH OF SEPTEMBER 2017 TO AUGUST 2018

<table>
<thead>
<tr>
<th></th>
<th>2018 Jan-Aug RM</th>
<th>2017 Sept-Dec RM</th>
<th>TOTAL RM</th>
</tr>
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<tbody>
<tr>
<td>REVENUE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Subscription and Entrance Fees</td>
<td>2,000.00</td>
<td>5,300.00</td>
<td>7,300.00</td>
</tr>
<tr>
<td>Conferences and Courses Fees</td>
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<td>48,002.00</td>
<td>76,892.00</td>
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<tr>
<td>Interest on Deposits</td>
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<td>10,000.00</td>
<td>10,000.00</td>
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<td>Production</td>
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<td>68,005.00</td>
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<tr>
<td>Trade Exhibitors</td>
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<td>19,200.00</td>
<td>30,200.00</td>
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<tr>
<td>UiTM - MES 2017 Seminar</td>
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<td>13,600.00</td>
<td>13,600.00</td>
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<tr>
<td>Purchases - Production</td>
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<td>(49,262.67)</td>
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<td></td>
<td>70,379.68</td>
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<td>175,067.18</td>
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<th>EXPENDITURE</th>
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<td>Bank Charges</td>
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<td>Committee Meeting Expenses</td>
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<tr>
<td>Conference and Clinical Meeting Expenses</td>
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<td>38,592.30</td>
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<td>EXP - MES 2017 Seminar</td>
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<td>26,350.50</td>
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<tr>
<td>Income Tax Expenses</td>
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<td>2,376.20</td>
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<td>Printing &amp; Stationery</td>
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<td>132.05</td>
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<tr>
<td>Transportation &amp; Travelling</td>
<td>100.00</td>
<td>12.70</td>
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<td>Upkeep of Office Equipment</td>
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<td>57,744.80</td>
<td>75,509.64</td>
<td>133,254.44</td>
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</table>

Surplus of Revenue over Expenditure

|                              | 12,634.88       | 29,177.86        | 41,812.74        |

I certify hereby that the statement given above is true to my knowledge and belief.

Dr Wong Lishen
# PERSATUAN ENDODONTIK MALAYSIA
(MALAYSIAN ENDODONTIC SOCIETY)

## BALANCE SHEET AS AT 31ST AUGUST 2018

<table>
<thead>
<tr>
<th>Fixed Assets</th>
<th>RM</th>
</tr>
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<tbody>
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<td>Computer at cost</td>
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<tr>
<td>Computer - Accm Depreciation</td>
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<td>1.00</td>
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<thead>
<tr>
<th>Current Assets</th>
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<tbody>
<tr>
<td>Balance in Fixed Deposits</td>
<td>537,255.43</td>
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<td>Balance in Saving Account</td>
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<td>Balance in Current Account</td>
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<tr>
<td>Cash in Hand</td>
<td>3,849.65</td>
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<tr>
<td>Trade Debtors</td>
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<td>808,903.38</td>
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<tr>
<th>Other Assets</th>
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<tbody>
<tr>
<td>Deposit - Conference Hotel Deposit</td>
<td>0.00</td>
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<table>
<thead>
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<td>Provision of Taxation</td>
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<table>
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**AUDITORS’ REPORT**

The above statement of Revenue and Expenditure for the year ended 31st August 2018 and the Balance Sheet as at 31st August 2018 have been prepared from the books and from the information and explanations given to us and in our opinion the account reflect a true and fair view of the financial position of the Malaysian Endodontic Society as at 31st August 2018.

Dated:

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Dr. Afzan Adilah Ayoub  
President, M.E.S

Dr. Wong Lishen  
Treasurer, M.E.S

Dr. Lam Jac Meng  
Hon. Auditor, M.E.S

Datin Dr. Roza Anon Mohd Ramlee  
Hon. Auditor, M.E.S
PERSATUAN ENDODONTIK MALAYSIA (MALAYSIAN ENDODONTIC SOCIETY)

BALANCE SHEET AS AT 31ST AUGUST

Fixed Assets

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<tbody>
<tr>
<td>Surplus of Revenue over Expenditure c/ forward</td>
<td>761,092.67</td>
<td>719,279.93</td>
</tr>
</tbody>
</table>

Dr. Afzan Adilah Ayoub
President, M.E.S

Dr. Wong Lishen
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AUDITORS’ REPORT

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Dated:

Dr. Lam Jac Meng
Hon. Auditor, M.E.S

Datin Dr. Roza Anon Mohd Ramlee
Hon. Auditor, M.E.S
A CASE OF A MISSED CANAL; MAXILLARY 2ND PREMOLAR: TOOTH NOT TO BE UNDERESTIMATED

1 Dr Muhammad Khiratti Bin Mat Zainal, BDS(Mal)
2 Dr Eason Soo, DDS (UKM), MDS (Endo)(HK), AdvDipEndodont (HK), M EndoRCS FDSRCSed
3 Assoc. Prof. Dr Dalia Abdullah, BDS (Mal) MClinDent Endo (Lond) FDSRCSed

1 Angkatan Tentera Malaysia, Ministry of Defense & Specialist Trainee in Doctor of Clinical Dentistry (Endodontology), Universiti Kebangsaan Malaysia
2 Consultant in Endodontics, Centre for Restorative Dentistry, Universiti Kebangsaan Malaysia

ABSTRACT This case report presents the relatively uncommon occurrence of an untreated canal in a single-rooted maxillary second premolar with 2 canals. The possibility of additional root canal should be considered even in teeth with a low frequency of abnormal root canal anatomy. A comprehensive knowledge of tooth morphology, careful interpretation of angled radiographs, proper access preparation, a detailed exploration of the internal aspect of the tooth are essential for a successful treatment outcome in a complex root canal therapy. Besides that, cone-beam computed tomography (CBCT) examination and the dental operating microscope (DOM) are excellent tools for identifying and managing complex endodontic cases.

Learning points/take home messages
As conclusion, the reader should be familiar with the possible signs & symptoms of an untreated root canal following conventional root canal treatment. The reader should also know the likely variations in tooth morphology and the techniques used to discover the presence of additional root canal(s).

INTRODUCTION
The main objective of endodontic therapy is to prevent and, when required, to cure endodontic disease, apical periodontitis (AP). (Ørstavik 1996)

The achievement of this goal depends on several factors:
 i. elimination of surviving microorganisms in the root canal system through effective cleaning and shaping procedures. (Ørstavik 1996)
 ii. creation of a tight 3-dimensional seal with an inert filling material. (Vertucci 2005)
 iii. blockage of any communication between the oral cavity and the periradicular tissue through a high quality coronal restoration. (Kirkevang & Horsted-Bindslev 2002)

However, locating, cleaning, and shaping the entire canal system may carry some difficult challenges in non-surgical endodontic treatment; due to aberrant canal configurations, accessory canals, bifurcations, isthmuses, and anastomoses that are often difficult to identify, thus causing incomplete cleaning and filling (De Deus & Horizonte 1975).

The impact of these untreated canal spaces on the outcome of endodontic treatment is difficult to assess and the endodontic literatures on this specific topic is scarce; however, it is generally accepted that the inability to recognize the presence of missed canal(s) and to adequately treat all of the canals of the endodontic system may be a major cause of the failure of root canal therapy (Vertucci 2005, Stewart 1967). The frequency and risk of missed anatomy are strictly linked with the complexity of the root canal system; thus sound knowledge of the potential aberrant canal morphology in maxillary and mandibular teeth will help clinicians to successfully recognize and treat those difficult cases.

Thus, the objective of this case report is to present a clinical case of non-surgical root canal retreatment of a single-rooted maxillary left second premolar with 2 canals, demonstrated by radiographical examinations and to emphasize on the possible clinical
challenges and the benefits of treating previously missed root canals, thus contributing to the awareness of another anatomic variant of maxillary premolars.

CLINICAL CASE REPORT
A 28-year-old Malay lady was referred to UKM Endodontic Specialist Clinic for non-surgical root canal retreatment of her maxillary left second premolar. The patient reported symptoms of sudden pain and swelling on the upper left face since a fiber post was placed inside the canal one day after. The pain was described as dull, throbbing, spontaneous, lasted more than 30 min and localized to the area of affected tooth. Pain score was 4/10. Subsequent history revealed that non-surgical root canal treatment of the maxillary left second premolar had been completed by the undergraduate student, approximately 1 year ago. Then, the case was continued by another clinician from UKM Prosthodontic Specialist Clinic. The tooth was restored with a fiber post and composite resin core; and followed by crown preparation on the same day. One day after the treatment, patient started to develop pain and swelling on her upper left face. Therefore, the patient returned to her clinician, who made a diagnosis of acute apical abscess and was prescribed with antibiotics (Amoxycillin and Metronidazole) and Mefenamic acid as pain killer. Consequently, the clinician decided to refer the patient to us for further evaluation and management. The medical history was non-contributory.

Clinical Examination:
Extraoral examination revealed no swelling, no sinus tracts, and no lymphadenopathy. The intraoral examination revealed an intact provisional crown of the left maxillary second premolar (tooth 25) (Figure 1). The tooth was tender on palpation and percussion test, with gingival recession around 2 mm. Tissues surrounding the affected tooth was slightly swollen (firm), without abscess, draining sinus or loss of stippling of gingiva (Figure 2). There was no bleeding on probing and the periodontal probing depth was within normal limit with no mobility. Patient’s oral hygiene was fair. The tooth responded to cold test using Endo-Frost cold spray (Coltene). However, the sensation lingered after removal of the stimulus.

Radiographic Examination;
1) The pre-operative intra-oral periapical (IOPA) radiograph (18/11/2016) took by the undergraduate student revealed the presence of secondary caries on mesial aspect of the tooth underneath amalgam restoration (Figure 3). Besides that, canal outline could not be seen clearly starting from middle third up to the apical region. The presence of periapical radiolucency also can be seen clearly.
2) The post-obturation IOPA radiograph (29/12/2016) revealed the presence of fairly acceptable quality of root filling material inside the canal which was short about 1mm from the apex (Figure 4).
3) A new pre-operative IOPA radiograph (29/12/2017) revealed the presence of different radio-opacities inside the canal suggesting different restorative materials starting from coronal third (composite resin)
to middle third (fiber-post) extended to apical third (gutta-percha) (Figure 5 & 6).

4) Since the routine 2-D radiographic examination revealed an unusual tooth anatomy, a CBCT (small field of view, high-resolution of Planmeca ProMax 3D CBCT) was performed (29/12/17) at a tube voltage of 120 kVp and tube current of 5 mA. Axial slices of the maxilla of 0.076 mm thickness were obtained at different levels to determine the root canal morphology as well as the missed canal. The CBCT images revealed 2 canals (buccal and palatal canals) in the maxillary upper second premolar.

Figure 3. Pre-operative IOPA radiograph of maxillary second premolar. The disappearance of the canal outline at the middle third suggesting the presence of bifurcated canals

Figure 4. Post-obturation radiograph of maxillary second premolar

Figure 5. New pre-operative IOPA radiograph (after fiber post placement) of the left second premolar showing presence of different radio-opacity inside the canal.

Figure 6. Inverted image of new pre-operative IOPA radiograph of the left second premolar showing the length of all different materials inside the canal.

Figure 7. Axial CBCT images showing the presence of 2 canals; buccal and palatal canals, with the buccal canal was untreated previously
The tooth was diagnosed with previously treated; and symptomatic apical periodontitis (AAE 2013) associated with missed buccal canal. After completion of routine history taking and examination, the patient was provided with several treatment options and the associated benefits and disadvantages of each being discussed. She then opted for non-surgical root canal retreatment of 25. The procedure was explained to her and informed consent was obtained.

Because of the good coronal restoration with a low risk of coronal microleakage; and the referring clinician also mentioned that all of her works were done strictly under dental dam isolation, thus we decided to search for the missed buccal canal without removing fiber post and gutta-percha in the palatal canal which could lead to unnecessary removal of dentine structure.

PROCEDURES (Non-surgical root canal retreatment)

1st visit : Removal of composite core; and missed buccal canal found and negotiated:

1. One cartridge of local anesthesia, Scandonest 2% (Mepivacaine hydrochloride with levonedefrin 1:20,000) was administered via buccal and palatal infiltration.
2. Provisional crown of tooth 25 was removed (Figure 8).
3. Tooth 25 was isolated with dental dam using single isolation technique.
4. Initial access cavity with slight widening in the buccal direction was performed using high-speed diamond round bur, then later on was replaced with long-shank slow-speed round bur which allowed direct visualization of the cavity under high-magnification of the DOM (Zeiss OPMI pico).
5. After removal of about 8 mm of composite core (out of 13mm full length), one IOPA radiograph was taken together with the #30 K-file in order to ensure the access bur/ultrasonic tip is in proper alignment. (Figure 9)

6. Piezoelectric ultrasonic tip, Start-X #3 was used to penetrate through the composite and dentine. This ultrasonic tip allows better vision through a sleek, contra-angled instrument where it can be monitored under DOM
7. A micro-opener (Dentsply Maillefer) was used to locate the calcified buccal canal and initial instrumentation was performed.
8. Buccal canal was negotiated to apical third using K-file size #6, 8, 10 and 15 up to estimated working length.
9. Working length was determined using electronic apex locator Root ZX II (J Morita Inc) and verified with an IOPA radiograph.
10. Calcium hydroxide (Calasept® Plus) was placed as an interim canal dressing, and the patient was seen again after 1 week, to re-assess any presence of signs & symptoms. Following the initial visit, the tenderness on palpation and percussion, redness and swelling of gingiva were...
disappeared, and the treatment was continued.

2nd visit: Cleaning and shaping, and obturation of buccal canal:

11. The buccal canal was shaped and cleaned with hand instruments (Dentsply Maillefer, Ballaigues, Switzerland) and nickel-titanium rotary instruments (Protaper Next; Dentsply Tulsa).
12. Canal was instrumented up to size 25.06 using Protaper Next X2.
13. Master cone was placed and verified with an IOPA radiograph.
14. The root canal was irrigated with 2.52% sodium hypochlorite after each instrumentation. Just before obturation, the canal was irrigated with 17% ethylenediaminetetraacetic acid, normal saline, and 0.12% chlorhexidine solution as the final irrigation using passive sonic irrigation (EndoActivator system, Dentsply).
15. The canal was dried with calibrated absorbent sterile paper points and obturation was done with the warm vertical compaction technique.
16. Downpack was completed with a heated fine tip mounted on the System B Analytics (SybronEndo, Orange Country, CA) and the canal was backfilled with Obtura Max (Obtura Spartan, Algonquin, IL, USA).

![Figure 10. The root canal length was determined by using apex locator Root ZX II (J Morita Inc) and verified with an IOPA radiograph](image10)

![Figure 11. Master cone in buccal canal](image11)

![Figure 12. Post-operative radiograph of 25 showing 2 canals (buccal and palatal) was adequately obturated up to working length](image12)

![Figure 13. Post-operative occlusal view of tooth 25 showing crown preparation done by referring clinician which was still remained intact](image13)

17. A new provisional crown was re-constructed with ProTemp™ II (3M ESPE) and cemented using zinc-oxide eugenol-based temporary cement Temp-Bond™ (Kerr Dental).
18. The patient was then referred back to the Prosthodontic Clinic for further management.
19. At 6 month recall, the tooth was restored with a crown; and the tooth was remained asymptomatic.

DISCUSSION

1) Risk of missing canals in maxillary premolar teeth
Vertucci classified the commonly occurring root canal morphologies into 8 different types (Vertucci 1984). According to Vertucci, it is the premolars that have the most anatomic variations (Vertucci et al, 1974). Basically, the maxillary second premolar usually has one canal (Vertucci type I) in 75% of cases, and two canals at apex (Vertucci type IV) in 10-20% of cases (Vertucci 2005) (Figure 15).

![Figure 15. Diagrammatic representation of Vertucci’s canal configurations](image)

Clinicians should be aware of any abnormalities or any deviation from from this classical study. Few case studies also reported the difference of numbers of canal in the maxillary second premolars. Lea et al, 2014 reported that maxillary second premolar having 4 canals in 3 roots, 1 in MB, 1 in P and 2 in DB root whereas Ferreira et al, 2000 reported of maxillary second premolar with 3 canals in 3 roots, 1 in MB, 1 in DB and 1 in P.

Therefore, missed canals could be one of the reasons for root canal treatment failure (Slowey 1974). One should be cautious when treating maxillary premolars because of the extreme variations of their anatomy and the possible risk of missed canal. It is possible to detect the additional canal(s) during the oral diagnosis and treatment planning stage, with proper investigation modalities.

2) Clinical impact of missed canal
The clinical impact of untreated canal may vary from clinical and radiographical normalcy to severe symptoms of acute pulpitis or apical abscess (Cantatore et al, 2009). It can be from thermal sensitivity, sinus tract, swelling, tenderness to percussion/pain on biting, tenderness to palpation of the gingival tissue, periapical radiolucency or unusual persistent symptoms. For example, in this case, the patient was complained of having swelling, tenderness on palpation/percussion and thermal sensitivity.

![Type I Type II Type III Type IV Type V Type VI Type VII Type VIII](image)

Thermal sensitivity is normally associated with a vital pulp and is an unusual finding in a tooth that has previously been root treated. However, occasionally, vital tissue can remain either within poorly debrided canals or in another canal, which has not been treated.

Therefore, it is incumbent that the treating dentist does not automatically discount the root treated tooth in the differential diagnosis of thermal sensitivity. The simplest and most logical first step would be to reproduce the patients’ thermal complaint by employing a cold stimulus, such as Endo Frost (Coltene).

3) Recommended clinical approach in prevention of missed canal
3.1 Assessment of pre-operative intra-oral periapical radiograph

Radiographic examination is a crucial component of successful endodontic treatment. Although periapical radiographs give a 2-dimensional image of the 3-dimensional root canal system, their interpretation reveals external and internal anatomic details that suggest the presence of extra canals and/or roots (Slowey 1979).

A minimum of 2 diagnostic periapical radiographs should be taken for a careful evaluation of the root canal morphology using the parallel and mesial or distal horizontal angle techniques (Castellucci 2006). The angled radiographs provide important information prior to the root canal treatment. They help to visualize superimposed roots, allow good visualization of the buccal roots often covered by the palatal root. Martinez-Lozano et al. examined the effect of X-ray tube inclination on accurately determining the root canal system present in premolar teeth. They found that by varying the horizontal angle, the number of root canals observed in maxillary premolars coincided with the actual number of canals present.

Besides that, pre-operative radiographs should be observed with careful attention; a sudden change in the radiographic density of the pulp space usually indicates an additional canal, whereas a sudden narrowing of or even disappearance of the root canal pulp space indicates a bi- or a tri-furcation (Slowey 1979).

In a case report of a mandibular molar with 5 canals, Friedman et al. stated that the examination of pre-operative radiographs was of critical importance in identifying the complex canal morphology (Friedman 1986).

Apart from that, Sieraski et al. came out with general guideline for the identification of 2-rooted maxillary premolars on straight-on pre-operative radiographs: if the mesial-distal width of the mid-root image appears equal or greater than the mesial-distal width of the crown image, then the tooth most likely has 3 roots. This guideline acts as a good visual clue, but is not absolute.

Furthermore, Omer et al. compared clearing and radiographic techniques in studying certain features of the root canal system; their results indicated the limited value of radiographs in detecting lateral canals, transverse anastomoses, and apical deltas. In another study, Bedford et al. stated that plain radiographs were ‘insensitive in assessing the number of root canals present, the presence of lateral canals and the occurrence of canal obstructions.’

To summarize, information on root canal anatomy that comes from pre-operative intra-oral radiographs is valuable but incomplete, and should always be integrated with a careful clinical examination, preferably under high magnification visualization.

3.2 Use of Cone Beam Computed Tomography

CBCT scanning has been used in endodontics for the effective evaluation of the root canal morphology (Altunsoy et al, 2014). Matherne et al. found that CBCT images always resulted in the identification of a greater number of root canals than digital radiographic images. Baratto Filho et al. showed that an DOM and CBCT scanning were important for locating and identifying root canals, and CBCT scanning can be used for initial identification of the internal morphology of maxillary first molars. Llena et al. showed that CBCT was useful to assess root canal morphology of mandibular premolars of a Spanish population. Cohenca and Shemesh found that CBCT is a good option for identifying root canals and anatomical variations.

In the present case, CBCT imaging confirmed the presence of 2 canals (buccal and palatal) with 2 portals of entry in 1 root. A CBCT scan was used for better understanding of the complex root canal anatomy especially on the missed canal before commencement of the retreatment. It is in line from the previous reported studies that additional/missed canals can be detected with the aid of advanced radiographic equipment such as CBCT (Matherne et al, 2008). It had also provided us with some guidance on the presence of different materials at different level of tooth.
length inside the canal so that we could prevent unnecessarily removal of tooth structure and possible iatrogenic errors that could happen during the treatment. Besides that, CBCT can ensure elimination of superimposition of anatomic structures, an undistorted 3-dimensional images of maxillofacial skeleton and provides viewing of an image in multiple planes.

To summarize, the American Association of Endodontists (AAE) and American Academy of Oral and Maxillofacial Radiology (AAOMR) agreed that CBCT should not be used routinely for endodontic diagnosis or screening purposes in the absence of clinical signs or symptoms. However, CBCT does have a place in endodontic diagnosis, when dealing with more complex cases such as missed canal using high-resolution limited field of view (FOV) CBCT. Thus, it is a complementary modality for specific application purposes.

3.3 Access opening
It is most important stage in locating the orifices of the root canals. An adequate opening should provide complete removal of the pulp chamber roof and all of the interferences to the root canal system such as dystrophic calcifications, dentinal neoformations, and restorations. Normally, the access opening for maxillary second premolars is usually oval in the buccopalatal direction. However, in certain cases, the access opening need to be modified accordingly. Thus, a proper access cavity preparation requires good knowledge of pulp chamber anatomy and a careful interpretation of the pre-operative radiographs. The use of the DOM and endodontic probes such as the Hu-Friedy DG16 or the JW-17 (CK Dental Specialties) significantly facilitate the inspection of the pulp chamber floor and the discovery of canal orifices and with less damaging to tooth structure (Krasner & Rankow).

Pulp space anatomies described by the literatures were generally based on photographs of teeth with a complete crown and pulp chamber that are ideal for both position and width. Unfortunately, many clinical situations such as prosthetic crowns, large restorations, occlusal trauma, and dystrophic calcification can alter the original anatomy (Castelluci 2006). In fact, ideal access cavity design in real teeth may lead to iatrogenic errors related to improper or over-aggressive preparation (Krasner & Rankow, 2004). The access cavity design should be adjusted to the anatomical and clinical situation of each tooth. In order to give clinicians reliable anatomical guides for access cavity preparation, in 2004, Krasner & Rankow evaluated the anatomy of 500 pulp chambers of extracted teeth and formulated the following anatomic laws:

1. The floor of the pulp chamber is always a darker color than the surrounding dentinal walls. This color difference creates a distinct junction where the walls and the floor of the pulp chamber meet (Law of color change).
2. The orifices of the root canals are always located at the junction of the walls and floor (Law of orifice location).
3. The orifices of the root canals are located at the angles in the floor–wall junction (Law of orifice location).
4. The orifices lay at the terminus of developmental root fusion lines, if present (Law of orifice location).
5. The developmental root fusion lines are darker than the floor color.
6. Except for the maxillary molars, the orifices of the canals are equidistant from a line drawn in a mesial–distal direction through the pulp-chamber floor (Law of symmetry).
7. Except for the maxillary molars, the orifices of the canals lie on a line perpendicular to a line drawn in a mesial–distal direction across the center of the floor of the pulp chamber (Law of symmetry).

Thus, the anatomical laws formulated by Krasner & Rankow should be taken into consideration prior to cavity access. For example, after removing the pulp chamber roof, the orifices of buccal and palatal canals are expected to be centrally-placed in a maxillary first premolar. If one of the canals is eccentrically located, it should immediately alert the possibility of a missed canal.
3.4 During canal negotiation
The use of EDTA during negotiation will allow easier movement of the files along canal walls (Putzer et al, 2008). Clinicians should be aware of any stoppage from the negotiating files which might be an indication for an extra canal or split canal. Endodontic files should be carefully moved along the canal walls in multiple direction to allow easier detection of the missed canal. Endodontic files should be pre-curved during canal negotiation stage.

3.5 During mechanical preparation
Endodontic treatment is a dynamic process, extra canals could be detected during any phase of treatment. Thus, one should be aware of any slippage of rotary or reciprocating files in different direction during this process (Barbizam et al, 2004). Therefore, when anatomic variations are detected clinically, conventional or rotary endodontic files can be used while respecting the technical and biological principles. Having said that, controlled memory files is a great tool for managing canal splits and deep divisions as it is pre-bendable so it can be used to mechanically clean and shape these canals without the need of sacrificing more coronal dentin (Journal of Natural Science, Biology and Medicine, DOI: 10.4130/0976-9668.160032).

3.6 Post-operative intra-oral periapical radiograph
Post-operative radiographs can also provide valuable information on the presence and position of an extra root and/or canal. Root filling material that is not centered within the root may be a sign of missed canal; and seepage of obturation material in different direction could indicate the presence of extra canals (the clinician should be able to differentiate between lateral or accessory canals and missed main canal).

In an investigation on the clinical factors associated with non-surgical re-treatment, Hoen & Pink observed a significant correlation in the asymmetric position of the previous obturation material and the subsequent ability to locate untreated canal space. In addition, Nattress et al. who assessed the ability to detect the presence of canal bi-furcation in a root by viewing radiographs taken in the standard bucco-lingual direction, based on ‘disappearance or narrowing of a canal infers division’ guideline. However, the result fails to diagnose one-third of the twin canals.

3.7 The use of dental operating microscope (DOM)
DOM is an important magnification aid for locating orifices and root canals. It enhances the clinician’s ability to selectively remove dentin with great precision, thereby minimizing procedural errors. Stropko determined that a higher incidence of mesio-buccal (MB2) canals were located ‘as he became more experienced, scheduled sufficient time for treatment, routinely used the DOM, and employed specific instruments adopted for micro-endodontics’. Besides that, Baldassari-Cruz et al. demonstrated an increase in the number of MB2 located from 51% with the naked eye to 82% with the DOM. In fact, Buhrley et al. determined that the DOM was effective in locating MB2 canals of maxillary molars. When no magnification was used, this canal was located in only 18.2% of teeth. When using the DOM, the MB2 canal was found in 41 of 58 teeth or 71.1%. Carvalho & Zuolo concluded that the DOM made canal location easier by magnifying and illuminating the grooves on the pulpial floor and differentiating the color between the dentin of the floor and the walls. The DOM enabled them to find 7.8% more canals in mandibular molars. To summarize, all of these studies show that magnification and illumination are essential armamentarium for performing high standard endodontic therapy.

3.8 The use of ultrasonics
Ultrasonic tips for endodontic use provide important advantages when refining access cavities, removing calcifications, and locating the orifices of hidden canals. US tips with thin, contra-angled, and parallel-sided profiles enhance access and vision while their abrasive coating improves the precision and cutting efficacy (Plotino et al 2000). The best results are obtained when US tips are used with a light brush touch, medium power, and under the
control of the DOM (Clark 2004). Furthermore, the use of US instruments under magnification enhances the precision and reduces the risk of complications such as ledges and perforations (Buchanan 2002).

When working with US instruments, it is important to select a tip with an adequate design to optimize efficiency while at the same time reducing the risk of complications such as tip breakage or perforation of the pulp chamber floor. Robust, slightly conical tips are indicated to refine the access cavity while thinner tips with rounded, non-aggressive ends are preferred when removing dentin from the orifice of MB2 or other hidden canals. The spherical end of these tips creates round grooves on the pulp chamber floor, which facilitate localization and negotiation of hidden canals. Conversely, thin US tips with sharp ends are indicated to remove calcification from the pulp chamber and canal orifices, always under magnification (Cantatore et al 2009). To summarize, these ultrasonic instruments are best used with greater magnification aids e.g. DOM to allow precise handling of this instrument.

4) Impact of missed canal on the outcome of endodontic treatments

It is generally accepted that a major cause for the failure of root canal therapy is an inability to recognize the presence of and to adequately treat all of the canals (Vertucci 2005). Unfortunately, prospective studies demonstrating the impact of missed canal on the outcome of endodontic treatment are not available for obvious ethical reasons; researchers could not neglect to treat a known MB2 for the sake of an experimental group with which to compare (Wolcott et al 2005). Therefore, the endodontic literature on this issue consists mainly of retrospective and epidemiological studies.

In a statistical analysis of re-treatment cases, Allen et al. analyzed a total of 1300 endodontic patients for factors that may have contributed to the failure of the original treatment or the success of the re-treatment. The reasons for retreatment were judged from patient records and radiographs and were divided into 7 categories; untreated canals, in this study, were responsible for failure in 114 cases, with a 8.8% prevalence.

A group of epidemiological surveys supports the impact of missed canals on endodontic failures, demonstrating a direct link between the complexity of the root canal system and the incidence of post-treatment disease. In the Washington study (Ingle et al 1994), the mandibular first premolar had the highest failure rate at 11.45%. Possible reasons for this conclusion are the numerous variations in root canal morphology that mandibular premolars may have and the difficult access to additional canal systems when present.

To summarize, teeth with frequent aberrant canal configurations present a higher risk of developing post-treatment disease.

Conclusions

Anatomic variation in the number of roots and root canals can occur in any tooth. Therefore, sound knowledge of root canal anatomy, detailed examination and radiographic (interpretation) taken from different angles and careful evaluation of the internal anatomy of teeth are essential elements prior to root canal therapy. In fact, there should be constant vigilance in locating 2 or more canal systems when performing root canal therapy for premolars. If not, root canal treatment is likely to be failed if extra roots or root canals are not detected. Lastly, the variation of symptoms, diagnostic and therapeutic difficulties make the treatment of missed canal a challenge for the general dental practitioners. Treatment of those complex cases should be managed by a clinician with advanced training in endodontics.

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NON-HEALING EXTRAORAL CUTANEOUS SINUS TRACT DUE TO PULPAL NECROSIS OF 36: A CASE REPORT.

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INTRODUCTION
Extraoral draining sinus or fistula may be confused with a wide variety of diseases for example furuncle, pericoronitis in relation to the mandibular third molars, parotid fistula, preauricular sinuses, periapical and periodontal pathology and others (Kumar et al. 2012). In this case, the extraoral draining sinus is caused by pulpal necrosis of a lower left mandibular molar. Obligate anaerobes have been the aetiologic cause for apical periodontitis in the infected root canal (Moller 1966). Patient might seek treatment from their physician as they are not aware of its odontogenic origin and these cases usually are misdiagnosed and inappropriately treated. Due to its rarity and the absence of any dental symptoms, thus, it’s paramount important to diagnose these type of cases to treat the disease and to avoid unnecessary treatments such as prolonged prescription of both systemic and topical antibiotic. Therefore, dental cause should be ruled out for any cutaneous sinus tract, so that correct diagnosis and proper management of the patient can be carried out. Odontogenic cutaneous sinus tract are uncommon cases to be seen in dental clinic. This case report will describe a successful treatment of a non-healing extraoral cutaneous sinus tract due to pulpal necrosis, chronic apical abscess of a lower left first molar (tooth 36).

Clinical Case Report:
A 21-year-old Chinese gentleman was referred from Dept. of Oral & Maxillofacial Surgery, UKM Medical Centre (UKMMC) for a non-healing cutaneous sinus tract at the left mandible. Extraoral swelling with pus discharged and occasionally bleeding noted since 6 months ago. The swelling recurred a month ago and a physician from a private clinic had performed extraoral incision and drainage. However, the sinus tract was not resolved. The patient was medically fit and healthy with no known drugs allergy. Upon extraoral examination, cutaneous draining sinus 3 cm above the inferior border of patient’s left mandible was noted. Patient has a fair oral hygiene. Intraoral examination showed that tooth 36 presented with a large disto-occlusal composite restoration (Figure 1). It was tender to percussion with a pain score of 2/10 on visual analogue scale.

Periapical radiograph revealed that the composite restoration extended towards the inner third of dentine and approaching the distal pulp horn of tooth 36. There were periapical radioluencies surrounding both roots (Figure 2). Sensibility testing was non-responsive.

Figure 1. Occlusal view of tooth 36 with disto-occlusal composite restoration.
The tooth was diagnosed with pulp necrosis, chronic apical abcess associated with extraoral draining sinus. After commencement of non-surgical endodontic treatment, resolution of the extraoral draining sinus was noted immediately (Figure 4). The key to the success of treating this case is to establish a correct diagnosis and by eliminating the source of infection, which is the pulpal pathology.
PROCEDURES
Inferior alveolar nerve block was performed with 2% Mepivacaine hydrochloride (Scandoneest, containing 1:100 000 Epinephrine) and tooth 36 was isolated using dental dam. Whole endodontic therapy was done under the dental operating microscope. Four canals were located (Figure 3), with DB and DL canals were merged at the apical third. Working lengths were determined using electronic apex locator and verified radiographically.

Protaper Next (Dentsply Maillefer, Ballaigues, Switzerland) rotary files were used for chemomechanical preparation of the canals, with X-smart motor (Dentsply Maillefer, Ballaigues, Switzerland) in a crown-down manner. Irrigation was performed with 5.25% sodium hypochlorite (NaOCl) using an Endo-Eze 1” irrigator tip (Ultradent, South Jordan, UT, USA). The MB and ML canals were prepared with X1 and X2 files. While the distal canals was prepared with X1, X2 and X3 files. EDTA 17% (chelating agent) was used as an adjunct irrigation solution to remove smear layer, as well as to increase dentine permeability by opening-up the dentinal tubules. Sonic activation of the irrigation solution was performed using Endoactivator (Dentsply Maillefer, Ballaigues, Switzerland) with medium size tip for 30 seconds, to enhance the disinfection procedure (Niu et al. 2014).

A non-setting calcium hydroxide dressing was placed in the canals using a Lentulo spiral, and the access cavity was double sealed with Cavit G (3M ESPE, Germany) and IRM (Dentsply Caulk, Milford, DE, USA) in between appointments.

On the third visits, the tooth was asymptomatic and all canals were obturated (warm vertical compaction technique) with AH Plus sealer (Dentsply Maillefer, Ballaigues, Switzerland). Radicular composite resin core was placed. Subsequently, a porcelain fused-to metal (PFM) crown was constructed and cemented within 2 weeks after completion of root canal therapy. At one-year review, the tooth was clinically asymptomatic, not tender to percussion, with no abnormal mobility and periodontal probing depths were within normal limits. Radiographic examination revealed that there was a reduction in the size of the periapical radiolucency.
Discussion

Extraoral draining sinus caused by odontogenic infection is relatively rare (Bradford 1999). However, about 80% reported cases at the cervicofacial region were odontogenic in origin. (Kumar et. Al 2012). Therefore, endodontic causes should be considered as one of the differential diagnoses for any extraoral cutaneous draining sinuses around the facial or cervical region. Other etiologies for extraoral draining sinus includes periodontal pathology, pericoronitis of third molars, infected fractures of mandible, furuncles, osteomyelitis, tuberculosis, sialolith and others (Kumar et al 2012).

Intraradicular infection originating from dental caries or trauma to the tooth will lead to the development of apical periodontitis (Nair 2004). As this chronic infection progresses, it will invade through the cancellous bone following the path of least resistance and emerges extraorally to form the draining sinus. The position of the sinus opening is determined by the location of muscle attachment and fascial sheaths. Extraoral sinuses have higher chances to occur compared to intraoral sinuses when the apices of the maxillary teeth are superior to the muscle attachment or when the apices of mandibular teeth are inferior to the muscle attachment (Gupta et al 2011). Tracing the sinus tract with a gutta-percha point would help to determine the etiological factor for the extraoral draining sinus. In this case, it was an incidental finding from CBCT images showed that there was penetration of the buccal cortical bone adjacent to the lower first left molar tooth, and the tooth was non-responsive to sensibility testing. For extraoral draining sinuses, eradication of the source of infection is utmost important, by means of non-surgical root canal treatment as the first line and most conservative treatment, sometimes complemented with endodontic surgery or dental extraction as last option (Soares et al 2007). Obvious reduction of the abscess after non-surgical root canal treatment, proved that the primary dental origin of the skin lesion. Self-closure of the tract has been noticed 3 months after the commencement of non-surgical root canal therapy. In cases of persistent extraradicular infection, the ability of certain microorganism e.g. Actinomycoces which can establish extraradicularly and perpetuate the periapical inflammation, even after orthograde root canal treatment. Therefore, surgical endodontic intervention might be needed (Nair 2004). Surgical excision of root apices is necessary if the fistula does not heal, to eliminate the inflammatory tissue thoroughly, including apical debridement, apicoectomy, and fistula debridement (Mishra et al 2013). Further confusion for clinicians arises because dental symptoms do not occur regularly. Insignificant treatment (e.g. extraoral incision and drainage, and repeated use of antibiotics) and the previous non-healing cutaneous sinus tract can be accredited to misdiagnosis of an odontogenic problem. Therefore, accurate diagnosis with appropriate treatment, and removing the source of infection are of great importance. The tooth 36 has a good prognosis and positive outcome (in healing), as there were no signs and symptoms, and reduction of periapical radiolucency at one-year recall.

Conclusion

Odontogenic cause of a cutaneous sinus although is rare, however can be misdiagnosed and unduly treated. Therefore, proper identification of the culprit, which is the necrotic tooth, is critical in treating this type of cases.

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USE OF BIOCERAMICS IN MANAGING NON-VITAL MAXILLARY CENTRAL INCISOR WITH AN OPEN APEX

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ABSTRACT
A 28 years old gentleman was referred to the Universiti Kebangsaan Malaysia (UKM) Endodontic Specialist Clinic for the management of tooth 11. Patient came with chief complaint of discolored upper front tooth that disturbed his appearance. The tooth was traumatized when patient was 11 years old but he noticed the tooth becoming discoloured 4 years ago. His medical history was non-contributory. Radiographic examination revealed an immature root with an open apex and a periapical radiolucency. The canal was mechanically cleaned using intracanal instruments and 2.5% NaOCl irrigation. Bioceramic material was delivered to the apical portion as an apical plug. The patient was asked to return 1 week later and canal was backfilled with thermoplastic GP and continue with internal bleaching.

INTRODUCTION
Treatment of immature teeth may vary according to the status of the pulp and clinical situations. The general consensus for clinical management of immature teeth with vital pulps is to preserve remaining vital tissue by apexogenesis in order to allow continued physiological development and complete formation of the root end. Whereas for those teeth with necrotic pulps, it is to clean and application of calcium hydroxide, Ca(OH)₂, to induce the apexification by formation of an apical barrier before obturation of the root canals. (Rafter 2005)

According to American Association of Endodontic Glossary term, apexification is defined as “a method of inducing a calcified barrier in a root with an open apex or the continued apical development of an incompletely formed root in teeth with necrotic pulp” (AAE Glossary of Endodontic Terms Ninth Edition 2016). Traditionally, the application of calcium hydroxide in apexification procedure requires multiple visit treatment sessions. Thus, the tooth is exposed to prolonged calcium hydroxide therapy. This long-term calcium hydroxide therapy could alter the mechanical properties of dentin and the tooth will be more susceptible to root fracture (Andreasen et al. 2002). Other drawbacks of prolonged calcium hydroxide therapy are unpredictable formation of an apical seal and requirement for excellent patient compliance. (Shabahang 2013)

An alternative method to calcium hydroxide therapy is placement of an apical plug by using mineral trioxide aggregate (MTA) as an osteoconductive apical barrier (European Society of Endodontology 2006). Torabinejad et al. (2017) in the recent systematic review stated that the treatment of immature teeth with pulp necrosis using a MTA apical plug treatment results in 97.1% high survival and 94.6% success rates respectively. However, the major limitation of MTA is the inability to obtain consistent results due to difficulty of handling characteristic while placing the material during treatment and the long setting time (Masoud Parirokh & Torabinejad 2010). Tooth discoloration has been reported with the use of both gray and white MTA due to present of bismuth oxide (Kahler & Rossifedele 2016).

Recently a new calcium silicate-based cement was introduced in the market. Bioceramics refer to the combination of calcium silicate and
calcium phosphate; to be used as root-end filling material as well as a root repair material. This new material is produced as a premixed product to provide the clinician with a homogeneous and consistent material (Haapasalo et al. 2015). Unlike MTA, bioceramics is claimed to be aluminum free and contains a significant amount of tantalum and zirconium oxide as a radiopacifier to eliminate tooth discoloration. Bioceramics also exhibits similar or better biocompatibility and osteo-conductive potential than MTA and significantly causes less discoloration. This case report describes the management of a non-vital maxillary central incisor with an open apex using a bioceramic material as apical plug.

CASE REPORT
A 28 years old gentleman was referred to the UKM Endodontic Specialist Clinic for the management of tooth 11. Patient presented with a chief complaint of discolored upper front tooth that disturbed his appearance. The patient reported that the tooth was traumatized when he was 11 years old and he noticed the discolored tooth 4 years ago. His medical history was non-contributory.

Figure 1. Yellowish discolouration on Tooth 11

Extraoral examination was unremarkable. At the site of complaint, tooth 11 had enamel fracture with dark yellowish discoloration (Figure 1). Tooth 11 did not respond to electric pulp test and cold test. It was tender to percussion, and no mobility was detected. The periodontal probing depth was within normal limits. Radiographic examination demonstrated incomplete root formation with an open apex and blunderbuss appearance along with an apparent radiolucency at the periradicular area of the tooth 11 (Figure 2). The clinical diagnosis of tooth 11 was pulp necrosis with asymptomatic apical periodontitis associated with open apex. Root canal treatment with apical plug with the use of bioceramic was opted with the informed consent of patient.

Figure 2. Pre-operative radiograph

At the first visit, access cavity was completed with high-speed burs under dental operating microscope after administration of local anesthesia with 2% mepivacaine with 1:100,000 epinephrine (Scandonest, Septodont, Australia). The canal was irrigated with copious amounts of 2.5% sodium hypochlorite and irrigation activated with EndoActivator (Dentsply, Tulsa Dental Specialties, United States). Pre-operative radiograph was used to calculate the working length and was confirmed with a periapical radiograph (Figure 3). Calcium hydroxide paste (Calasept, Directa AB, Sweden) was placed into the canal directly from a syringe with a plastic needle as intracanal medicament. Then, the access cavity was closed with a cotton pellet and double sealed with Cavit and IRM.

At the following visit one week later, the tooth was asymptomatic and the temporary filling was intact. Temporary filling was removed under dental dam and canal was irrigated with copious amount of 2.5% sodium hypochlorite, followed by activation with EndoActivator to
remove the calcium hydroxide paste from the canal. A final rinse with 17% EDTA and 2% chlorhexidine was performed. The canal was dried with paper point size 90. Apical plug was placed with Bioceramic iRoot BP Plus putty (Innovative Bioceramix, Vancouver, Canada) at the apical portion of canal with a thickness of 5 mm using an MAP System and endodontic pluggers. A sterile sponge pellet was placed over the canal orifice and the access cavity was double sealed temporarily with Cavit & IRM. Adequate placement of Bioceramic was confirmed radiographically (Figure 4).

Figure 3. Working length radiograph

After one week, the canal was back-filled with thermoplastic gutta-percha and AH Plus sealer (Dentsply) to the level 2 mm below the CEJ (Figure 5). To improve the color of the tooth, internal bleaching procedure was carried out. The initial shade of the tooth was taken at A3.5 as baseline prior to placement of dental dam (Figure 6). Flowable composite (SDR, Dentpsly) was placed as protective seal over the gutta percha and cervical area (Figure 7). Then, bleaching gel 35% hydrogen peroxide gel (Opalescence Endo, Ultradent) was placed in the pulp chamber. A piece of dry cotton was placed over this bleaching gel and the access cavity was sealed with modified zinc oxide eugenol cement (IRM, Dentsply). The patient was recalled after two weeks for a review.

Figure 4. Placement of Bioceramic Root Repair Material

The tooth shade was evaluated and the bleaching procedure was repeated. After two sessions, a satisfactory result was achieved (Figure 8). The access cavity and enamel fracture was restored with composite three week after bleaching treatment is over (Figure 9). Post-operative restoration was confirmed radiographically (Figure 10).

Figure 5. Radiograph to confirm backfill with thermoplastic GP
DISCUSSION
Traditionally, apexification was the treatment approach for pulpal necrosis in immature teeth presented with an open apex (Rafter 2005). Calcium hydroxide has been conventionally used as a successful material for apexification. However, prolonged use of calcium hydroxide can also change the mechanical properties of dentine (Andreasen et al. 2002). Thus, the traditional long-term calcium hydroxide treatment for these cases may be less than ideal for many patients. Today with the advancement of new technology in endodontics, biomaterials known as bioactive endodontic cement (BEC) mainly comprised of calcium silicate base cement had been developed (Parirokh et al. 2018; Torabinejad 2018). These materials are not only biocompatible but promote healing and tissue regeneration (Parirokh & Torabinejad 2010). Starting from that point, the calcium silicate based cement has become new paradigm shift in management of teeth with an open apex with reduction in treatment time. Instead of waiting for the slow process of apexification by calcium hydroxide, the apical part is filled with a calcium silicate based cement material in order to establish an apical stop that would enable the root canal to be immediately filled at the first or second visit (Torabinejad & Abu-tahun 2012; Wang 2015).
Mineral trioxide aggregate (MTA) was the first generation of calcium silicate based cement that was introduced in the market by Torabinejad in the 1990s and has been approved by the Food and Drug Administration (FDA) to be used in the United States in 1997 (Parirokh et al. 2018). The main composition of MTA is tricalcium silicate, dicalcium silicate, tricalcium aluminate, bismuth oxide and calcium sulfate dehydrate. It has been proved to have excellent biocompatibility and superior sealing ability, as well as being associated with desirable clinical success when used for repair of perforations, vital pulp therapies, root-end fillings and root fillings, and when used as an apical plug (Torabinejad 2018). The hydrophilic nature of the particles from MTA powder allows its usage even in the presence of moisture contamination, specifically blood, and does not affect its sealing ability (Witherspoon et al. 2008). Despite the tremendous clinical success of MTA, a number of disadvantages are apparent. MTA does have poor handling characteristics, long setting time, tooth discoloration, high cost and difficult handling characteristics have emerged as potential drawbacks.

To overcome some of the drawbacks of MTA, an expanding assortment of MTA like cements have been developed with similar endodontic applications and yield better clinical performance. These bioactive endodontic cements known as Bioceramics Root Repair material that were developed by Canadian research and product development company name Innovative BioCeramix, Inc. In 2007, they produced two Bioceramic Root Repair material with similar compositions, but different consistencies namely iRoot® BP injectable root repair filling material paste and iRoot® BP Plus injectable root repair filling material putty (Ree & Schwartz 2014). Sometime later in 2008, these products are available in North America as EndoSequence Root Repair Material Paste™ and EndoSequence Root Repair Material Putty™ (Brasseler USA Dental LLC, Savannah, GA)(Ree & Schwartz 2014).

In the current case, apical plug was placed with iRoot BP Plus Root Repair Material. It is a novel premixed bioceramic putty developed for root canal filling, apical plug, pulp capping and perforation repair applications. The chemical composition mainly includes calcium silicate, calcium phosphate, tantalum, and zirconium oxide. The manufacture claimed that this premixed bioceramic materials are biocompatible, hydrophilic, they do not shrink and are insoluble in tissue fluids. Several in vitro studies have proved that, MTA and bioceramic root repair material exhibited similar characteristics in many respects such as biocompatibility, sealing ability, and antimicrobial efficacy (Wang 2015). Recently in an animal study, Chen et al reported that both MTA and Bioceramic Root Repair Material putty showed good sealing abilities when used as root-end filling materials in an apical periodontitis dog model, even in infected root canals (Chen et al. 2015). Another recent study also showed that both MTA and Bioceramic Root Repair Material putty has greater release of silicon (Si) and calcium (Ca) ions in an acidic environment that simulate an infectious acidic environment. The higher concentrations of Si and Ca ions may facilitate osteoblast differentiation and inhibit osteoclastogenesis, thus promoting the healing of periapical tissues (Tian et al. 2017). Moreover, compared with MTA, Bioceramic Root Repair Material putty also exhibits similar antimicrobial efficacy against Enterococcus faecalis and Candida albicans (Damlar et al. 2014). Thus, it appears that the advantages of these bioceramic root repair materials can fulfill clinical application in providing apical seal in management of tooth with open apex.

In clinical management involving open apex permanent teeth with apical pathosis, the placement of an apical plug is crucial for sealing and preventing bacterial leakage. Thus, the sealing ability of material of choice is a very important factor for successful endodontic treatment in teeth with open apex. The results of in vitro studies have shown Bioceramic Root Repair material (BRR) have similar ability with MTA in term of sealing ability (Antunes & Gominho 2015). Besides that, the thickness of apical plug plays important role in providing better seal. A few studies have investigated the
different thickness of apical plug for an open apex tooth and studies have reported that 5 mm thicknesses of MTA apical plug provide better seal and completely prevent bacterial leakage (Al-kahtani et al. 2005). Thus, minimum 5 mm thickness was chosen for this case.

As the tooth was discolored and fracture was involving only at incisal edge of maxillary right central incisor, non-vital (internal) bleaching was planned and followed by composite resin restoration. Non-vital bleaching is the minimally invasive procedure for esthetic rehabilitation of discolored non-vital teeth. Prior to placement of bleaching agent, it is essential to seal the root filling with a base. The sealing material should reach the level of the epithelial attachment or the cemento enamel junction (CEJ), in order to avoid leakage of bleaching agents into the periodontium (Plotino et al. 2008). Variety of dental materials such as glass-ionomer cements, intermediate restorative material (IRM), resin composites, zinc oxide–eugenol cement, and zinc phosphate cement have been suggested as an interim sealing agent during bleaching techniques. In this case, SDR (Smart Dentin Replacement, Dentsply) was placed over the gutta percha with 2 mm thickness. The use of hydrogen peroxide as an effective bleaching agent has been described many times as a successful technique. Nevertheless, high concentrations should only be used with caution, in order to avoid increasing the risk of root resorption (Attin et al. 2003).

In this case, composite restoration as the permanent filling as carried out three week after the bleaching procedure completed. This is to allow the release of residual oxygen from the tooth structure. It has been established that remnants of peroxide or oxygen inhibit the polymerization of resin composites (Dishman et al. 1994). Some authors recommend using resin composite with lighter shade to compensate for bleaching that was not completely successful. Optimal bonding to bleached dental hard tissue can be achieved after a period of about 3 weeks (Plotino et al. 2008). During this period, the color of the bleached tooth should be stable. Non-vital bleaching is economical, predictable and rather quick with good esthetic result.

**CONCLUSIONS**

Advanced treatment options using bioactive endodontic cement definitely would improve clinical outcomes and benefit patients of all ages. However, because the majority of bioactive endodontic cement materials are newly developed, most studies and case reports of apical plug have involved the use of MTA. Published clinical studies and high level of evidence for these Bioceramic Root Repair material cements as apical plug are limited and insufficient at this point. This case required a long-term follow up in order to evaluate the long-term success of Bioceramic as an apical plug in management of non-vital immature teeth with open apex.

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EFFECTS OF OPERATIVE PROCEDURES ON PULPAL HEALTH.

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BACKGROUND
The long-term effects of tooth preparation on pulp vitality and the incidence of pulp necrosis associated with operative procedures have been reported to be 13.3% with full-crown preparations compared with only 5.1% for partial veneer restorations (Felton 1989). The incidence of pulpal necrosis in crown preparations increases to 17.7% in the presence of a core build-up compared with 0.5% in the control group of unrestored teeth. Although pulpal complications occur in 5.1% of veneer cases, the acute nature of the symptoms in this case along with the high incidence of pulpal involvement in multiple teeth represents a highly unusual reaction to bonded restorations. It is important to review some of the scientific basis for normal pulp response to injury before making specific recommendations for techniques to avoid them.

Normal Pulpal Response to Injury
Untreated dental caries is the most common cause of pulpal disease; however, among the various forms of dental treatment, operative dental procedures are the most frequent cause of pulpal injury in human teeth (Brannstrom & Lind 1965). Three basic reactions tend to protect against insult to the pulp: (1) a decrease in the permeability of the dentine through dentinal sclerosis; (2) formation of new secondary and reparative dentine; (3) inflammatory and immune reactions in the pulp. The most common response to such localized injury is dentinal sclerosis (Stanley et al 1983).

Dentinal sclerosis has the effect of decreasing dentine permeability, thereby sealing the pulp from potential irritants, such as bacteria and bacterial byproducts. Similarly, secondary and reparative dentine reduces dentinal permeability while creating more distance between the irritant and the pulp (Bergenholtz 1990). Once bacteria or bacterial byproducts reach the pulp, inflammatory and immune reactions further attack and help destroy the antigens.

Pulpal reaction is observed as soon as bacteria reach the dentine (Massler 1967). It is important to realize that the bacteria do not have to reach the actual pulp before pulpal changes begin taking place. Early changes occur as a response to the diffusion of the inflammatory stimuli into the pulp. Such substances include bacterial toxin, enzymes, antigens, chemotoxins, organic acids, and products of tissue destruction (Bergenholtz 1990). Substances also pass outward from the pulp through the dentinal tubules into the carious lesion. Plasma proteins, immunoglobulin, and complement proteins have been found in carious dentine (Okamura et al 1980). Therefore, a dynamic interaction between the dentinal surface and the pulp exists at all times. As soon as the dentine is exposed, should the tubules be patent and permeable, an exchange takes place across the dentine, resulting in changes in the pulp.

Dentinal tubules are conical in nature. Therefore, the deeper the dentine is cut, the wider the diameter of the tubules and the larger the permeable area of the surface. Deeper preparations allow for more permeability and therefore a higher chance of bacterial contamination of the pulp (Pashley 1986).

Luckily, there is a constant outward flow of fluid in the dentinal tubules, which essentially flushes them clean of such antigens (Okamura et al 1980). This outward flow is caused by the physiological presence of intrapulpal pressure,
The pressure of blood circulating in the pulp and that of pulpal tissues on the walls. In the absence of this flow, a higher incidence of pulpal reactions to surface salivary contamination could potentially occur. Most pulpal reactions are a result of the contamination of the pulp by bacteria or bacterial byproducts.

**The Role of Bacteria in Pulpal Injury**

Today, we know that the cause of pulpal infection is always bacteria and/or bacterial byproducts. In the landmark study on germ-free mice by Kakehashi et al 1965, the animal’s pulps were completely unaffected despite deep restorations and even pulpal exposures that were left open to the oral cavity (the saliva of such animals contains no bacteria either). As long as they were not contaminated with bacteria, the pulps remained vital despite exposure to the oral cavity during a period of several months. In the absence of bacteria, restorative fillings were placed directly into the pulp chamber with very little tissue reaction from the pulp. This study demonstrates the importance of bacteria and bacterial antigens in pulpal reactions and further demonstrates the need for aseptic techniques during operative procedures. Another important study by Bergenholtz and Reit (1980) speculated on the cause of postoperative pain and sensitivity. In this study, restorative materials that were either bactericidal or prevented bacterial leakage through their margins resulted in the least amount of postoperative sensitivity. In contrast, bacteria were found in histological sections under all the restorative materials where postoperative pain was present. It was therefore proposed that the cause of postoperative pain in restored teeth has little to do with the toxicity of the material itself and more to do with the material’s ability to prevent bacterial leakage.

**Acid Etching**

Acid etching of dentine to enhance long-term adhesion has been questioned; furthermore, this practice greatly increases dentine permeability, enhancing bacterial penetration of the dentine (Stanley et al 1975). However, the direct effect of the acid on the pulp appears to be negligible, possibly as a result of the buffering of the acid by intratubular fluids found in dentine. Only in very deep preparations can the actual acid become the primary source of pulpal injury. Therefore, acid etching of dentine is generally not a primary cause of pulpal injury; however, the increased permeability caused by such action could potentially become a source of bacterial conduction into the pulp and be an indirect cause of injury.

**Desiccation of Dentine**

When freshly cut dentine is dried with a prolonged blast of air, a rapid outward flow of fluids is caused in the dentinal tubules. This fluid can draw along the odontoblasts into the tubules, virtually destroying them in the process (Brannstrom 1984). However, according to Brannstrom 1984 the desiccation of dentine by operatory procedures or with a blast of air does not injure the pulp. There are generally too few cells that die through this process to evoke a significant reaction. Furthermore, odontoblasts that die through this process are replaced by new ones from the cell-rich zone of the pulp, and in 1 to 3 months, reparative dentine is formed.

**Thermal Injury**

Production of heat during the restorative procedures is the most severe form of stress induced on the pulp (Zach 1972). Thermal changes leading to pulpal injury can take place as a result of cutting of the dentine and enamel without a coolant and by using dull burs at low revolutions per minute (RPMs) with excessive cutting pressure. Blushing of the teeth during a crown preparation has also been attributed to thermal injury to the pulp. This occurs more readily if a ligamental injection has been used to anesthetize the tooth. The best way to avoid thermal injury of the pulp is by meticulous use of sharp burs at high speed, with light pressure, and adequate water coolant.

**Effects of Local Anaesthetics on the Pulp**

A few studies have shown the profound effect of vasoconstrictor-containing local anaesthetics on pulpal blood flow. Kim et al (1984) showed the significant reduction in
pulpal blood flow after administration of lidocaine 2% with 1:100,000 adrenaline. Because the rate of oxygen use by the pulp is generally low this tissue can withstand a period of reduced blood flow. Research has shown this to be true for periods as long as 3 hours (Olgart and Gazelius 1977).

Irreversible pulp damage resulting from tooth preparation is most likely caused by the release of substantial amounts of vasoactive agents, including but not limited to substance P into the extracellular compartment of the underlying pulp (Okamura et al 1980). During normal circumstances, these vasoactive substances are quickly removed from the pulp by the bloodstream. However, when blood flow to the pulp is drastically decreased or completely arrested, the removal process is greatly delayed and accumulation of these substances and other metabolic waste products may result in permanent damage to the pulp (Pashley 1979). It is therefore recommended to avoid ligamental injections of epinephrine-containing anaesthetics in vital but compromised teeth requiring crown preparations.

Discussion

It is true that the exact cause of the severe pulpal reaction in this case may never be fully known. In the absence of dental decay, virgin teeth requiring veneers do not normally suffer irreversible damage from the preparations, even if the cutting is deep into dentine. However, when a combination of potentially caustic factors, such as the use of an epinephrine-containing ligamental injection, deep, heavy cutting into dentine, etching, desiccating, and allowing contamination of the permeable tubules before cementation is followed by traumatic occlusion, the pulps of patients with a lower physiologic compliance and capacity to recover from injury may become irreversibly inflamed. In such situations, multiple root canal therapy and pulpal extirpation may become the only choice to relieve symptoms. Because the primary cause of postoperative pulpitis is bacterial contamination of the pulp through the dentinal tubules, immediate sealing of the freshly cut dentine with bonding agents may be a potential way of reducing this sensitivity from bacterial leakage (Magne 2002).

In general, the optimal approach to avoid pulpal complications is to avoid ligamental injections containing adrenaline and use sharp burs with light pressure at high RPMs. Using copious water coolant during the operative procedure is also very important to limit heat-induced pulpal injury. Most importantly, aseptic techniques such as using a rubber dam and dentine disinfection during the preparation and cementation of any restoration are of paramount importance. Furthermore, traumatic occlusion should be avoided at all cost in anterior restorations and teeth should be restored with proper posterior support to avoid accumulation and magnification of pulpal symptoms. In itself, occlusal trauma is generally not considered a cause of pulpal necrosis; however, it has been shown to increase neurogenic inflammation and create pulpal symptoms which could put an already inflamed pulp over the edge (De Carteret Edlin 1970, Kvinnsland and Heyerras 1992).

Conclusion

The confluence of several potential factors of pulpal injury makes this case unique. Although each factor on its own is not enough to elicit such severe postoperative pulpal reaction, the combination of multiple factors in this case culminated into severe and irreversible pulpal injury requiring multiple root canal treatments. The primary cause of the pulpitis was probably bacterial in nature; however, the role of occlusion had a magnifying effect on the symptoms.

Each patient is unique and so is his or her individual response to seemingly safe treatments recommended by their healthcare professionals. The wise clinician pays close attention to proper case selection to decrease the chance of complications. Adhering to the basic biological and clinical care principals of occlusion and pulpal-periodontal health preservation can further optimize treatment
outcome and decrease the chance of potential complications during elective aesthetic procedures.

As clinicians, our primary goal should be to do no harm. Our adherence to sound scientific principles and the biological basis of our work can decrease the possibility of untoward treatment outcomes and enhance the quality of our treatment and the satisfaction and service we render our patients.

References
E-poster abstracts

Case report of periapical surgery after conventional endodontic treatment failure.

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Abstract
Introduction Periapical surgery is an endodontic surgical procedure done when conventional root canal treatment or retreatment has failed and the periapical lesion still persists. The goal of this procedure is to eliminate the periapical pathology by root-end resection, root-end cavity preparation followed by tight seal at the root-end with retrograde filling.

Case report This is a case report of periapical surgery of an upper right lateral incisor after retrieval of fractured instrument and conventional root canal treatment. A 17 years old female patient was referred to Klinik Pakar Pergigian Restoratif Jalan Abdul Samad, Johor for management of separated instrument on 12 from an outpatient clinic. Patient complaint of on and off pain from the tooth. Periapical radiograph findings of tooth 12 revealed a curved root, root filling with fractured file. Retreatment commenced followed by removal of lentulo spiral paste carrier from the canal. During removal of gutta percha in apical curved portion, transportation of the canal occurred and was repaired with MTA. The tooth was then obturated using warm vertical condensation technique. It was then followed by periapical surgery and was reviewed at 3 months, 6 months and at 1 year. Tooth was asymptomatic at 1-year review. Radiographically, there was an increase in bone density periapically at 1-year review.

Conclusion. In view of the clinical case follow-up, we can conclude that in teeth with persistent periapical lesions after having undergone an appropriate endodontic treatment, surgical retreatment with retro filling can be an efficient option in the resolution of the infection and periapical tissue repair.

Keywords: apicectomy retrograde filling periapical surgery flap root retreatment
Endodontic Management of Bilateral Dens Evaginatus Mandibular Second Premolars with Large Periapical Lesions

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Introduction: Dens evaginatus, or DE, is a developmental anomaly characterized by the presence of an accessory cusp composed of enamel and dentine, usually containing pulp tissue. This condition is clinically important because of fracture or wear of the tubercle, which can frequently lead to the major complication of pulp necrosis and periapical infection. Treatment varies according to pulp condition, tubercle integrity, and stage of root development. Objectives: To report a case of endodontic management of bilateral dens evaginatus involving the mandibular second premolars in which the affected pulps became necrotic.

Case Report: A 14-years old Malay boy with a noncontributory medical history was referred to Endodontic Specialist Clinic of Universiti Kebangsaan Malaysia for evaluation and management of repeated episodes of buccal swelling arising from right and left mandibular areas. Clinical examination revealed worn accessory occlusal cusps and pinpoint defects of both caries-free lower second premolars (teeth 45 and 35). Both of these teeth were slightly sensitive to percussion and palpation and failed to respond to electric pulp sensitivity testing. Radiographic examination revealed a large radiolucent lesion around the mature apex of the tooth 45 and, around the immature apex of tooth 35. Thus, an apexification using bioceramic material as an apical plug and regenerative endodontic treatments were performed for each right and left mandibular second premolars. At 6 month’s review, the teeth were asymptomatic and radiographically showed healing of the periapical lesions.

Conclusion: Apexification using bioceramic as an apical plug and regenerative endodontic treatment achieved a comparable outcome in regard to the resolution of symptoms and apical healing. In fact, regenerative endodontic treatment showed a good outcome regarding with continuation of root development and apical closure.

Keywords: Dens Evaginatus, Pulp Necrosis, Apexification, Regenerative Endodontic, Bioceramic Material
Iatrogenic Root Perforations and its Management: A Case Series

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Abstract:
Introduction: Root perforations is defined as destruction of the dentinal root wall or floor along with the investing cementum resulting with a communication to the supporting periodontal apparatus (AAE 2003). In this case series, three cases of iatrogenic perforation at coronal, crestal and middle third of the root will be discussed with its management.

Case report 1:
A 51-year-old Malay lady, was referred to the Comprehensive Care Suites UiTM due to supra-crestal perforation of her upper second right premolar which was caused during access cavity by an undergraduate student. It was repaired immediately using composite resin and upon 1 year review the tooth was asymptomatic.

Case report 2:
A 57-year-old Malay lady was referred to the Endodontic Specialist Clinic UKM for revision of root canal treatment on her maxillary right lateral incisor. An iatrogenic crestal perforation was noted upon examination and repaired with Mineral Trioxide Aggregate (MTA). Crestal level perforation was regarded as having questionable pognosis and as minimal tooth structure available to support the crown, the patient was refered for surgical crown lengthening prior to crown. At 6 months follow-up the tooth was asymtomatic.

Case report 3:
A 29-year-old Malay lady was referred to the Endodontic Specialist Clinic UKM due to root perforation caused by undergraduate student during post space preparation on her lower left first molar. The perforation was repaired with MTA and the tooth was asymptomatic upon 6 months review.

Discussion: The successful management of each case depend on the early detection to seal the perforation, severity of the perforation and location of the perforations. The advancement in technology with the use of dental operating microscope and biomaterials (ie: MTA, bioceramics) has increased the success rate of perforation cases up to 70% (Siew et al. 2015).

Conclusion: Apart from proper case selection, early diagnosis and proper seal of perforation cases is necessary for a successful outcome.
Effect of clinical audit on the quality of record keeping and technical quality of root canal therapy performed by dental undergraduates

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Abstract

Objective: To evaluate the effect of clinical audit on the record keeping and technical quality of root canal therapy (RCT) performed by dental undergraduates. Material and method: 350 clinical records of patients who have received root canal therapy performed by dental undergraduates from July 2012 to May 2015 were audited in August 2015 (Audit 1). Each set of patient records and periapical radiographs were evaluated independently by two examiners. The examiners were trained by and calibrated against an endodontist (κ ≥ 0.80). The quality of record keeping was evaluated against specific evaluation criteria in compliance with standards adapted from the guidelines defined in the consensus report of the European Society of Endodontology 2006 and the technical quality of root canal fillings was evaluated according to its condensation, extension and presence of procedural mishap. After getting the results of audit I, gaps were identified and remedial action were taken such as reinforcement of guidelines, closed supervision and understanding the importance of clinical audit. Thereafter, another clinical audit was done on 370 root canal therapy records from 356 patients performed by dental undergraduates from July 2015 to July 2018 (Audit II) using the same methodology. These data were then compared against Audit I and statistically analyzed using the Chi-square test (p<0.05). Results: Overall compliance with record keeping guidelines of audit II was 99.0% as compared to 72.8% in the previous audit I with a statistically significant difference (<0.05). The overall acceptable technical quality of RCT in audit II was 68% as compared with 56.7% in audit I. Acceptable homogeneity, extensions and absence of mishap were 78.0%, 89% and 89.0% in audit II while 74.2%, 88.0% and 78.6%, respectively in audit I. Conclusion: Clinical audit plays an important role in improving the quality of record keeping and technical quality of RCT performed by dental undergraduates.
THE REASONS BEHIND ENDODONTIC REFERRALS TO THE ENDODONTIC CONSULTATION CLINIC,
FACULTY OF DENTISTRY, NATIONAL UNIVERSITY OF MALAYSIA

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Abstract

Objectives: To investigate the different primary reasons for endodontic referrals to the Endodontic Consultation Clinic (ECC), Faculty of Dentistry, UKM where postgraduate endodontic students and specialist endodontists attend patients. Material and Methods: Clinical data of patients referred to the ECC waiting list by undergraduate dental students and general dentists between January 2013 and December 2015 were investigated retrospectively. The primary cause of referral to the ECC was recorded. The recorded data were tabulated and analyzed. Results: A total of 201 patients were referred to the ECC between January 2013 and December 2015. The reasons for endodontic referral can be classified into three main categories: i) primary root canal treatment without complications (n=73), ii) procedural difficulties (n=88), and iii) root canal retreatment (n=40). The referrals in cases involving procedural difficulties included canal blockages (n=40), perforations (n=12), C-shaped canals (n=9) and suspicion of a fractured tooth (n=6). Meanwhile, the common reasons specified for the retreatment cases were obturation short of the radiographic apex (n=17), extrusion of gutta percha beyond the radiographic apex (n=5) and voids in the gutta percha filling (n=5). Conclusions: The high number of cases involving the management of endodontic procedural difficulties and retreatment cases indicates that these are among the procedures that are deemed difficult by the undergraduate dental students and general dentists which led to their referrals to the ECC.

EVALUATION OF IMAGE QUALITY OF BITEWING RADIOGRAPH AT FACULTY OF DENTISTRY UiTM

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ABSTRACT

Objectives: The aim of this study is to analyse the image quality of bitewing radiograph taken by UiTM dental students.

Materials and method: 120 patients were selected and their bitewing radiographs were retrieved from the patient record to be evaluated. The quality of bitewing radiograph was classified into three categories: excellent, acceptable and poor based on European guideline on radiation protection in dental radiology in 2004. Result: The qualities of bitewing radiographs were mostly acceptable to be used as diagnostic tool and one of the factors which commonly affected the quality of the bitewing was overlapping of adjacent teeth. Good quality of bitewing radiograph is important for diagnostic purpose and to propose a suitable treatment plan for the patient. Conclusion: It can be concluded that bitewing radiograph provides additional value for determination of interproximal and secondary caries compared to clinical examination only. For a bitewing radiograph to be used as diagnostic tool, it should have acceptable quality without affecting image interpretation that can affect dentist's treatment decision.

Keywords: Bitewing radiograph, clinical examination, dental caries, radiograph
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