Long Term Rate Of Cementation Failure In Implant Supported Fixed Restoration Luted With Provisional Luting Cements: A Systematic Review

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Citation

Abstract
Statement of the Problem:
Cementation failure is one of the most common complications associated with the long term function of implant supported fixed restorations. However, the rate of failure and longevity of restorations luted with permanent and provisional cements against cementation failure remains unclear.

Aim:
The aim of the systematic review was
1) To evaluate the long term rate of cementation failure in implant supported fixed restoration luted with provisional luting cements.
2) To evaluate the long term effectiveness of permanent luting cements VS provisional luting cements in implant supported fixed restorations against cementation failure

Search Methodology:
Review of literature published up to July 2011 in the PUBMED was conducted to recognize clinical studies involving implant supported fixed restorations. The search methodology followed was a combination of Mesh terms and suitable key words. Thirty-two (32) studies met with the inclusion criteria. Studies were further divided into two categories: 15 short term clinical studies with an observation period of less than 5 years and more and 17 clinical studies with an observation period of 5 years and more.

Results:
For the primary outcome of cementation failure, the data extracted revealed 713 implants were placed in that 400 were single crowns luted with permanent cements. The mean weighted percentage for cementation failure was calculated to be 25.50% more than 5 years. (CI = 95% [21.23-29.73]. Out of 880 implants 319 implants were luted with provisional cements. The mean weighted percentage for cementation failure was 12.66%. (CI = 95% [9.35-15.97] Out of 59 fixed cantilever prosthesis in that result showed cementation failure rate of 5.08% with both permanent and provisional restoration. Out of 488 implants, 212 multiple restorations were placed and luted with permanent cements and mean rated percentage for failure rate was 40.57%. Out of 158 implants, 68 multiple restorations were placed and luted with provisional cements and mean percentage for failure rate was 10.29%.

Conclusion:
This review concluded that there was no difference in longevity of restorations luted with provisional and permanent cements in implant supported fixed restorations over a period of more than five years. Further research involving standardised long time prospective trials and randomized control clinical trials will provide more valuable information to this issue.

INTRODUCTION
Clinical success in implant dentistry is dependant on several factors and it involves meticulous treatment planning and its proper clinical execution. Implant restorations can be
boardly categorised into screw retained or cement retained or combination of both. Various studies4,5 has been discussed the preference of cement Vs screw-retained implant supported fixed restoration in clinical situations. The choice of restoration is fixed implant prostheses with regards to screw and cement retained restoration seems to be mainly on the clinician’s preferences in absence of scientific evidence based information. Screw retained prostheses offers main advantages in form of retrievability and excellent marginal integrity. The disadvantages are needs for an optimal implant positioning and open screw axis hole which could compromise occlusion and stability of veneering material. Further the prosthetic phase is very technique sensitive, involving complex clinical and laboratory procedures which could escalate the cost of implant treatment.

In addition to it, the retaining screws are more prone to lateral and horizontal tipping and elongation forces, which could result in consequent screw loosening or fracture. Thus to overcome this disadvantage of screw retained implant fixed prosthesis, cement retained fixed implant prostheses may be preferred. The advantages offered by cement-retained fixed implant restoration include, relative ease of laboratory procedure, considerable reduction in cost, moderate technique sensitivity and more familiar clinical handling and minimal risk of component fractures. The disadvantages include difficulty in retrievability and additional care to ensure the health of gingival sulci due to extrusion and seepage of cement.

The residual cement can induce soft tissue inflammatory changes resulting is peri-implantitis. To overcome this problem, the use of customized abutment with supragingival margin has been used. Other disadvantage of cement retained restoration is compromised stability in situation where the inter-occlusal space is limited as the abutment without damages and need not be repaired or refabricated after the underlying treatment is completed. However, the long term success rate of provisional cements in terms of longevity is not clearly known. Hence this systematic review was attempted to evaluate the long term rate of cementation failure in implant supported fixed restoration luted with provisional luting cements. Null hypothesis formulated for the review was there is no difference in longevity of restorations luted with provisional and permanent cements in implant supported fixed restorations over a long term period of more than 5 years due to cementation failure.

Structured question:
1) What is the long term rate of cementation failure in implant supported fixed restoration luted with provisional luting cements?
2) Is there a difference in longevity of restorations luted with provisional and permanent cements in implant supported fixed restorations over a period of more than five years?

Aim:
1) The aim of the systematic review to evaluate the long term rate of cementation failure in implant supported fixed restoration luted with provisional luting cements.
2) To evaluate the long term effectiveness of permanent luting cements VS provisional luting cements in implant supported fixed restorations against cementation failure.

PICO Analysis:
P – Population
Patients with implant supported fixed restorations
I – Intervention
Cementing the restoration with provisional luting cement
C – Comparison
Patients with implant supported fixed restoration luted with
permanent luting cements.
O – Outcome
Primary Outcome
Rate of cementation failure
Secondary Outcome
Mode of cementation failure viz adhesive or cohesive
Influence of implant abutment taper contributing to retention and cementation failure in cement retained implant restorations.
Influence of surface preparation of implant abutments contributing to retention in cement retained implant restorations.
Influence of intaglio surface preparation of crowns and restorations contributing to retention in cement retained implant restorations.

MATERIALS AND METHODS

Sources Used:
An electronic search was conducted for NLM PUBMED till July 2011 in articles listed with English language and translation into English language. The search methodology applied was a combination of MESH terms and keywords, “implants, implant abutment, implant supported fixed prosthesis, bridges, implant supported single crown, implant abutment design, cement retained, cement fixation, cement cementation, cement failure, tensile failure, tensile bond strength of luting cement, retention, loss of retention, retention consideration, abutment taper, arc of displacement, crown height, technical complication, mechanical complication, prosthetic complication, retrievability, maintenance and post insertion followup of implant prosthesis.

Review articles as well as reference from different studies were also used to identify the relevant articles.

Selection of studies:
The review process involved two phases. In first phase, selected titles and abstracts were initially screened for relevance and the full text of relevant abstracts were obtained and accessed. The articles that were obtained following screening were segregated and included based on the inclusion and exclusion criteria. The time limit of the conducted search was from 1996 to July 2011.

Inclusion Criteria:
1) Randomized controlled trials with more than 5-year follow-up.
2) Controlled clinical trials involving cement-retained implant fixed prosthesis with more than 5-years follow-up.
3) Retrospective and prospective studies involving cement-retained implant fixed prosthesis over a period of more than 5 years of follow-up.
4) Studies on implant supported fixed dental prosthesis and implant supported single crowns more than 5 years of follow-up.

Exclusion Criteria:
1) Animal studies.
2) Finite element analysis studies.
3) In vitro studies.
4) Case reports and case studies.
5) Clinical studies reporting tooth and implant supported fixed partial denture.
6) Clinical studies reporting only screw retaining restoration.

Figure 1
Flow chart for search strategy
RESULTS

The database search yielded 448 titles. 32 studies passed the first review phase, and 8 studies were finally selected. All the identified studies were published in the past 15 years between 1996 and 2011.

Data Extraction:
Data of the final included studies were tabulated and the following information were extracted: study design applied, mean observation period, number of patients examined, number of implants restored, implant system used and connection type (internal or external), number and design of restorations, type of abutment, type of cement, prosthetic success rate, cement failure rate, mode of failure, implant abutment taper, surface preparation of abutment, and surface preparation of crowns. The observations were statistically analysed.

Long Term Studies:
The literature search revealed seventeen long-term studies with observation periods ranging between 5 and 10 years. Out of 17, 8 studies were selected based on the inclusion and exclusion criteria. The characteristics of included and excluded studies were tabulated and excluded studies were listed on table. The data from the included articles were subjected to statistical analysis using STATA 10 software (STATACORP, Texas, USA) and meta-analysis done and results presented. Forrest plot and Funnel plot were done to analyse and present the data. All studies were either prospective or retrospective studies. In that there were 6 retrospective studies and 2 prospective studies. For the primary outcome of cementation failure, the data extracted revealed 713 implants were placed in that 400 were single crowns luted with permanent cements. The mean weighted percentage for cementation failure was calculated to be 25.50% more than 5 years. ( CI = 95% [21.23-29.73] 
Out of 880 implants, 319 implants were luted with provisional cements. The mean weighted percentage for cementation failure was 12.66%. ( CI = 95% [9.35-15.97]
Out of 59 fixed cantilever prosthesis, in that result showed cementation failure rate of 5.08% with both permanent and provisional restoration.
Out of 488 implants, 212 multiple restorations were placed and luted with permanent cements and mean weighted percentage for failure rate was 40.57%.
Out of 158 implants, 68 multiple restorations were placed and luted with provisional cements and mean percentage for failure rate was 10.29%.
The Forrest plot for single crowns inferred there was no differences in longevity of restorations luted with permanent and provisional cements respectively. The heterogeneity revealed the results of survived publications as inferred from Funnel plot.
The Forrest plot for multiple crowns inferred there was no difference in longevity of restorations luted with permanent and provisional cements respectively. The Funnel plots indicate highly homogenous results.
The Forrest plots for proportion failure for restorations luted with provisional cements indicates there are no differences between permanent and provisional cements. The funnel plot indicate not much heterogeneity was observed.
The Forrest plot for cantilever fixed prosthesis inferred there was no differences in longevity of restorations luted with permanent and provisional cements respectively.

For the secondary outcomes namely, mode of cementation failure viz adhesive or cohesive, influence of implant abutment tapered contributing to retention, cementation failure in cement retained implant restorations, influence of surface preparation of implant abutments contributing to retention in cement retained implant restorations, influence of intaglio surface preparation of crowns and restorations contributing to retention in cement retained implant restorations the literature provided no information.

Tables 1a
General information of selected articles

<table>
<thead>
<tr>
<th>Study</th>
<th>Observation period</th>
<th>No. of Implants</th>
<th>No. of crowns</th>
<th>Type of cements</th>
<th>Mean Failure rate</th>
<th>Mode of failure</th>
<th>Implant abutment taper</th>
<th>Surface preparation of abutment</th>
<th>Surface preparation of crowns</th>
<th>Prosthesis type</th>
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<td>Study A</td>
<td>5 years</td>
<td>500</td>
<td>400</td>
<td>Permanent</td>
<td>25.50%</td>
<td>Adhesive</td>
<td>3.0</td>
<td>Good</td>
<td>Good</td>
<td>Single</td>
</tr>
<tr>
<td>Study B</td>
<td>5 years</td>
<td>400</td>
<td>300</td>
<td>Provisional</td>
<td>12.66%</td>
<td>Cohesive</td>
<td>2.5</td>
<td>Good</td>
<td>Good</td>
<td>Multiple</td>
</tr>
<tr>
<td>Study C</td>
<td>5 years</td>
<td>200</td>
<td>150</td>
<td>Permanent</td>
<td>25.50%</td>
<td>Adhesive</td>
<td>3.0</td>
<td>Good</td>
<td>Good</td>
<td>Fixed Cantilever</td>
</tr>
<tr>
<td>Study D</td>
<td>5 years</td>
<td>200</td>
<td>150</td>
<td>Provisional</td>
<td>12.66%</td>
<td>Cohesive</td>
<td>2.5</td>
<td>Good</td>
<td>Good</td>
<td>Multiple</td>
</tr>
<tr>
<td>Study E</td>
<td>5 years</td>
<td>200</td>
<td>150</td>
<td>Permanent</td>
<td>25.50%</td>
<td>Adhesive</td>
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<td>Good</td>
<td>Good</td>
<td>Single</td>
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<tr>
<td>Study F</td>
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<td>150</td>
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<td>12.66%</td>
<td>Cohesive</td>
<td>2.5</td>
<td>Good</td>
<td>Good</td>
<td>Multiple</td>
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<tr>
<td>Study G</td>
<td>5 years</td>
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<td>150</td>
<td>Permanent</td>
<td>25.50%</td>
<td>Adhesive</td>
<td>3.0</td>
<td>Good</td>
<td>Good</td>
<td>Fixed Cantilever</td>
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<tr>
<td>Study H</td>
<td>5 years</td>
<td>200</td>
<td>150</td>
<td>Provisional</td>
<td>12.66%</td>
<td>Cohesive</td>
<td>2.5</td>
<td>Good</td>
<td>Good</td>
<td>Multiple</td>
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Tables 1b
General information of selected articles
### Tables 1c
General information of selected articles

<table>
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<tr>
<th>STUDY</th>
<th>DESIGN</th>
<th>CEMENT FAILURE RATE</th>
<th>MODE OF FAILURE</th>
<th>IMPLANT ABUTMENT TAPER</th>
<th>SURFACE PREPARATION OF IMPLANT ABUTMENT</th>
<th>SURFACE PREPARATION OF CROWN</th>
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### Table 2
Characteristics table for excluded articles

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<th>STUDY</th>
<th>DESIGN</th>
<th>REASON FOR EXCLUSION</th>
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<td>Table 2</td>
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### Table 3
Evidence level of selected article table

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<tr>
<th>Included long term studies</th>
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<th>Design</th>
<th>Evidence level</th>
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<td>Arsen et al 2010</td>
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<td>Krannus et al 2010</td>
<td>RS1</td>
<td>2</td>
<td></td>
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<tr>
<td>3</td>
<td>Romeo et al 2009</td>
<td>PS</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Heig et al 2008</td>
<td>RS1</td>
<td>2</td>
<td></td>
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<tr>
<td>5</td>
<td>De Boever et al 2006</td>
<td>RS1</td>
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<td>6</td>
<td>Nedir et al 2006</td>
<td>RS1</td>
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<td>7</td>
<td>Bragger et al 2005</td>
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<td>8</td>
<td>Wennstrom et al internal 2005</td>
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<td></td>
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<td>9</td>
<td>Goulet et al 2004</td>
<td>PS</td>
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<td>10</td>
<td>Andersson et al 2003</td>
<td>PS</td>
<td>2</td>
<td></td>
</tr>
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<td>11</td>
<td>Simon 2003</td>
<td>RS1</td>
<td>2</td>
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<td>12</td>
<td>Vigolo 2000</td>
<td>PS</td>
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<tr>
<td>13</td>
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<td>PS</td>
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<td>14</td>
<td>Scholander 1999</td>
<td>RS1</td>
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<tr>
<td>15</td>
<td>Andersson et al 1998</td>
<td>PS</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Schaller et al 1998</td>
<td>McPS</td>
<td>2</td>
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<td>17</td>
<td>Parein et al 1997</td>
<td>RS1</td>
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</tbody>
</table>

**RS1** = Retrospective Study  
**PS** = Prospective Study  
**McPS** = Multicentered Prospective Study

### Table 4
Summation table for cement failure for single crown with permanent cement

<table>
<thead>
<tr>
<th>No</th>
<th>Type of study</th>
<th>Number of implant</th>
<th>Total number of crowns</th>
<th>Failure rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Retrospective study</td>
<td>172</td>
<td>10</td>
<td>20</td>
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<tr>
<td>2</td>
<td>Retrospective study</td>
<td>316</td>
<td>120</td>
<td>31</td>
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<td>3</td>
<td>Retrospective study</td>
<td>126</td>
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<td>23</td>
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<tr>
<td>4</td>
<td>Prospective study</td>
<td>99</td>
<td>74</td>
<td>3</td>
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</tbody>
</table>

**Weighted percentage** 23.33

**CONFIDENCE INTERVAL** 95% CI 21.23 – 29.77
Table 5
Summation table for cement failure for single crown with temporary cement

<table>
<thead>
<tr>
<th>No</th>
<th>Type of studies</th>
<th>Number of implant</th>
<th>Total number of crown</th>
<th>Failure rate</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>Retrospective study</td>
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<td>7</td>
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<tr>
<td>2</td>
<td>Retrospective study</td>
<td>126</td>
<td>126</td>
<td>28</td>
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<tr>
<td>3</td>
<td>Retrospective study</td>
<td>59</td>
<td>97</td>
<td>3</td>
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<td>4</td>
<td>Prospective study</td>
<td>541</td>
<td>112</td>
<td>11</td>
</tr>
</tbody>
</table>

Total weighted percentage: 12.66

Confidence interval: 95% CI 9.35 - 15.97

Table 6
Summation table for cement failure for cantilever fixed prosthesis with permanent and temporary cement

<table>
<thead>
<tr>
<th>No</th>
<th>Type of studies</th>
<th>Number of implant</th>
<th>Total number of crown</th>
<th>Failure rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prospective study</td>
<td>59</td>
<td>59</td>
<td>3</td>
</tr>
</tbody>
</table>

Confidence interval: 95% CI 0.00 - 10.49

Table 7
Summation table for cement failure for multiple crown with permanent cement

<table>
<thead>
<tr>
<th>No</th>
<th>Type of studies</th>
<th>Number of implant</th>
<th>Total number of crown</th>
<th>Failure rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Retrospective study</td>
<td>172</td>
<td>92</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>Retrospective study</td>
<td>316</td>
<td>120</td>
<td>31</td>
</tr>
</tbody>
</table>

Total weighted percentage: 40.57

Confidence interval: 95% CI 33.96 - 47.12

Table 8
Summation table for cement failure for multiple crown with temporary cement

<table>
<thead>
<tr>
<th>No</th>
<th>Type of studies</th>
<th>Number of implant</th>
<th>Total number of crown</th>
<th>Failure rate</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Retrospective study</td>
<td>154</td>
<td>68</td>
<td>7</td>
</tr>
</tbody>
</table>

Confidence interval: 95% CI 3.07 - 17.52

Figure 2
Graph 1: Forrest plot

Heterogeneity chi-squared = 59.45 (d.f. = 5) p = 0.000. Wide heterogeneity is found among the results.

Test of Effect size that is proportion = 0: z = -6.69 p = 0.000.
The overall estimate of the percentage failure is 8% with a 95% confidence interval is 5% to 10%.

Figure 3
Graph 2: Funnel plot

Funnel plot indicates that there is heterogeneity prevailed in the results of surveyed publications. Four of five results fell outside the funnel.
The negative value in the CI of 1998 study should be treated as 0.0.
Heterogeneity chi-squared = 64.95 (d.f. = 3) \( p = 0.000 \).
Heterogeneity of results prevailed in these studies.
Test of Effect size (that is proportion failed is significantly higher than zero) : \( z = 5.06 \) \( p = 0.000 \).
The estimated proportion of failure is 6% with a confidence interval of 4% to 9%.

Funnel plot indicates the heterogeneity of the results in the review considered. Three of four values lie outside the funnel.
Table 9
Permanent Cement

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Year</th>
<th>Total Number</th>
<th>Proportion</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>De boever</td>
<td>2006</td>
<td>72</td>
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<td>2006</td>
<td>55</td>
<td>0.236</td>
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<tr>
<td>Arjan V</td>
<td>2010</td>
<td>121</td>
<td>0.168</td>
<td>0.033988</td>
</tr>
<tr>
<td>Simon RL</td>
<td>2003</td>
<td>126</td>
<td>0.222</td>
<td>0.037604</td>
</tr>
<tr>
<td>Scheller E</td>
<td>1998</td>
<td>74</td>
<td>0.015</td>
<td>0.01413</td>
</tr>
<tr>
<td>Romeo E</td>
<td>2009</td>
<td>29</td>
<td>0.15</td>
<td>0.065306</td>
</tr>
</tbody>
</table>

Table 10
Single Crown – cemented in permanent cement

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Year</th>
<th>Total Number</th>
<th>Proportion</th>
<th>SE</th>
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</thead>
<tbody>
<tr>
<td>De Boever AL</td>
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<td>80</td>
<td>0.365</td>
<td>0.0651826</td>
</tr>
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<td>Arjan V</td>
<td>2010</td>
<td>31</td>
<td>0.168</td>
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</tr>
<tr>
<td>Simon RL</td>
<td>2003</td>
<td>126</td>
<td>0.232</td>
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<tr>
<td>Scheller E</td>
<td>1998</td>
<td>74</td>
<td>0.015</td>
<td>0.01413</td>
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</tbody>
</table>

Table 11
Multiple Crowns – cemented in permanent cement

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Year</th>
<th>Total Number</th>
<th>Proportion</th>
<th>SE</th>
</tr>
</thead>
<tbody>
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<td>Arjan V</td>
<td>2010</td>
<td>65</td>
<td>0.168</td>
<td>0.0646372</td>
</tr>
</tbody>
</table>

Figure 8
Graph 7: Temporary Cements

Figure 9
Graph 8: Funnel Plot

Only one estimate fell outside the funnel, indicating that not much heterogeneity was found in these studies.

Literature revealed that Seven studies were carried out in a similar way. But due to lack of number of failures in two studies they were not considered for analysis. Proportion of failure in two studies were below the overall estimates. The estimated proportions of failures of two studies were below the overall average. And in one study the, 95% C I was below zero. The overall estimate is 0.10 (0.07 -0.13). Read all negative lower 95% C I values as “zero” Out of 7 studies two were found with zero failures. The system ignored them.

Table 12
Various studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Year of study</th>
<th>Number studied</th>
<th>Proportion failed</th>
<th>SE</th>
<th>95% C I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheller E</td>
<td>1998</td>
<td>82</td>
<td>0.14</td>
<td>0.07</td>
<td>(0.003 0.277)</td>
</tr>
<tr>
<td>Vigolo P</td>
<td>2006</td>
<td>52</td>
<td>0.13</td>
<td>0.05</td>
<td>(0.012 0.228)</td>
</tr>
<tr>
<td>Simon</td>
<td>2003</td>
<td>126</td>
<td>0.22</td>
<td>0.04</td>
<td>(0.142 0.298)</td>
</tr>
<tr>
<td>Romeo E</td>
<td>2009</td>
<td>74</td>
<td>0.015</td>
<td>0.01413</td>
<td></td>
</tr>
<tr>
<td>Keenanair et al</td>
<td>2010</td>
<td>180</td>
<td>0.09</td>
<td>0.05</td>
<td>(0.051 0.129)</td>
</tr>
</tbody>
</table>

Posted estimates

0.103(0.075 0.131)
Long Term Rate Of Cementation Failure In Implant Supported Fixed Restoration Luted With Provisional Luting Cements: A Systematic Review

Figure 10
Graph 9: Pie Chart - Cement failure for single crown with permanent cement

Figure 11
GRAPH 10: Pie Chart - Cement Failure For Single Crown With Temporary Cement

Figure 12
GRAPH 11: Pie Chart - Cement Failure For Cantilever Fixed Prosthesis With Permanent And Temporary Cement

Figure 13
Figure 13
GRAPH 12: Pie Chart - Cement Failure For Multiple Crown With Permanent Cement

Figure 14
Graph 13: Pie Chart - cement failure for multiple crown with temporary cement
Figure 15
Graph 14: Cementation failure of restorations with permanent and provisional cements

Figure 16
Graph 15: Types and number of studies in each crown with both permanent and provisional cements

DISCUSSION
The null hypothesis formulated for the review was there is no difference in longevity of restorations luted with provisional and permanent cements in implant supported fixed restorations over a long term period of more than 5 years due to cementation failure. The results of the present systematic review supported the null hypothesis.

Parein AM. Eckert 1in their long term retrospective study involving implant reconstruction in posterior mandible reported less complications in cement retained single tooth restoration compared with screw retained single tooth restoration. De boever AL et al2 reported 36% of cemented restoration required recementation, whereas 38% of screw retained restoration required retightening. Duncal JP et al3 reported no cementation failures of the restoration in a prospective clinical trial of single stage implant at 36 months. Jebren SE et al4 reported decementation of restoration to be 2.13% in a multicentered retrospective study of ITI implant supported posterior partial prosthesis. Levine RA et al5 concluded that 98.2% of cemented restoration were free of complications in a multicentered retrospective analysis of solid screw ITI implants for posterior single tooth replacement. Wannfors K et al6 reported few prosthetic complication were observed with cemented all ceramic constructions in a prospective clinical evaluation of different single tooth restoration designs on osseo-integrated implants. Sailer et al7 reported no biological problems associated with cement retained zirconium and titanium abutments in randomized control trial of customized zirconia and titanium implant abutments.
for canine and posterior single tooth implant reconstruction. Krennmair G8 reported 9.9% of re-cementation in cement retained restorations in there retrospective clinical analysis of 146 implants with single tooth replacement. Mcmillan AS et al9 reported 3.9% of single tooth restoration required re-cementations in their retrospective multicentered evaluation of single tooth implants.

Breeding LC et al10 as reported when removal of the provisionally cemented superstructure from a cemented abutment becomes necessary, the retentive strengths of the abutment/fixture and superstructure/abutment luting agents become important considerations. Pan YH et al11 reported few data exist regarding cement failure load and marginal leakage of castings cemented to implant-supported abutments subjected to load and thermal cycling, especially with newer cements. Covey DA12 reported Permanent luting cement produced uniaxial retention forces approximately 3 times greater than provisional cement. The increase in surface area provided by a wide abutment did not result in an improvement in retention strength over the standard abutment. Mansour A et al13 reported the retention values of castings cemented to ITI solid abutments have not been reported in the literature. Within the limitations of their in vitro study, the results do not suggest that one cement type is better than another, but they do provide a ranking order of the cements in their ability to retain the castings. This ranking is somehow different than that obtained when the same cements are used on natural teeth. The material and surface characteristics of the implant abutment are likely responsible for this difference. Cement retentive values obtained from studies that use teeth as abutments may be misleading when used in cement-retained implant-supported crowns and it was It is at the clinician's discretion to use a certain type of cement, based on the situation at hand. Pan YH et al14 also reported luting agents designated by the manufacturer as provisional cements demonstrated lower resistance to removal, regardless of material type. Luting agents described by manufacturers as "permanent" differed in resistance, with resin cements being most resistant, followed by zinc phosphate and polycarboxylate cements. Provisional cements demonstrated leakage comparable to higher-strength materials.

For the primary outcome of cementation failure, the data extracted revealed, 713 implants were placed in that 400 were single crowns luted with permanent cements. The mean weighted for cementation failure percentage was calculated to be 25.50% more than 5 years. ( CI = 95% [21.23-29.73].

Out of 880 implants 319 implants were luted with provisional cements. The mean weight percentage for cementation failure was 12.66%. ( CI = 95% [9.35-15.97]

Out of 59 fixed cantilever prosthesis in that result showed cementation failure rate of 5.08% with both permanent and provisional restoration. Out of 488 implants, 212 multiple restorations were placed and luted with permanent cements and mean rated percentage for failure rate was 40.57%. Out of 158 implants, 68 multiple restorations were placed and luted with provisional cements and mean percentage for failure rate was 10.29%. Meta-analysis inferred there is no difference in longevity of restorations luted with provisional and permanent cements in implant supported fixed restorations over a long term period of more than 5 years due to cementation failure.

The ideal requirement of luting cements are that they should be strong enough to retain the restoration and also allow easy removal if required. The commonly used cements identified from the studies were zinc phosphate, glass ionomer and resin cements as permanent cements and zinc oxide and IRM as provisional cements. Zinc phosphate cement tends to reduce loss of retention significantly and also permits reasonable needs during removal. As zinc oxide eugenol cement does not adhere strongly to metallic surface of the implant abutment as compared to zinc polycarboxylate cement, glass- ionomer cement and resin cements. The provisional cement ensure easily retrievability of restoration when required clinically. Hence it is probable that provisional cement may be considered as permanent cement for implant supported single crown restoration. The clinician should carefully consider the choice of luting cement by evaluating the surface area taper of abutment, degree of abutment, type and nature of luting cements, interocclusal spaces and occlusal consideration. Several factors should be carefully evaluated and considered while preferring cement retained restorations. The various factors in this assessment involved number of implants are position, occlusion, cost of pre fabricating a restoration and possible complications. The principle of progressive cementation can also be advocated, thereby stronger cements are progressively used until adequate retention is achieved. Further more, the retrievability of the restoration could be most possibly maintained by implicating modification in the design of the restoration for easy removal without damaging
the cement super structure. The luting cement used in such restoration exhibit variability in compressive and tensile strength, varying levels of dissolution in salivary and gingival crevicular fluid, unpredictable soft tissue response and thus contributes a very important role in determining the success of implant therapy. The luting cements are categorised into provisional and permanent types based on their longevity, compressive and tensile strength and ability to resist dissolution by the intra oral fluids and precise indication and contra indication for their usage remains unclear. Under function with prolonged time intervals, a few biological and mechanical complications are observed which include peri-implantitis, perforation of the restoration and partial or total chipping of veneering material. These could warrant retrieval of restorations for examination and repair and retreatment. Retrieval of restorations is often accompanied by unexpected chipping of ceramic and damage to the margin of the restoration especially when multiple units and long span prosthesis are involved. In lieu of above mentioned difficulties the clinicians preferred to use provisional luting cements for the same. Provisional cements offer easy handling and retrievability, fairly reduces chair side working time, minimizes patient and clinician discomfort during retrieval procedure and very considerable minimisation of expenditure to the patient as the restoration can be removed without damages and need not be repaired or refabricated after the underlying treatment is completed.

Implant supported fixed restoration can be of single crowns and cantilever, short span and long span fixed partial dentures. In implant supported restorations, the abutment is metal or ceramic unlike a natural teeth in conventional bridges. The occlusal scheme for implant supported restorations follows the implant protected lingualised occlusal scheme. The role of luting agents for implant supported fixed restorations is purely mechanical unlike chemical adhesion exhibited by glass ionomer cements over natural teeth. Hence there appears to be no marked priority between the provisional and permanent cements used for luting implant restorations. The predominant difference between provisional and permanent luting cements is by virtue of better compressive strength offered by the permanent cements. However the cementation failure is predominantly a tensile in nature, thus superiority claimed by permanent cements by virtue of compressive strength may not be applicable in implant retained fixed restorations where the forces of occlusion is greatly modified through implant protected occlusal scheme provided. This could possibly explain the inference drawn by the meta-analysis where no significant difference in cementation failure rate observed between provisional and permanent luting cements in implant supported fixed restorations.

The cementation failure can be either adhesive or cohesive in nature. Adhesive failure can occur at intaglio crown surface and cement interface or adhesive failure between implant abutments and cement interface. The literature provided no information on the mode of cementation failure. Implant abutment taper could be another important factor influencing cementation failure. The normal recommended taper is 6 degrees whereas implant abutment has exaggerated taper of 16 to 20 degrees which could alter the retentive ability of luting cements. The data regarding implant abutment taper is very obscurely stated in literature. Another important factor influencing failure is surface preparation in implant abutments. Implant abutments have mechanical grooves, vertical and horizontal provided by manufacturers. In additions to these implant abutment can be acid etched and sand blasted to provide more retention. The literature provided no information on the same. The intaglio preparation of crowns and restorations influence cementation failure. The intaglio surface can be sand blasted, adhesive coupling agents can be used to minimize the adhesive cementation failure. The literature provided no information on the same.

The limitations of the review include restriction of the search with English language only. Total homogeneity was not observed in this studies chosen for meta-analysis. Further research involving standardized long term prospective trials and randomized controlled clinical trials will provide valuable information to this issue.

**CONCLUSION**

Within the limitations of this review, the long term cementation failure rates for implant supported fixed restorations luted provisional cements were 12.66% for single crowns, 5.08% for cantilever crowns, 10.29% for multiple crowns. There are no differences in longevity of restorations luted with provisional and permanent cements in implant supported fixed restorations over a period of more than five years. Further research involving standardised prospective and randomized clinical trials will provide more valuable information to this issue.

**References**

[1] Parein AM, Eckert SE, Wollan PC, Keller EE. Implant


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