The outcomes of root canal treatment
Musliana Mustaffa and et al

Abstract
It is not known whether or not root canal treatment provided by undergraduate dental students in the Kulliyyah of Dentistry (KOD), International Islamic University Malaysia (IIUM) is successful; therefore, the need to investigate the outcome of treatment is indispensable. This study was conducted at the KOD, IIUM from 11th July 2018 until 12th June 2019. Follow up visits were conducted at least 6 months after the completion of root canal treatment. A total of 175 root canal treated teeth from 143 patients aged between 17 and 71 years old were still present during the follow up visits. Information on the extraction of root canal treated teeth, including reasons for extraction was obtained from the patients or patient's records. Treatment was considered failed when the tooth was extracted due to fracture or persistent intraradicular infection. The results show that survival rate of root canal treated teeth was 98.9% over an observation period of at least 42 months. Two root canal treated teeth were extracted due to tooth fracture. Root canal treatment provided by undergraduate dental students in the Kulliyyah of Dentistry was effective, with minimal percentage of failure.

Received date: 15 March 2021 Accept date: 23 May 2021

Introduction
The outcome of root canal treatment has been reported in many studies. Some studies have highlighted periapical healing while others reported the survival of root canal treated teeth, determined by the tooth retention.

The data reported in literatures shows a wide variation in percentage of tooth survival ranging from 36% to above 60% over an observation period of 2 years to 10 years. An epidemiological study carried out in the United States over an 8-year period showed 97% tooth survival in 1 462 936 teeth of 1 126 288 patients. The results from a systematic review observed survival rate of approximately 81% in the root canal treated teeth that were restored with crowns after 10 years follow up in comparison to the root canal treated teeth without crowns. Another systematic review showed survival rate ranging between 86% and 93% over an observation period of 2 to 10 years. The survival data reported in the previous studies show large differences that could be attributed to the study characteristics such as study design, follow up period and sample size.

The survival data of a root canal treated tooth is based on various levels of evidence. Therefore, a robust conclusion pertaining to the long-term survival of the tooth is difficult to make, although in recent years a 10-year observation period has been reported in some studies. Due to the various factors dictating the survival of root canal treated teeth, the preoperative prognosis of a root canal treated teeth should be made with great caution.

The prognostic indicators determining survival of root canal treated teeth have been reported by previous researchers. These include the influence of preoperative, intraoperative and post-operative factors that in certain situations are difficult to control. However,
this information can be used to help inform patients of possible treatment benefits, risks and outcomes, so that the clinicians and patients have a general understanding of the factors influencing the survival of root canal treated teeth.

It is not known whether or not root canal treatment undertaken by undergraduate dental students in the Kulliyyah of Dentistry (KOD), International Islamic University Malaysia (IIUM) is successful, therefore, the need to investigate the outcome of treatment is indispensable. This is important to determine the success of root canal treatment that is provided to patients. Moreover, the limitations encountered during treatment could be identified early and hence could be improved in future clinical practice.

Based on the discussion above, the objective of this study was to assess the survival rate of root canal treated teeth provided by undergraduate dental students and to identify the prognostic indicators determining survival.

Materials and methods

This study received ethical approval from the International Islamic University Malaysia Research Ethics Committee (IREC 2018-039).

This was a retrospective study assessing the survival of root canal treated teeth. The study was conducted at the Kulliyyah of Dentistry, IIUM from 11th July 2018 until 12th June 2019. The samples were selected based on the inclusion and exclusion criteria as follows. Inclusion criteria included primary root canal treatment undertaken by undergraduate dental students in KOD, IIUM, with at least 6 months follow up. The exclusion criteria included periodontically involved root canal treated teeth, secondary root canal treatment, incomplete root canal treatment and the extracted root canal treated teeth due to orthodontic treatment. All included samples were treated between 31st March 2015 and 28th March 2019.

Sample size calculation was done using Raosoft sample size calculator involving a total number of 151 teeth. Initially, patient records were retrieved from the database or clinical logbooks of the undergraduate dental students. Potential patients for review were contacted by phone and invited for the follow up visits. The explanation regarding the study was done by the researchers and patients who agreed to participate in the study was required to sign a consent form.

During the follow up visit, the pain and other relevant history was asked, the clinical examination was conducted and the periapical radiographic images for assessment of the periapical status was taken. The primary outcomes were clinical and radiographic evidence of absence of apical periodontitis or periapical healing of the tooth. The secondary outcome was tooth survival.

A total of 175 root canal treated teeth from 143 patients were reviewed, the age of patients ranged between 17 and 71 years old (mean: 39 years old). Information on the extraction of root canal treated teeth including the reasons for extraction was obtained from the patients or patient’s records. Teeth extracted due to the fracture or persistent intraradicular infection and teeth required root canal retreatment or periapical surgery were considered failed treatment.

Statistical analysis was performed using IBM SPSS version 25. The overall longevity of root canal treated teeth was analyzed using Kaplan-Meier statistics.

Results

In total, 196 teeth from 161 patients underwent root canal treatment by undergraduate dental students between 31st March 2015 and 28th March 2019. A total of 16 root canal treated teeth (8.2%) from 15 patients were affected by localized periodontitis (at least one site with probing pocket depth of at least 4 mm), 1 root canal treated tooth from 1 patient was extracted for orthodontic reason and 2 root canal treated teeth from 2 patients were extracted without specific reasons. A total of 177 root canal treated teeth from 143 patients; 83 females (58%) and 60 males (42%) were included in the analysis. Of these, 1 root canal treated tooth from 1 patient was extracted due to tooth fracture about 5 months after completion of the root canal treatment and another 1 root canal treated tooth from 1 patient was extracted after 12 months. The age of patient during root canal treatment ranged between 17 and 71 years old (mean: 39 years old). Tooth type, observation period and post-operative status of the root canal treated teeth are presented in Table 1 and 2 respectively.
The outcomes of root canal treatment

Table 1. Tooth type and the observation period.

<table>
<thead>
<tr>
<th>Tooth type</th>
<th>Number of root canal treated teeth (n = 175)</th>
<th>Percentage (%)</th>
<th>Observation period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incisors</td>
<td>51</td>
<td>29.1</td>
<td>0 to 12 months</td>
</tr>
<tr>
<td>Canine</td>
<td>6</td>
<td>3.4</td>
<td>1 to 2 years</td>
</tr>
<tr>
<td>Premolars</td>
<td>65</td>
<td>37.1</td>
<td>2 to 3 years</td>
</tr>
<tr>
<td>Molars</td>
<td>53</td>
<td>30.4</td>
<td>3 to 4 years</td>
</tr>
</tbody>
</table>

Table 2. Post-operative status.

<table>
<thead>
<tr>
<th>Tooth type</th>
<th>Coronal restoration</th>
<th>Abutment of prosthesis</th>
<th>Number of the adjacent tooth</th>
<th>Terminal tooth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incisors</td>
<td>Adhesive</td>
<td>Removable</td>
<td>Fixed</td>
<td>Yes No</td>
</tr>
<tr>
<td>Canine</td>
<td>Amalgam</td>
<td>Removable</td>
<td>Fixed</td>
<td>Yes No</td>
</tr>
<tr>
<td>Premolars</td>
<td>Cast</td>
<td>Removable</td>
<td>Fixed</td>
<td>Yes No</td>
</tr>
<tr>
<td>Molars</td>
<td>Amalgam restoration</td>
<td>Removable</td>
<td>Fixed</td>
<td>Yes No</td>
</tr>
</tbody>
</table>

Figure 1. Kaplan-Meier survival analysis of root canal treated teeth.

Kaplan-Meier survival analysis showed tooth loss from month 5 post-treatment, meanwhile, the probability of tooth survival until month 12 is 98.7%. The average tooth survival was 42 months [95% CI (41.99 - 43.16)].

Discussion

The survival rate of root canal treated teeth undertaken by various operators has been evaluated in previous studies such as by the undergraduate dental students,19 endodontic postgraduate students,5, 7, 13, 16 a combination of undergraduate and postgraduate dental students,22 dental practitioners11, 14, 15, 20, 23, 24 and a combination of dental practitioners and endodontic specialists.8 However, the survival of root canal treated teeth undertaken by undergraduate dental students is less frequently evaluated, perhaps due to a larger focus on the technical quality of root canal treatment.25-35

The follow up visit conducted in the present study was from 6 months to 4 years post-treatment, although longer observation periods have also been reported in the past, including 8 years,16, 19 and 10 years.5, 7, 11, 20

The survival rate of root canal treated teeth in the present study was 98.9% over an observation period of at least 42 months. One root canal treated tooth was extracted due to fracture within 5 months and another one root canal treated tooth was extracted 12 months after the completion of root canal treatment. In a previous study, the survival rate of root canal treated teeth was 79.5% over an observation period of 8 years19 whereas in another study, the survival rate of root canal treated teeth was 72.7% over an observation period of at least 3 years.22 The findings reported in the former study19 could be attributed to the longer observation period, in which the failure rate would have likely increased over time36 and the findings in the latter study22 could be associated with a lack of proper post-operative restoration and some of the root canal treatments was carried out by the less experienced practitioners.

Comparison of the survival rates of root canal treated teeth undertaken by undergraduate dental students in the present study against the same treatment done by dental practitioners showed 74%,23 80%,14 81.7%,20 and 93%13 survival rate in the latter over an observation period of 10 years. In other studies spanning less than 10 years observation period, 90% survival rate was reported after 5 to 6 years19 and 97.1% survival rate was reported after 8 years.8 Although the majority of studies reported of the survival rate, one study reported annual failure rate, which was 1.9% over a 10-year observation period.24 The reported survival data showed that the root canal treatment provided was of high quality considering the experience of the dental practitioners and endodontic specialists. However, due to the longer observation period, the failure rate would have likely increased, explaining the survival data reported by the previous researchers.14, 20, 23

It was not possible to determine the prognostic indicators determining the survival of root canal treated teeth owing to the limited number of failures within the observation period. Perhaps, a longer follow up duration of more than 4 years could better assess the status of failure. Meanwhile, previously reported data show that there are 13 prognostic indicators for the survival of root canal treated teeth, such as history of
diabetes, systemic steroid therapy, narrow but deep periodontal probing depth, preoperative pain, sinus discharged, preoperative iatrogenic perforation (for root canal retreatment cases), intraoperative iatrogenic perforation, patency at apical terminus, extrusion of root fillings, presence of cast restoration, presence of cast post and core, proximal contacts with both mesial and distal adjacent teeth and terminal location of the tooth. These prognostic indicators could dictate the prognosis of the root canal treated teeth and can be used in patient informed consent prior to root canal treatment. However, due to insufficient data in the present study, the prognostic indicators determining the survival of root canal treated teeth could not be determined.

The present study was limited by insufficient historical data, leading to retrospective analysis, as well as different observation periods, complicating standard comparison. The prognostic factors indicating tooth survival could not be identified due to the limited number of root canal treated teeth that were extracted within the observation period. Based on the findings, root canal treatment provided by undergraduate dental students in the KOD, IIUM followed a predictable approach with good short-term prognosis. Multiple factors could influence the survival of root canal treated teeth, however, in the present study it was not possible to address these factors owing to a retrospective nature of the study. Future research selecting the appropriate cases over a standard observation period can be performed to overcome this limitation.

Conclusions

Within the limitations of the present study, the survival of root canal treated teeth undertaken by undergraduate dental students in KOD, IIUM showed 98.9% over an observation period of at least 42 months, with a minimal percentage of failure. A longer observation period is needed to assess the survival rate of the root canal treated teeth so that factors contributing to treatment failure could provide insights on the precautions that needs to be addressed when providing root canal treatment to patients.

Acknowledgements

This research was supported by the Research Initiative Grant Scheme 2017 from the International Islamic University Malaysia (RIGS17-090-0665).

Declaration of Interest

The authors report no conflict of interest.

References


