Quality and readability of online information about root canal treatment and its outcomes: an infodemiological study

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ABSTRACT

Root canal treatment, also known as endodontic treatment, is a common dental procedure that involves the removal of inflamed or infected pulp tissue, followed by cleaning, disinfecting, filling, and sealing the canals. The aim of this study is to categorize the content and assess the quality and readability of the online information regarding root canal treatment and related outcomes. An online search using three different terms regarding the root canal treatment and related outcomes was undertaken using Google, Yahoo, and Bing search engines. The first 100 websites that appeared in each search were analyzed. Data recorded included DISCERN instrument scores, Journal of the American Medical Association (JAMA) benchmarks, and the presence of the health on the net seal (HON). Flesh reading ease scores, flesh-kincaid grade level, the simplified measure of Gobbledygook index, and the Coleman-Liau index were calculated to assess readability. Eighty-five of the first websites remained for analysis after applying appropriate exclusion criteria. The mean overall DISCERN score was 2.91 (+1.12). Only one website (1.17%) achieved all four JAMA benchmarks. Only 12 websites (14.1%) displayed the HON seal. The reading level varied from standard to difficult among the majority of websites. Based on this study, the online information regarding root canal treatment and related outcomes has challenging readability with content of poor quality. Further efforts should be made to create and maintain high-quality, reliable, and easily readable online information sources related to root canal treatment outcomes.

Keywords: Flare-up, root canal treatment, complications, online information, patient education.

Introduction

Root canal treatment, also known as endodontic treatment, is a common dental procedure that involves the removal of inflamed or infected pulp tissue, followed by cleaning, disinfecting, filling, and sealing the canals [1]. Studies have shown that more than half of the population studied has had at least one tooth treated endodontically [2]. The primary objective of this treatment is to prevent or eliminate infections from the root canal system, and failure to achieve this objective can lead to impaired outcomes [3]. Endodontic complications can occur at various stages of treatment, including access cavity preparation, instrumentation, irrigation, and obturation [3]. One such complication is perforation, defined as the creation of a pathological or mechanical communication between the root canal system and the outer surface of the tooth [3]. Tooth loss is significantly increased when pre or intraoperative perforations occur [4,5]. Instrument separation is another complication where an instrument fractures and remains inside the canal, potentially hindering further cleaning, shaping, or filling.
of the canal [3]. The impact of instrument separation on treatment outcomes varies in the literature [6-8]. Missed canals during endodontic treatment are also a notable cause of treatment failure, with an incidence estimated to be around 12% [9,10]. Ledge formation is an iatrogenic complication in which an irregularity is created in the root canal, obstructing access of instruments to the apex of the canal [3].

Additionally, flare-up is a common post-treatment complication characterized by postoperative pain occurring shortly after root canal treatment. It often requires urgent treatment and can lead to chronicity. The prevalence of flare-ups ranges from approximately 2.5% to 60% of patients undergoing endodontic treatment [11-14]. The flare-up is challenging to prevent and can be influenced by various factors, including patient-related factors such as gender and age, the pulp status and type of the treated tooth, and the type of treatment performed, whether primary root canal therapy or retreatment [14]. Patients should be informed about the possibility of postoperative complications and advised on using analgesics as necessary [15,16].

In the contemporary era, a growing number of patients turn to the Internet for health-related information [17]. Studies conducted in seven countries have shown that 71% of Internet users seek health-related information online, driven by reasons such as seeking reassurance, obtaining alternative medical opinions, and better understanding of clinical information [18,19]. However, concerns persist regarding the quality, accuracy, and readability of online health information [20]. Therefore, the objective of this study is to assess the quality and readability of web-based information available on root canal treatment and its associated outcomes.

Materials and Methods

An online search for three different terms “root canal treatment outcomes,” “root canal treatment complications,” and “root canal treatment flare-up” was carried out on the 21st and 22nd of July 2023 using Google, Yahoo, and Bing search engines. The first 100 sites that appeared through each search engine for each term were explored to evaluate the content, quality, and readability of the available information.

The list of websites was thoroughly screened for any duplicates or nonworking links. The exclusion criteria applied included scientific articles, book reviews, websites with no content related to root canal treatment outcomes and complications, websites that denied direct access to the content or membership-based websites, promotional product websites, discussion groups, video feeds, online medical dictionaries, and non-English language websites.

The remaining websites were categorized by Ní Riordáin and McCreary [20], based on affiliation (commercial, nonprofit organization, university/medical center, and government), specialization (exclusively related, partly related), content type (medical facts, clinical trials, human interest stories, question, and answer) and content presentation (image, video, and audio).

The quality of the online information was assessed using the DISCERN instrument [21], the Journal of the American Medical Association (JAMA) benchmarks for website analysis [22], and the health on the net (HON) [23]. Data were collected and analyzed in Microsoft Excel.

DISCERN is a validated 16-point questionnaire developed by the University of Oxford to examine the reliability (questions 1-8) and specific details of information on treatment choices (questions 9-15) plus an additional question for overall quality rating (question 16) [21]. Each question is rated on a numerical scale from 1 to 5 (1 = very poor, 2 = poor, 3 = moderate, 4 = good, 5 = excellent). JAMA benchmarks were used to analyze the quality of the website. These benchmarks require clarity about content authorship including (authors and contributors), their affiliations, and relevant credentials, attribution (list of references and sources of information), disclosure (website ownership, sponsorship, advertising, commercial funding arrangements, and conflicts of interest), and currency (dates content posted and updated) [22]. HON is a nonprofit organization, founded in 1995, that promotes reliable and transparent health information online. It gives accreditation to websites that follow the HON code of ethical conduct, consisting of eight principles including authority, privacy, attribution, transparency, financial disclosure, and advertising policy [22].

The readability was assessed using four different measures such as, flesh reading ease scores (FRES), flesh-kincaid grade level (FKGL), the simplified measure of Gobbledygook (SMOG) Index, and the Coleman-Liau index (CLI). FRES formula, developed in the 1940s, measures the readability of text by considering the average sentence length and the average number of syllables per word [24]. A higher score indicates that the text is easier to read. A score of more than 90 equates to the reading age of a 10 year old while a score of 30-49 equates to the reading age of an adult [24]. The FKGL is based on the average number of words per syllable and sentence, while the SMOG index takes into account the number of polysyllabic words per sentence. The CLI is another readability test that uses characters instead of syllables per word and sentence length [24].

Results

Available websites

The search strategy for the term “root canal treatment outcomes/complications/flare up” generated 19,539,000 websites, 6,981,000 websites for “root canal treatment outcomes” and 7,997,000 by searching “root canal treatment complications,” and 4,561,000 by searching “root canal treatment flare up” on the Google, Yahoo, and Bing search engines. Of the first 900 websites of the three search
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terms, 410 were scientific articles, 13 were book reviews, 14 were nonworking links, 40 were commercial, and 119 were nonrelated websites. Only 85 selected websites remained for final review after eliminating the duplicates between the three search terms (Figure 1). Concerning specialization, it was not possible to determine the exact proportion of each site dedicated to the root canal treatment due to the site design and multiple linkages available. However, none of these selected sites (85) were exclusively dedicated to the root canal treatment outcomes, complications, and/or flare-ups. Regarding the affiliation of the websites, 40 websites (47.05%) were commercial, 4 (4.7%) were nonprofit websites, 3 (3.52%) were considered as governmental, and 38 (44.7%) were either related to universities or medical centers. All of the included websites have medical facts. However, four (4.7%) of the sites included clinical trials, one (1.2%) included human-interest stories, and only two (2.4%) included questions and answers. The content presentation varied as 15 (17.6%) websites included images and 5 websites (5.9%) included videos. None of the websites included an audio illustration. Summary of the categorization of the website is shown in Table 1.

Quality assessment

The mean DISCERN score among the 85 websites was 2.91 (1.12). Seven websites (8.24%) received the minimum overall rating, whilst nine (10.59) received the

Table 1. Categorization of websites based on affiliation, specialization, content type, and content presentation.

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Number of websites (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affiliation</td>
<td>Commercial</td>
<td>40 (47.05)</td>
</tr>
<tr>
<td></td>
<td>University/medical center</td>
<td>38 (44.70)</td>
</tr>
<tr>
<td></td>
<td>Governmental</td>
<td>3 (3.52)</td>
</tr>
<tr>
<td></td>
<td>Nonprofit organization</td>
<td>4 (4.70)</td>
</tr>
<tr>
<td>Specialization</td>
<td>Exclusively related</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Partly related</td>
<td>85 (100)</td>
</tr>
<tr>
<td>Content type</td>
<td>Medical facts</td>
<td>85 (100)</td>
</tr>
<tr>
<td></td>
<td>Clinical trials</td>
<td>4 (4.7)</td>
</tr>
<tr>
<td></td>
<td>Human interest stories</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td></td>
<td>Question and answer</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Content presentation</td>
<td>Image</td>
<td>15 (17.6)</td>
</tr>
<tr>
<td></td>
<td>Video</td>
<td>5 (5.9)</td>
</tr>
<tr>
<td></td>
<td>Audio</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Figure 1. Flow of search strategy.
maximum rating. The majority of the websites had scores ranging from 1 to 3.

The questions with the lowest DISCERN scores is associated with the explicit sources [“Is it clear what sources of information” were used to compile the publication (other than the author or producer?”)], additional sources of support and information (“Does it provide details of additional sources of support and information?”), and the explicit aims (“Are the aims clear?”) with mean scores of 1.86 (±1.47), 1.89 (±1.39), and 1.99 (1.22), respectively (Table 2). Only 12 (14.12%) of the 85 websites presented the HON seal.

According to the JAMA benchmarks, (56.5%) of the websites achieved the authorship and currency benchmarks. However, only 21 (24.7%) of the websites achieved the attribution benchmarks, whereas only 2 (2.4%) achieved the disclosure benchmark (Table 3). Only one website (1.17%) achieved all JAMA items while none of the items were achieved in 27 (31.76%) websites. Table 4 shows the number of JAMA benchmarks per website.

**Readability**

The FRES values ranged from 7.9 to 72.6, with a mean total readability score of 52.4 (14.02). FKGL varied from 7 to 39, with a mean total readability score of 11.1 (3.90), SMOG ranged from 4.8 to 19, with a mean total readability score of 9.7 (2.20), and CLI ranged from 7 to 17, with a mean total readability score of 10.5 (1.98). The most frequent reading grade was standard for 30 websites. Furthermore, 54 websites had readability levels that ranged from fairly difficult to very difficult, while only one website obtained a readability level of fairly easy (Figure 2).

**Discussion**

Nowadays, online information platforms are considered the most reliable source for people seeking answers to their queries [25,26]. Root canal treatment, a common dental procedure worldwide, often results from neglecting oral health [2]. This procedure, known as endodontic treatment, aims to prevent or eliminate root canal infection and related pathology. Complications during any stage of endodontic treatment, including

**Table 2. Means and SD scores for DISCERN.**

<table>
<thead>
<tr>
<th>Domain</th>
<th>DISCERN question</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>Q1. Explicit aims</td>
<td>1.99 (1.22)</td>
</tr>
<tr>
<td></td>
<td>Q2. Aims achieved</td>
<td>2.11 (1.37)</td>
</tr>
<tr>
<td></td>
<td>Q3. Relevance</td>
<td>3.38 (1.11)</td>
</tr>
<tr>
<td></td>
<td>Q4. Explicit sources</td>
<td>1.86 (1.47)</td>
</tr>
<tr>
<td></td>
<td>Q5. Explicit date</td>
<td>2.55 (1.87)</td>
</tr>
<tr>
<td></td>
<td>Q6. Balanced and unbiased</td>
<td>3.88 (1.02)</td>
</tr>
<tr>
<td></td>
<td>Q7. Additional sources</td>
<td>1.89 (1.39)</td>
</tr>
<tr>
<td></td>
<td>Q8. Areas of uncertainty</td>
<td>2.02 (1.07)</td>
</tr>
<tr>
<td>Treatment options</td>
<td>Q9. How treatment works</td>
<td>2.62 (1.41)</td>
</tr>
<tr>
<td></td>
<td>Q10. Benefits of treatment</td>
<td>2.49 (1.32)</td>
</tr>
<tr>
<td></td>
<td>Q11. Risk of treatment</td>
<td>2.72 (1.27)</td>
</tr>
<tr>
<td></td>
<td>Q12. Effects of no treatment</td>
<td>2.11 (1.29)</td>
</tr>
<tr>
<td></td>
<td>Q13. Effects on quality of life</td>
<td>2.06 (1.16)</td>
</tr>
<tr>
<td></td>
<td>Q14. All alternatives described</td>
<td>2.34 (1.35)</td>
</tr>
<tr>
<td></td>
<td>Q15. Shared decision</td>
<td>2.58 (1.38)</td>
</tr>
<tr>
<td>Overall rating</td>
<td></td>
<td>2.91 (1.12)</td>
</tr>
</tbody>
</table>

**Table 3. Websites content based on JAMA benchmarks.**

<table>
<thead>
<tr>
<th>JAMA benchmarks</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authorship</td>
<td>48</td>
<td>56.5</td>
</tr>
<tr>
<td>Attribution</td>
<td>21</td>
<td>24.7</td>
</tr>
<tr>
<td>Disclosure</td>
<td>2</td>
<td>2.4</td>
</tr>
<tr>
<td>Currency</td>
<td>48</td>
<td>56.5</td>
</tr>
</tbody>
</table>

**Table 4. Total number of achieved JAMA benchmarks.**

<table>
<thead>
<tr>
<th>Score</th>
<th>Number of websites</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>27</td>
<td>31.76</td>
</tr>
<tr>
<td>1</td>
<td>16</td>
<td>18.82</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td>28.23</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1.17</td>
</tr>
</tbody>
</table>
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Diagnosis, planning, access cavity, instrumentation, and obturation, can compromise treatment outcomes [3]. Patients may experience pain, swelling, and discomfort after root canal treatment due to various reasons, including instrumentation and obturation procedures [12]. The incidence of postoperative pain varies depending on the diagnosis, therapeutic modalities, and prognosis, ranging from 34.6% to 63.8% [12]. Vital pulp tissue is more likely to experience pain than necrotic pulp or retreated teeth [12].

However, there is limited evidence regarding online information about endodontic treatment outcomes. One study evaluating the quality of videos about the risks of root canal treatment found that YouTube videos provide poor information on these risks, potentially affecting patient decisions negatively [27].

Various assessment tools have been employed to evaluate internet sources regarding treatment outcomes, complications, and flare-ups [21-24]. Search engines such as Google, Yahoo, and Bing offer extensive dental information on swelling, discomfort, and pain after root canal treatment, including how to relieve it and its impact on patients’ health-related and oral health-related quality of life.

Regarding the content of the websites assessed in this study, none of them were solely focused on root canal treatment outcomes. All reviewed websites included medical facts, leading to a generally low level of readability, ranging from “fair difficult” to “very difficult.” The ability of patients to accurately interpret medical information has been questioned previously [28,29].

In terms of reliability, the overall mean DISCERN score of the assessed websites was 2.91 (± 1.12), indicating low to moderate quality of available information. The majority of websites (31.76%) did not meet any of the JAMA benchmarks, with only one website (1.17%) meeting all the benchmarks, and 24 websites (28.23%) meeting only two of them. Less than a quarter of the websites achieved the attribution benchmark (24.7%), and only two websites (2.4%) achieved the disclosure benchmark, while more than half of the websites met the authorship and currency benchmarks (56.5%). Several studies on various oral health-related conditions have reported similar findings [30-32].

According to the American Food and Drug Administration (FDA, 2005), the most reliable online information is usually provided by governmental, nonprofit, and educational institutions. In this study, the percentages were 3.5%, 4.7%, and 44.7%, respectively. Commercial websites accounted for the highest number of included websites (47.05%). This is consistent with previous evidence, which has attributed the variation in the quality of included websites to potential commercial bias [33].

This study has limitations, including a restricted search to three websites and not evaluating the content of social media videos, which are becoming significant sources of knowledge. Future research should consider including more search engines and tools for evaluating social media content.

**Conclusion**

This study highlights the poor quality and challenging readability of the online content regarding root canal...
treatment and related outcomes. Our findings indicate that the online information was not written at a level that is easily understandable by the average person. The available online information may have been overly complex, technical, or exceedingly using scientific terminology. There is a need for more qualified web pages with high-quality, reliable, and easily readable information regarding root canal treatment and possible complications.

List of Abbreviations

- CLI: Coleman-Liau index
- FKGL: Fles-Kincaid grade level
- FRES: Flesh reading ease scores
- HON: Health on the net
- JAMA: Journal of the American Medical Association
- SMOG: Simplified measure of Gobbledygook
- SMOF: Simplified measure of Gobbledygook
- JAIT: Journal of the American Dental Association
- FRES: Flesh reading ease scores
- CLI: Coleman-Liau index
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Conflict of interest

Funding

Consent to participate

Ethical approval

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