Estimation of Remaining Dentine Thickness (RDT) Under Caries Lesion with a Cone-Beam Computed Tomography and Standardized Paralleling Technique in Comparisons to Actual Measurement. In Vitro Comparative Study

Rozhyna Peshraw Kamal¹, Bestoon Mohammed Faraj², Raed Fahim³

Department of Dentistry, Sulaimaniyah University, Iraq

Corresponding author: Rozhyna Peshraw Kamal, Department of Dermatology, Sulaimaniyah University, Iraq. Email: dastan@dr.com

Received: July 11, 2021 Published: August 04, 2021

Abstract
Objective: Determining a viable and reliable method for estimation of remaining dentine thickness before starting caries excavation thus reducing the incidents of post-operative sensitivities and direct pulpal exposure through finding a logistic and accurate relationship between the amounts of actual remaining dentine thickness and the radiographic remaining dentine thickness.

Methods: In three-stage experiment 60 extracted human teeth were examined by digital radiography, cone beam computed tomography, and microscopically after hand excavation of remaining caries, the results were compared and statistically analyzed for each tooth.

Result: No significant difference between actual clinical and CBCT measurements (P=0.98) but a significant difference between actual clinical and periapical radiographs (P = 0.000021).

Conclusion: Determining the remaining dentine thickness through everyday periapical radiographs is inaccurate, finding a reliable and cost-effective method remains a challenge.

Keywords: remaining dentine thickness, CBCT, challenge, caries.

Introduction
With the outgrowing emphasis on the importance of minimally invasive dentistry and preservation of as much as possible of the sound tooth structure, more focus has been put on the estimation of the remaining dentin thickness below the carious lesion.

Estimating the depth of a carious lesion remains an important challenge for dentists [1]. Judging a cavity depth through the practitioner’s eyes is not always accurate and, in many cases, a shallow-looking cavity may be in fact much deeper and result in pulp exposures during cavity preparation and caries removal.

Maintaining vitality remains a major concern in restorative procedures which almost directly relates to the removing of adequate amounts of tooth structure [2].

Even with the enormous advances in technology, public dental health care, and caries prevention methods, caries remains one of the most prevalent diseases worldwide, with an extension of caries towards the pulp chamber more and more of tooth structure is lost through bacterial byproducts losing its protective barriers against chemical and mechanical irritation [3].

The protective barrier of healthy dentine extending between the pulp chamber and pulpal floor serves the function of protection against mechanical injury and inflammation and is referred to as remaining dentine thickness3, throughout centuries there have been many arguments about the proper amount of RDT to do its function in pulp protection, A 0.5 mm of remaining dentin in deep carious cavities were seen to induce pulpal reactions similar to pulpal exposure [4], while other authors have suggested the necessity of 2mm or 1 mm of remaining dentine thickness for pulpal protection [5,6] but a minimum thickness of 0.5mm and above should always be preserved to maintain the pulpal health [7].

As far as today the excavation of caries has been mainly through the experience of the dentists in judging the cavity depths by observing the color changes in the prepared cavity with or without the aid of radiographs, many parameters have been used to assist the determination of the actual RDT [8-12], the digital radiographs have been proven as the most useful [13] as the choice of appropriate treatment with proper diagnosis depends on the removal of the correct amount of tooth structure and avoiding unnecessary pulpal exposure; clinical skills in the management of deep cari-
ous lesions can be greatly enhanced by finding a correlation be-
tween the actual remaining dentine thickness and radiographic
remaining dentine thickness [14].

This study is aimed towards determining a viable and reliable
method for estimation of remaining dentine thickness before
starting caries excavation thus reducing the incidents of post-
operative sensitivities and direct pulpal exposure through find-
ing a logistic and accurate relationship between the amounts
of actual remaining dentine thickness and the radiographic re-
mainning dentine thickness.

Material and Methods

100 extracted human teeth including teeth from incisors to
molars were collected from the surgical department of shorsh
teaching hospital, Sulaymaniyah City. The teeth collected cleansed of visible blood and gross debris
and maintained in a hydrated state in a glass jar of normal sa-
line and a well-sealed lid for nearly 3 months until the required
sample size was gathered, they were decontaminated prior to
storage in a solution of 1:10 sodium hypochlorite for 30 min-
utes according to the safety guidelines of disease and infection
control of CDC [15].

Teeth were embedded in acrylic resin to the level of the ce-
ment-enamel junction Inside custom made 3D printed cy-
inders using polylactic acid filaments and PRUSA MK3 3D
printer (PRUSA research Czech Republic’s). After 24 hours,
the acrylic resin was finished and polished with abrasive paper,
each specimen is encoded with a number on the bottom of the
cylinders that was used as a reference code for the Digital im-
ages and the CBCT that was taken for each tooth in the next
steps.

Digital images were taken for each tooth using Sopix Ace Sen-
so and SoPro software at 90-degree angulation with an expo-
sure time of 0.16ms and 70kv in buccolingual dimension.
To aid these a second image was taken for each tooth in a
20-degree mesial shift technique.

6 custom made wood box with the dimensions of (10cm x
10cm) and (2 cm height) is prepared and filled with dental plas-
ter to standardize the position of the teeth during CBCT image
acquisition.

Ten specimens are inserted inside each box consistently. Both
wood boxes and acrylic resin are covered with a separating
medium (Pure petroleum jelly) to facilitate their removal,
After setting the plaster, the number of each specimen is written
on the upper surface of the plaster with the permanent pencil.
All the teeth were scanned by using Carestream CS9600 (care
stream dental USA) CBCT machine using a field of (10 x 10)
cm and 25 µsv.

For Actual clinical measurement; The tooth is sectioned in the
mesiodistal plane, Diamond cutting disc (Skill-bond, High
Wycombe, UK, Sintered Diamond Disc, size 400, 1/10 mm set
638R1) is used. The bur is replaced after every fifth section.
Water from the 3-in-1 syringe is used as a coolant continuously,
The level of the sectioning was determined based on the lo-
cation of caries in the crown and not in a standard position
for all the teeth so as to gain access to the deepest area of the
carious lesion so as to be hand excavated, after sectioning was
completed the different zones of the carious lesions were iden-
tified with the aid of caries detection dye RED detector ( Ro-
damine B, CERKAMED Poland) for 10 seconds according to
the manufacturer’s instructions to facilitate distinction between
differential zones of dentine [17,18].
following hand-excavation, the remaining dentine thickness is measured directly on the tooth using a translucent plastic ruler with the aid of stereomicroscope; Zumax oms1950 dental microscope (zumax medical, China) magnification of 10x.

Measurements were taken from the thinnest point of the remaining dentine on the floor of the lesion to the pulp dentine border to the nearest 0.5 mm [19].

**Inclusion criteria:**
Visually inspected, selected teeth had carious lesions in at least one surface, without direct pulp exposure, including ICADS 20 code 3,4,5 and code 6.

**Exclusion criteria:**
Caries free or very initial caries not reached to dentine, that is excluding ICADS20 code 0,1 and code 2.

**Statistical analysis:**
All the obtained data will be collected, tabulated, and entered in MS excel and analyzed by using SPSS version 25.0.0 software 2017. Pearson’s correlation is used to assess interexaminer reliability. One-way ANOVA is used for statistical analysis. An Independent sample t-test can be used for individual evaluation of caries and dentin differences.

**Result**
This study consisted of 60 extracted human teeth including; 5 incisors, 10 canines, 20 premolars, and 25 molars with carious lesion distributed on different surfaces including 40 occlusal and 20 smooth surface caries.

For each tooth, three Measurements were taken including actual clinical, periapical radiographs, and CBCT.

The mean measurement for periapical radiographs was 1.23 mm with a standard deviation of 0.45mm and a range of (1.11mm -1.35 mm).
The mean measurement for CBCT was 0.82 mm with a standard deviation of 0.55 mm, and a range of (0.68mm – 0.98 mm).
The mean measurement for clinical measurements was 0.81 mm with a standard deviation of 0.31 mm and a range of (0.72mm – 0.89 mm).
The results indicated no significant difference between actual clinical and CBCT measurements (P=0.98) but a significant difference between actual clinical and periapical radiographs (P = 0.000021).

Descriptives

<table>
<thead>
<tr>
<th>Measurement/M</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA</td>
<td>60</td>
<td>1.2357</td>
<td>.45798</td>
<td>.05913</td>
<td>1.1174 - 1.3540</td>
<td>.50</td>
<td>2.50</td>
</tr>
<tr>
<td>CBCT</td>
<td>60</td>
<td>.8223</td>
<td>.56092</td>
<td>.07112</td>
<td>.6800 - .9647</td>
<td>.00</td>
<td>2.37</td>
</tr>
<tr>
<td>Clinical</td>
<td>60</td>
<td>.9108</td>
<td>.31625</td>
<td>.04109</td>
<td>.7266 - .9330</td>
<td>.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
<td>.9563</td>
<td>.49178</td>
<td>.03665</td>
<td>.8839 - 1.0286</td>
<td>.00</td>
<td>2.50</td>
</tr>
</tbody>
</table>
The decision to excavate remaining caries in moderate to deep carious lesions is an everyday challenge for most dental practitioners from students to specialists.

Radiographs the most commonly used mean in determining the remaining dentine thickness has proven to be misleading according to the above investigations, however, CBCT seems to be more promising in providing accurate measurements which may not be the best option due to its less accessibility and higher cost in contrast to digital radiography.

Future advancements and technologies may help to find a more reliable and accessible method in guiding dental specialists in accurately determining the remaining dentin in a both more time and cost-effective manner.

References
15. Centers for Disease Control and Prevention. Guidelines for Infection Control in Dental Health-Care Settings. MMWR 2003; 52 (No. RR17)