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# A SURVEY ON THE CURRENT PRACTICE IN THE USE OF LUTING AGENTS FOR ZIRCONIA RESTORATIONS BY GENERAL DENTISTS

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**ABSTRACT**

**Aim:** The aim of the survey conducted was to evaluate the current practice in the use of luting agents for zirconia restorations by general dentists.

**Materials and methods:** The survey questionnaire consisted of 14 questions aimed towards evaluating the current practice in the use of luting agents for zirconia restorations by general dentists. This questionnaire was validated by a panel of senior prosthodontists and was sent to 1000 dental practitioners in Mumbai and Navi Mumbai.

**Results and conclusion:** Within limitations of the present study, it can be concluded that, zirconia crowns are being increasingly used by dental practitioners and most practitioners advocate monolithic zirconia. Majority practitioners use glass ionomer cement for luting zirconia crowns. Most dental practitioners believed that zirconia crowns did not require to be etched. Most, however, also believed that zirconia did not need surface treatment. Sand blasting was suggested as the preferred surface treatment to the laboratory by a greater percentage of the dental practitioners surveyed. Most practitioners rarely encountered debonding of zirconia crowns and debonding was observed greatest when luted with zinc phosphate cement. The surface from which debonding of zirconia crowns occurred was not observed by the majority of the practitioners who participated in the survey.

**Clinical significance:** The results of the present study will serve as a guide to the clinicians for the appropriate selection of the luting agent and surface treatment of zirconia restorations, which will in turn help to increase the clinical performance of the zirconia restorations.



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## INTRODUCTION

A growing number of new restorative materials are being introduced to meet the increasing popularity of esthetic dentistry. Metal-ceramic prostheses are considered as the gold standard in dentistry and their long-term structural performance is well documented. The growing demand for metal-free tooth-colored prostheses led to development of ceramics with increased strength and reliability.[i] New dental ceramic materials such as glass ceramics, poly-crystalline alumina, and zirconia-based ceramics along with new CAD/CAM processing technology (computer-assisted design/ computer-assisted manufacturing) have been successfully introduced in the past decade.[ii] In the late 1990s, Yttria partially stabilized tetragonal zirconia (Y-TZP) was first introduced to dentistry.

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The prosthesis was composed of a zirconia core in the substructure veneered by feldspathic porcelain in the superstructure. The most common complication encountered was a high incidence of veneer chipping with an incidence of 2% -9% for single crowns after 2-3 years and 3%- 36% for fixed partial dentures after 1-5 years. Thus, to avoid veneering failure full-contour zirconia restoration or monolithic zirconia was developed. Since it had a high fracture resistance, it could be used in load-bearing areas without the problem of chipping that was encountered with the layered zirconia.[iii] Conventional ceramics are rich in the glass phase. Their basic components are silica ($SiO_2$) and potash feldspar ($K_2O$, $Al_2O_3$, $6SiO_2$) and/or soda feldspar ($Na_2O$, $Al_2O_3$, $6SiO_2$). Bonding to resin cements is by mechanical and chemical means and they show high bond strength. Sandblasting of the ceramic with aluminum oxide particles and conditioning with hydrofluoric acid are the mechanical ways to increase the bond strength. Hydrofluoric acid interacts with the silica phase of the

feldspathic ceramics to form hex fluorosilicate salt. This is removed by water spray to expose crystals at the surface of the ceramic. These micropores create areas for infiltration of the resin cement. Chemical bonding is provided by application of silanes. A silane is a bifunctional molecule containing two different reactive functional groups: the inorganic radical and the organfunctional radical. It reacts with the inorganic particles of ceramics through the inorganic radical and co-polymerizing with the resin cement through the organofunctional radical.[iv] Compared to silica-based ceramic material, bonding of zirconia to tooth or other substrates is difficult. Absence of silica in the zirconia microstructure does not allow the bonding mechanisms used on glass-ceramics to be used with zirconia. Thus, mechanical bonding by roughening of the surface with the use of an etchant and the use of silanes for developing a chemical bond cannot be used with zirconia.[v] Different approaches like surface abrasion or roughening, application of tribochemical silica coating, vapor phase deposition technique, chloro- silane treatment, selective infiltration technique, nanostructured alumina coating, laser application, zirconia ceramic powder coating, gas- phase fluorination process; have been used to roughen the surface, activate it for bonding and free it of contaminants. To achieve durable bond values, application of phosphate ester primers and phosphate modified resin cements in combination with mechanical pre- treatments has also been suggested.[v] This survey will help us gather information on the current trend followed by the dental practitioners in the preferred choice of surface treatment and the luting agent advocated for luting of zirconia crowns. We will also gather insight on the performance of these restorations through the clinical experience of the dental practitioners surveyed.

## MATERIALS AND METHODS

A survey was conducted among the dental practitioners of Mumbai and Navi Mumbai. This survey was approved by the Research Committee and Institutional Ethics Committee. The survey questionnaire consisted of 14 questions aimed toward evaluating the current practice in the use of luting agents for zirconia restorations by general dentists. This questionnaire was validated by a panel of experts and was sent to 1000 dental practitioners of Mumbai and Navi Mumbai in the form of a printed form. The forms were received and the results were analyzed.

**Survey Form**

**A survey on the current practice in the use of luting agents for zirconia restorations by general dentists**

1. In your practice, which type of restorations do you advocate?

a) Ceramo-metal crowns
b) Lithium disilicate crowns
c) Zirconia crowns
d) All

2. What is the percentage of Zirconia crowns in your practice?

a) Less than 10%
b) More than 10%

3. Which type of zirconia do you advocate?

a) Monolithic Zirconia
b) Layered Zirconia

4. Which luting agent do you use for ceramo-metal crowns?

a) Zinc phosphate
b) Glass ionomer cement
c) Resin modified glass ionomer cement
d) Resin cement: self cure with etch and bond
e) Resin cement: dual cure with etch and bond
f) Resin cements: self- etch

5. Which luting agent do you use for lithium disilicate crowns?

a) Zinc phosphate
b) Glass ionomer cement
c) Resin modified glass ionomer cement
d) Resin cement: self cure with etch and bond
e) Resin cement: dual cure with etch and bond
f) Resin cements: self- etch

6. Which luting agent do you use for zirconia crowns?

a) Zinc phosphate
b) Glass ionomer cement
c) Resin modified glass ionomer cement
d) Resin cement: self cure with etch and bond
e) Resin cement: dual cure with etch and bond
f) Resin cements: self- etch

7. Does your laboratory etch lithium disilicate prior to sending it to the clinic?

a) Yes
b) No

8. Do you chair-side etch lithium disilicate?

a) Yes
b) No

9. Does zirconia need to be etched by the laboratory/ chair-side?

a) Yes
b) No

10. Does zirconia crown need surface treatment?

a) Yes
b) No

11. Which of the following surface treatment would you suggest to your lab?

a) Sand blasting
b) Rocatec
c) Silanization
d) Laser

12. Have you encountered debonding of zirconia crowns from the tooth surface?

a) Frequently
b) Rarely
c) Never

13. Debonding was observed when luted with which of the following luting agents?

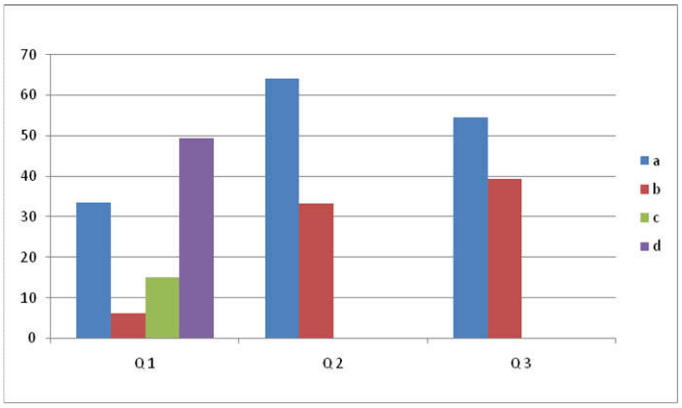
a) Zinc phosphate
b) Glass ionomer cement
c) Resin modified glass ionomer cement
d) Resin cement: self cure with etch and bond
e) Resin cement: dual cure with etch and bond
f) Resin cements: self- etch

14. Debonding was observed from which surface?

a) From the tooth surface and luting agent
b) Zirconia surface and the luting agent
c) Within the luting agent
d) Not observed.

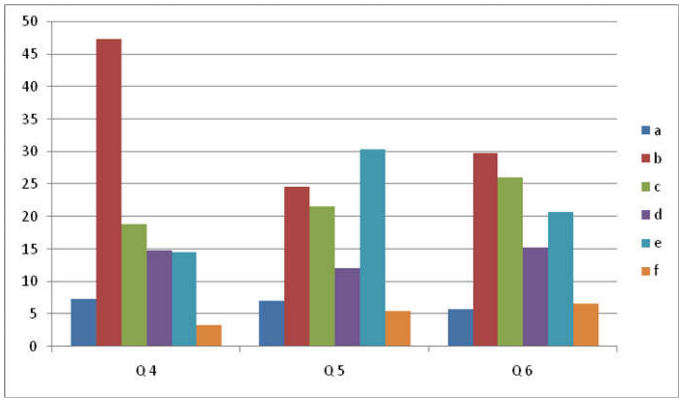
## RESULTS

Questionnaires were sent to 1000 dental practitioners, of which 730 responded. Frequencies and percentages of all the questions and answers were calculated. The results of this study showed that 49.58% practitioners advocated ceramo-metal, zirconia and lithium disilicate crowns in their practice, 33.69% advocated ceramo-metal crowns, 15.06% advocated zirconia crowns and 6.3% advocated lithium disilicate crowns in their practice. The percentage of zirconia crowns in their practice was less than 10% for 64.10% practitioners. Out of the practitioners who used zirconia, 54.52% advocated monolithic zirconia and 39.45% advocated layered zirconia (Graph 1).



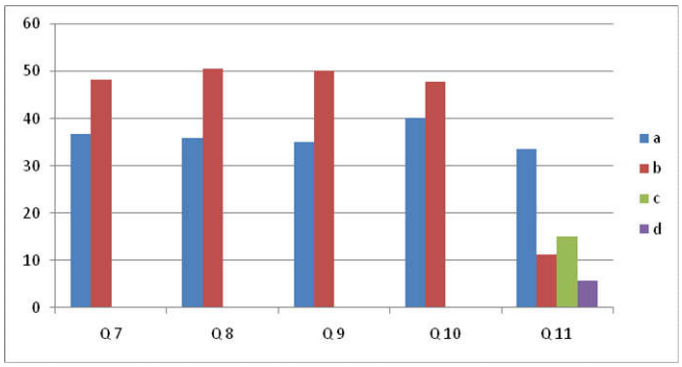

**Graph 1. Q1 to Q3**

For luting ceramo- metal crowns, it was observed that 47.39% practitioners use glass ionomer cement, 18.90% use resin modified glass ionomer cement, 14.79% use resin cement: self cure with etch and bond, 14.52% use resin cement: dual cure with etch and bond, 7.39% use zinc phosphate, 3.28% use resin cement: self etch and bond. For luting lithium disilicate crowns, 30.41% practitioners use resin cement: dual cure with etch and bond, 24.65% use glass ionomer, 21.64% use resin modified glass ionomer cement, 12.05% use resin cement: self cure with etch and bond, 7.12% use zinc phosphate, 5.47% use resin cement: self etch and bond. For luting zirconia crowns, the results of the survey showed that 29.86% practitioners use glass ionomer cement, 26.02% use resin modified glass ionomer cement, 20.82% use resin cement: dual cure with etch and bond, 15.34% use resin cement: self cure with etch and bond, 6.57% use resin cement: self etch and bond, 5.75% use zinc phosphate (Graph 2).



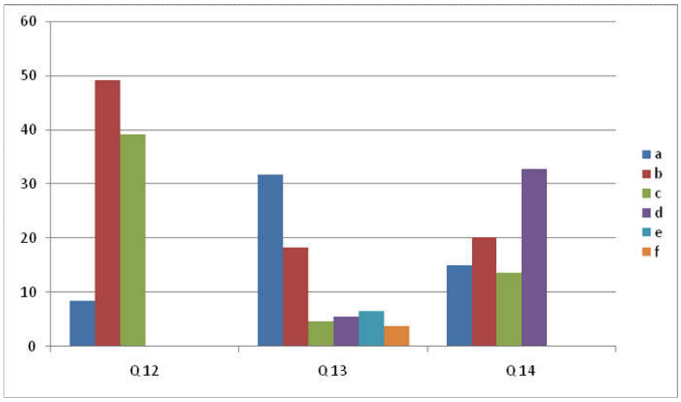

**Graph 2. Q4 to Q6**

It was observed from the survey that 48.21% practitioners did not receive lithium disilicate crowns that were etched by the laboratory, 36.71% practitioners received etched lithium disilicate crowns from the laboratory, 12.87% did not answer the question. Chair side etching of lithium disilicate crowns was not done by 50.68% practitioners, 35.89% practitioners chair side etched the lithium disilicate crowns, 11.50% did not answer the question. The results of the survey show that 50.13% practitioners answered that etching of zirconia crowns was not required, 35.06% practitioners answered that zirconia crowns required etching, 13.15% did not answer the question. It was observed that 47.94% practitioners were of the view that zirconia did not need surface treatment, 40.27% were of the view zirconia needed some form of surface treatment, 9.8% did not answer the question. The preferred surface treatment suggested to the laboratory was sand blasting as suggested by 33.69%, 15.06% suggested silanization, 11.23% suggested rocatec, and 5.75% suggested laser treatment as (Graph 3).




**Graph 3. Q7 to Q11**

Debonding of zirconia crowns was rarely encountered by 49.31%, 39.17% never encountered debonding of zirconia crowns, 8.49% practitioners frequently encountered debonding of zirconia crowns. Debonding was observed when luted with zinc phosphate cement by 31.78%, 27.94 left the question unanswered, 18.35% with glass ionomer cement, 6.57% with resin cement: dual cure with etch and bond, 5.47% with resin cement: self cure with etch and bond, 4.65% with resin modified glass ionomer cement, and 3.83% with resin cement: self etch and bond. The surface from which debonding of zirconia crowns occurred was not observed by 32.87%, 20.27% observed debonding between the zirconia surface and luting agent, 16.16% left the question unanswered. 15.06% observed debonding between the tooth surface and luting agent, 13.69% observed debonding within the luting agent (Graph 4).




**Graph 4. Q12 to Q14**

## DISCUSSION

The use of zirconia restorations by dental practitioners has been on a rise in the recent years. This survey found that 15.06% practitioners advocated zirconia crowns in their practice and 64.10% practitioners had less than 10% zirconia crowns in their practice. To improve esthetics, opaque zirconia is layered with a more translucent feldspathic ceramic. However the core–veneer interface is one of the weakest aspects of these restorations leading to chipping of the layered ceramic.[vi] Several factors have been implicated to cause chipping of the layered ceramic.[i,vii] Full-contour or monolithic zirconia restoration was developed to overcome this problem. In the present study, a majority of the practitioners advocated monolithic zirconia. Cements used for cementation of porcelain fused to metal crowns should be able to retain crowns without difficulty during normal service. However, the crowns may wear out, break, become esthetically or functionally unacceptable and may have to be removed. Cements should not be so strong that crowns cannot be removed or removal is difficult and time consuming. Other desirable characteristics include ease of use, strength, insolubility in mouth fluids, no postoperative sensitivity and bonding to the tooth and/or core substrates. Resin modified glass ionomer (RMGI) cements fulfill these characteristics better than other cements and are stronger than conventional zinc phosphate, glass ionomer and polycarboxylate cements.[viii] However, this study shows that most practitioners use glass ionomer cement for luting ceramo- metal crowns.

The use of an adhesive technique increases not only the retention, but also the survival rates and is strongly recommended for all types of glass ceramics, including lithium disilicate material. Because of their ability to bond to different substrates, insolubility in the oral cavity, high mechanical resistance, and availability in various dentinal shades, resin cements represent the ideal choice for all types of metal-free restorations, including non-etchable core materials. Dual cure resin cements covers most of the clinical indications.[vi,ix] Most practitioners surveyed in this study, preferred resin cement: dual cure with etch and bond for luting lithium disilicate crowns. When placing indirect ceramic restorations, optimal surface preparation techniques for chemical and/or mechanical bonding to ceramic substrates are necessary to ensure clinical success.[x] Chair-side etching of lithium disilicate restorations with hydrofluoric acid followed by application of a silane coupling agent should be carried out to increase covalent bond formation at the ceramic-resin interface and improve the wetting of the ceramic surface by the resin cement. Simultaneously, the tooth surface is etched, primed and a resin bonding agent is applied. The resin cement is finally applied.[ix] The results of this study showed that a maximum of the practitioners answered that the laboratory did not etch the lithium disilicate crowns prior to sending it to their clinics and that they did not chair side etch the lithium disilicate crowns. The mechanical and chemical bonding methods used on glass ceramics cannot be used with zirconia because of the absence of silica in the zirconia microstructure. Thus, mechanical bonding brought about by etching and chemical bonding facilitated by the use of silanes for lithium disilicate are not applicable with zirconia.[v] Most practitioners who participated in the survey answered that zirconia crowns did not require etching. A different approach is required to bond zirconia restorations using resin-based adhesives and luting cements.[x] Several techniques have been suggested for the surface treatment of zirconia restorations with a view to improve their bond strength. These include sandblasting, silanisation, rocatec and laser application among others. Surface abrasion or roughening utilises 50-110 µm alumina particles at 0.25 MPa for roughening and cleaning the bonding surface of zirconia. It enhances adhesion through micro-mechanical retention. However, it has been reported that it makes zirconia more susceptible to radial cracking during function due to creation of sharp crack tips and structural defects.[v] Rocatec makes use of 30 µm silica–coated aluminum oxide particles. Silica particles get embedded in the ceramic surface creating a base for micromechanical bonding and interlocking in ceramic. This is followed by application of silane. Miyazaki T et all[ii] reported that combined application of silica coating, silane, and methacryloyloxydecyl dihydrogen phosphate (MDP) is currently one of the most reliable bonding systems for zirconia. For luting of zirconia crowns, a greater number of practitioners used glass ionomer cement and believed that zirconia did not need any form of surface treatment.

The manufacturer's recommendation of the optimal surface treatment for the internal surface of zirconia and the resin cements compatible with the specific brand they use must be followed as there is no specific surface treatment protocol to optimize zirconia bonding.[xi] In the current study, most practitioners suggested sand blasting as the preferred surface treatment. Establishing a strong bond with zirconia and maintaining this bond under the influence of fatigue conditions, in presence of saliva, and temperature changes for a clinically acceptable time is essential. A study by Aboushelib MN et all[xii] evaluated the chemical stability of the zirconia resin bond strength. They concluded that the zirconia–resin interface was the weakest link in the structure. Such a finding could be related to two important factors. The first factor is the hydrolytic effect of water on the adhesive joints and the second factor is the water inhibition phenomenon that could lead to thickening of the cement layer leading to disruption of the established bond. A majority of the practitioners surveyed rarely encountered debonding of zirconia crowns. Those few who encountered debonding, observed it when luted with zinc phosphate cement. The luting agent left on both the zirconia crown and tooth surface was not observed by most dentists when zirconia crowns were dislodged due to luting failure.

### Conclusion

Within limitations of the present survey, it can be concluded that:

- Zirconia crowns are being increasingly used by dental practitioners and most practitioners advocate monolithic zirconia
- Majority practitioners use glass ionomer cement for luting zirconia crowns.
- Most dental practitioners believed that zirconia crowns were not required to be etched and did not need any form of surface treatment.
- Those who believed in surface treatment suggested sand blasting as the preferred surface treatment to the laboratory.
- Most practitioners rarely encountered debonding of zirconia crowns. When debonding was observed, it was greatest when zinc phosphate cement was used as the luting agent. When zirconia crowns were dislodged due to luting failure, the luting agent left on both the zirconia crown and tooth surface was not observed.

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**Summary**

The survey carried out to analyse the current trends in the use of zirconia as a restoration, their surface modifications, selection of luting agents and clinical performance of the zirconia restorations showed that monolithic zirconia has become a popular choice amongst dental practitioners. However, practitioners are not aware of the surface treatments needed for the success of the restoration and also the correct choice of the luting agent for the specific restoration. The practitioners need to be enlightened on the utilisation of zirconia as a restorative material as regards to their luting and surface modifications.

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