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Abstract:

Background: The design of access cavity preparation affects the successive steps of root canal treatment and its outcome. This study aims to evaluate and compare the effect of different types of access cavity designs on the sealing ability of obturation by different techniques.

Material and methods: Seventy-two mandibular premolars having a single canal were taken. These were divided into two main groups, i.e., Traditional endodontic access (TEA) and Contracted endodontic access (CEA) (n = 36) and further divided into three subgroups (n = 12 based on obturation technique, i.e., lateral compaction (LC), thermoplastic (TF) & single cone (SC). A glucose penetration model was used to evaluate the glucose leakage at different time intervals using a spectrophotometer.

Statistical analysis: Data obtained was subjected to SPSS software version 25 and analyzed using the Unpaired t-test.

Results: CEA group showed significantly inferior results when compared with TEA. Significantly more leakage (p<0.05) was observed in the SC technique. When compared with lateral compaction and thermoplastic obturation in both TEA & CEA groups.

Conclusion: The TEA group showed significantly lower glucose leakage as compared to the CEA group. The single cone technique showed the highest glucose leakage when compared with different obturation techniques in both groups.

Keywords: Contracted Endodontic Access, Lateral Compaction, Thermoplastic, Traditional endodontic access.
**Introduction:**

The endodontic access cavity preparation influences all subsequent endodontic treatment steps, which helps shape canals and three-dimensional obturation.\(^1\) TEA provides straight-line access in root canals to increase efficacy in instrumentation and prevent any iatrogenic errors. However, resultant removal of tooth structure in the pulp chamber may undermine the fracture resistance of the tooth under masticatory loads.\(^2\) Therefore, the primary purpose behind the development of Minimally Invasive Endodontics (MIE) was to minimize the removal of sound tooth structure, thereby increasing the tooth’s resistance to fracture.\(^3\)

The aim of obturating the canal is to provide a three-dimensional filling of the root canal and its complexities to prevent the entrance of bacteria and their transfer into the periapical tissues.\(^4\) It has been established that the thermoplastic method of root canal obturation allows the endodontist to achieve a higher gutta-percha to sealer ratio than other techniques. It was observed in a study by Wu et al. that the area of the root canal filled with gutta-percha (GP) was more significant for the warm GP technique than that of the cold GP in oval canals.\(^5\) However, some studies in literature present quite the opposite outcomes.\(^6\) Various methods have been used to assess the sealing efficiency of obturation, viz. dye penetration, radioisotope penetration, bacterial leakage, fluid filtration, and capillary flowmetry.\(^7\)-\(^9\) Xu et al. introduced spectrophotometry for quantifying microleakage in canals based on the filtration rate of glucose along the root canal obturating material.\(^10\)

Minimal literature is available on the effect of CEA on obturation quality. So, our study aimed to evaluate and compare the effect of different types of access cavity designs on the sealing ability of different obturation techniques by glucose leakage model using spectrophotometry.

The null hypothesis to be tested was that the type of endodontic access does not affect the seating efficiency of obturation performed with different obturation techniques.

**Materials and methods:**

Intact, mature, non-carious human mandibular premolars extracted for prosthodontic, orthodontic, and periodontal reasons were gathered. Digital radiographs were taken for all samples to check for the presence of a single canal, measurement of the degree of curvature, and dimensions of the pulp chamber. Teeth with caries, immature root apices, cracks, calcification, resorption, and developmental anomalies were not included in the study.
A sample size of 72 was calculated by using the formulae \( n = \frac{4 \times 132}{12} \). Where \( \sigma^2 \) = variation among the sample observations & 12 = least permissible error, I allowable error. Systematic random sampling technique was used to divide samples into 40 influential groups on the access cavity design.

1) Traditional endodontic access (TEA) (n=36)
2) Contracted endodontic access (CEA) (n=36)

Each group was further subdivided based on obturation technique into 3 sub groups:

a) Lateral compaction (LC) (n=12)
b) Thermo plasticized obturation with calamus dual (TP) (n=12)
c) Single cane obturation (SC) (n=12)

TEA was prepared using endo access bur No. 1 (Dentsply Tulsa Dental Specialties, Oklahoma) mounted on a high-speed handpiece and directed at the right angle to the occlusal surface of the crown. Once the drop was felt, an inside-outside motion was used to deroof the pulp chamber, Final Refinement of the cavity was completed using Endo Z bur (Dentsply Tulsa Dental Specialties, Oklahoma) at slow speed moving outward from the pulp chamber.

CEA was prepared using endo access bur No.1 (Dentsply Tulsa Dental Specialties, Tulsa, Oklahoma) under ex magnification of microscope (Labomed Gurugram, India). Once the drop was felt, the cavity was extended apically, conserving a part of the chamber roof and lingual shelf, ultimately resulting in a slot-like access preparation.

After the access preparations, canal orifices were located with the DG-16 probe. Working length was determined using #10 K file when the file's tip became visible at apical foramen under magnification (10x) under the microscope. Patency of canal and a reproducible glide path is prepared using #10 K file and #15 K file, respectively. ProTaper gold rotary files were used to prepare the canal till F4. 2ml of 5.25% sodium hypochlorite was used to irrigate the canal, and it was agitated using passive sonic activation by Endoactivator lip #30/0.04. Final Irrigation of root canal was done by 17% EDTA and a flush of 2ml of saline.

Group 1(LC) and 2(LC) Lateral compaction; Cold lateral compaction was done by a master gutta-percha cone of #40/0.02 and accessory GP points of smaller sizes using AH Plus sealer. A heated instrument removed the excess GP above the orifice level.
Group 1 (TP) and 2(TP) Thermoplastic obturation: AH PLUS sealer was applied using a lentulo spiral (MANI Inc, Japan). The master cone, F4 gutta-percha, was placed, and the apical tug back was confirmed. The downpack headpiece was activated, and the working end of the Electrically Heated Plugger (EHF) was used to press on this heat vertically softened guile percha at 350°C for 5 sec. The downpack was done till 5 mm of GP was left in the apical third. The backfilling of the canal was started by activating the oalamus flow handpiece by setting the temp to 180°C, and the procedure was continued until the entire canal was filled.

Group 1(SC) and 2(SC) Single cone obturation: Bio C sealer (Angelus, Brazil) was directly injected into the canal with the syringe fitted with disposable tips, Master GP cone was introduced into the canal using up and down motion to full working length, The excess GP above orifice was then seared off using heated plugger.

All specimens were stored in an incubator (Narang Scientific Works, Pvt. Ltd, India) at 37°C and 100% humidity for 24 hours.

The obturated specimens were decoronated at the level of cementoenamel junction. Root specimens were coated with a double layer of nail varnish, leaving the apical third of the root. A spectrophotometer was used to read the absorbance of the specimen at the wavelength of 505 nm at periods of 1, 2, 4, 7, 10, 15, 20, and 30 days respectively.

Statistical Analysis: The data so acquired was subjected to statistical analysis using SPSS version 25. Mean and standard deviations were established, and the Unpaired T-test was used to analyze the level of significance set at <0.05.

Results:
There was an increase in glucose leakage at successive time points for all the groups and subgroups with maximum values on the 30th day (Table 1 & 2). When the TEA & CEA groups were compared, the glucose leakage was significantly more significant for the CEA group than the TEA group. In both the TEA & CEA group, the glucose leakage at 30th day was significantly higher for the single cone group (mean values 4.423±2.259 & 10.118±2.749 respectively for TEA & CEA), when compared to lateral compaction (1.048±0.728 & 5.269±3.412 respectively for TEA & CEA) and thermoplastic obturation (0.963±0.679 &
5.575±1.876 respectively for TEA & CEA). However, the difference between lateral compaction & thermoplastic obturation in both TEA & CEA groups was not significant.

Table — 1 Mean, Standard deviation (S.D.) and Standard error of mean (S.E.M.) of glucose concentration (mg/mL) for lateral compaction, thermoplastic and single cone obturation in Traditional endodontic access at different time-points

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>TIME-POINTS /DAYS</th>
<th>LC (Lateral Compaction)</th>
<th>S.E.M</th>
<th>IP (Thermoplastic)</th>
<th>S.E.M</th>
<th>SC (Single Cone)</th>
<th>S.E.M</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AT DAY-1</td>
<td>0.031±0.057</td>
<td>0.016</td>
<td>0.026±0.047</td>
<td>0.061</td>
<td>0.039±0.232</td>
<td>0.069</td>
<td>0.0874</td>
</tr>
<tr>
<td>2</td>
<td>AT DAY-2</td>
<td>0.122±0.135</td>
<td>0.069</td>
<td>0.106±0.174</td>
<td>0.055</td>
<td>0.305±0.510</td>
<td>0.045</td>
<td>0.0789</td>
</tr>
<tr>
<td>3</td>
<td>AT DAY-4</td>
<td>0.190±0.0132</td>
<td>0.008</td>
<td>0.221±0.199</td>
<td>0.008</td>
<td>0.509±1.265</td>
<td>0.030</td>
<td>0.0006</td>
</tr>
<tr>
<td>4</td>
<td>AT DAY-7</td>
<td>0.478±1.075</td>
<td>0.025</td>
<td>0.274±0.532</td>
<td>0.018</td>
<td>0.800±0.320</td>
<td>0.064</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>AT DAY-10</td>
<td>0.491±0.223</td>
<td>0.023</td>
<td>0.469±0.492</td>
<td>0.064</td>
<td>0.94±1.250</td>
<td>0.086</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>AT DAY-15</td>
<td>0.575±0.334</td>
<td>0.043</td>
<td>0.593±1.046</td>
<td>2.413</td>
<td>1.004±0.620</td>
<td>0.130</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>AT DAY-20</td>
<td>0.671±0.677</td>
<td>0.077</td>
<td>0.675±1.075</td>
<td>0.065</td>
<td>1.890±1.520</td>
<td>0.038</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>AT DAY-30</td>
<td>1.048±0.728</td>
<td>0.193</td>
<td>0.963±0.679</td>
<td>0.105</td>
<td>4.423±2.259</td>
<td>0.156</td>
<td></td>
</tr>
</tbody>
</table>

p value 0.0874 0.0789 0.0006
Discussion:

The eventual goal of RCT is to create a self-healing environment for the lesion to heal itself. MIE emphasizes endodontically treated tooth structure preservation, including pericervical dentin, as sound dentin is more biologically and functionally significant when compared with any restorative material used. Improper sealing of root canals through obturation leads to post-operative complications, failing endodontic therapy. In this study, different obturation techniques were used to determine which technology has the better sealing ability in traditional and contracted endodontic access.

According to the present study's findings, there was glucose leakage evident in all the group's all time periods, which increased with time. However, significantly inferior results were seen for CEA than for the TEA group. Hence the null hypothesis got rejected. This might be justified because the shaping of canals, debridement of canals, accumulated hard tissue debris, irrigation efficacy, etc., are essential factors determining the quality of obturation. Since it has been seen in

<table>
<thead>
<tr>
<th>TIME POINTS/ DAYS</th>
<th>LC (LATERAL COMPACTION)</th>
<th>S.E.M</th>
<th>TP (THERMOPLASTIC)</th>
<th>S.E.M</th>
<th>SC (SINGLE CONE)</th>
<th>S.E.M</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT DAY -1</td>
<td>0.031±0.057</td>
<td>0.301</td>
<td>0.036±0.059</td>
<td>0.315</td>
<td>0.031±0.057</td>
<td>0.154</td>
</tr>
<tr>
<td>AT DAY -2</td>
<td>0.055±0.090</td>
<td>0.336</td>
<td>0.133±0.361</td>
<td>0.320</td>
<td>0.315±0.699</td>
<td>0.378</td>
</tr>
<tr>
<td>AT DAY -4</td>
<td>0.259±0.481</td>
<td>0.062</td>
<td>0.676±1.423</td>
<td>0.082</td>
<td>0.405±0.682</td>
<td>0.081</td>
</tr>
<tr>
<td>AT DAY -7</td>
<td>0.347±1.109</td>
<td>0.01</td>
<td>0.694±1.169</td>
<td>0.162</td>
<td>1.617±2.049</td>
<td>0.163</td>
</tr>
<tr>
<td>AT DAY -10</td>
<td>0.890±0.710</td>
<td>0.067</td>
<td>0.717±0.581</td>
<td>0.083</td>
<td>1.634±0.391</td>
<td>0.365</td>
</tr>
<tr>
<td>AT DAY -15</td>
<td>0.908±0.776</td>
<td>0.220</td>
<td>1.345±0.599</td>
<td>3.327</td>
<td>2.577±1.965</td>
<td>0.439</td>
</tr>
<tr>
<td>AT DAY -20</td>
<td>1.413±0.786</td>
<td>0.064</td>
<td>2.740±8.903</td>
<td>0.074</td>
<td>3.965±1.996</td>
<td>0.093</td>
</tr>
<tr>
<td>AT DAY -30</td>
<td>5.269±3.412</td>
<td>0.228</td>
<td>5.575±1.876</td>
<td>0.208</td>
<td>10.118±2.749</td>
<td>0.653</td>
</tr>
</tbody>
</table>

p-VALUE          0.0005  0.0003  0.0001
various studies that contracted access cavities negatively affect all these factors. Therefore, these could be the reason that the results of the present study showed more glucose leakage in CEA than TEA.

The difference between lateral compaction and thermoplastic obturation in the TEA group was not statistically significant. This study's results followed previous studies, like studies done by Vizgirda et al. & Peng et al., who concluded that obturation quality was similar between lateral compaction and the thermoplastic techniques. However, a statistically significant difference was found when a single cone was compared with lateral compaction and thermoplastic.

Also, when different obturation techniques were compared for the CEA group, the results showed that LC and TP were better techniques than SC when preparing a contracted access cavity. In the available literature, we could not find any study in which different obturation techniques were compared in teeth prepared with CEA design. Hence, the findings of our study cannot be compared with any of the previous studies conducted before.

The present study results follow previous studies that have been done with conventional endodontic access cavities. A study conducted by Sayeed concluded that single cone technique with bioceramic sealer showed the highest apical leakage when compared with cold lateral compaction. This could be explained on the basis that change in surface energy of dentin by EDTA can reduce the wetting ability of bioceramic sealer and thus reduce its adhesion when used with a core material that has dimensional stability such as gutta-percha. In addition to this, another major limitation of the single cone technique is the poor adaptation capability of the master cone to the irregularities of canals, as the more expansive root canal space does not allow a snug fit of the single cone and has a higher potential for the creation of voids. Kyung et al. showed that single cone obturation had more voids than the thermoplastic obturation in the total volume and coronal thirds of the root canal. Also, a study by Park et al. observed that the single cone technique with calcium silicate-based sealers might be more efficient in small round canals than in oval canals, as in the present study, mandibular premolars were used, which have oval root canals. This could be contributing factor for the inferior performance of single cone obturations in this study.

**Conclusion:** Following conclusions were drawn within the limitation of the current study;
1) All the obturation techniques failed to prevent glucose leakage irrespective of the type of access preparation,
2) Traditional endodontic access cavity showed less leakage than the contracted endodontic access cavity for all the three obturation techniques evaluated.
3) In traditional and contracted endodontic access, single cone obturation showed significantly more glucose leakage among the obturation techniques tested. However, no difference was seen between lateral compaction and thermoplastic obturation techniques.

References


