Charles University in Prague
Faculty of Medicine in Hradec Králové
Department of Dentistry

ABSOLUTE MARGINAL DISCREPANCY OF PROCERA® ALLCERAM INCISOR AND MOLAR CROWN COPINGS

SHRIHARSHA PILATHADKA, B.D.S.

Ph.D. Thesis in Dentistry

Hradec Králové, 2008

This dissertation thesis has been done to obtain the Ph.D. degree at the Department of Dentistry, Faculty of Medicine in Hradec Králové, Charles University in Prague, Czech Republic.

Candidate: Shriharsha Pilathadka, B.D.S.
Department of Dentistry
Faculty of Medicine in Hradec Králové
Charles University in Prague

Academic advisor: Assoc. Prof. Radovan Slezák, M.D., Ph.D.
Department of Dentistry
Faculty of Medicine in Hradec Králové
Charles University in Prague

Opponents:

MUDr. Josef Vacek, CSc.
Stomatologická klinika 1. lékařské fakulty Univerzity Karlovy a Všeobecné fakultní nemocnice, Praha

doc. MUDr. Hana Hubálková, Ph.D.
Stomatologická klinika 1. lékařské fakulty Univerzity Karlovy a Všeobecné fakultní nemocnice, Praha

The research was conceived and results of the dissertation work were achieved at the Department of Dentistry, Faculty of Medicine in Hradec Králové, Charles University in Prague, Czech Republic.

Original dissertation thesis will be available for reference at the chairperson of the Committee for defending the dissertation thesis at the Department of Dentistry, Faculty of Medicine, Sokolská 581, 500 05 Hradec Králové, Czech Republic.

Assoc. Prof. Radovan Slezák, M.D., Ph.D.
Chair of the commission for the defence of doctoral dissertations
at the Department of Dentistry

TABLE OF CONTENTS

1 INTRODUCTION

The most common dental treatment that the patients seek in prosthetic dentistry is crown or fixed partial denture. Recent materials, technical and clinical innovation in ceramic materials have increased the complexity of material selection and treatment planning. Metalo-ceramic restorations represent the most popular and successful treatment modality. Long-term clinical studies have proved that metalo-ceramic restorations are durable and long lasting (18). Although, metalo-ceramic restorations had some limitation of satisfying the optical properties of the natural teeth, and few patients reported an allergic reaction, hypersensitivity to the base metal alloys used in ceramo-metal crowns (14). Recent research work on material technology and manufacturing of ceramics provided more aesthetic, biocompatible, and high strength all-ceramic restorations. The modern and novel method of CAD/CAM based restoration production provided the more realistic alternative to metalo-ceramic restorations.

The quest for all-ceramic materials with properties that would enable their use in stress bearing area has led to the development of many new materials and processing techniques. In 1965, McLean *et al.* (11) suggested the usage of aluminum oxide to strengthen feldspathic ceramic, which marked the beginning of use of oxide based ceramic. The strongest and toughest oxide ceramics used today are based on aluminum oxide (alumina), and recent being zirconium dioxide (4). Andersson and Oden introduced CAD/CAM based aluminum oxide restoration Procera® AllCeram crowns and bridges in 1993 [Procera, Nobel Biocare AB, Goteborg, Sweden] (1) by using 99.5% purity aluminum oxide.

The three primary criteria for selection of restorative materials for crown and bridge restorations are marginal fit, strength and aesthetics. This also decides the clinical longevity of the all-ceramic materials (9). Today, dentists can choose from a variety of all-ceramic materials as sub-structure for crown and bridge restorations to satisfy the aesthetic and functional demand of the patient. Success rate of the recent materials in anterior and posterior teeth are promising. CAD/CAM produced aluminum oxide restoration, Procera® AllCeram crowns and bridges are being used since 12 years. Published long-term results are promising (21).

The marginal gap of restorations is very critical for the long-term survival of the full coverage restorations (12). If the restoration has wider gap at the margin area the luting agents are exposed to the oral fluids and dissolution of luting cement ensues. This sets in the microleakage under the oral fluid and bacteria (6, 16). This can cause the caries, gingivitis and periodontitis. Marginal gap evaluation of restorations depends on the multiple factors (2, 5). Clinically accepted marginal gap of CAD/CAM restoration has been suggested to be 100 to 120 μm (10). Positive factors affecting the marginal adaptation of Procera® AllCeram crowns need to be studied in vitro for the better understanding.

2 AIMS OF THE INVESTIGATION

Marginal fit of indirectly produced restoration are very important, because a large marginal openings allow more plaque accumulation, gingival sulcular fluid flow, and bone loss, resulting in microleakage, recurrent caries and periodontal disease. Marginal fit of metalo-ceramic restorations has been well documented. CAD/CAM produced Procera® AllCeram crowns are produced by different methodology than conventional metalo-ceramic restorations. In our investigations we quantified the marginal gap of Procera® AllCeramic crown copings.

Primary objective

The main purpose of this *in vitro* study was to investigate the "absolute marginal adaptation" of the Procera® AllCeram crown copings.

Specific objectives

1. To investigate whether marginal fit of Procera® AllCeram crown copings can be influenced by the tooth group variations [incisors, molars].
2. To investigate the marginal gap value differences depending upon their location within the tooth [mid-buccal, mid-mesial, mid-lingual, mid-distal].
3. To investigate, whether the difference in cementing media can influence the "mean absolute marginal discrepancy" of the Procera® AllCeram crown copings.

3 MATERIALS AND METHODS

3.1 Type of investigations

This study was in vitro in nature.

3.2 Tooth preparation

Two maxillary right central incisors and first molar acrylic AG 3 model teeth [Frasaco, Germany] were manually prepared for all-ceramic crown with high-speed hand piece. The incisal/occlusal reduction of 2 mm, 0.8 mm deep chamfer following the course of cemento-enamel junction of model tooth and with total convergence angle of 6 degree was prepared. All sharp line angles and edges were smoothened using 30μm diamond abrasives. Prepared tooth samples were mounted onto self-cured resin blocks [Premacryl® Plus, Spofa Dental, Czech Republic]

3.3 Fabrication of die samples

Four prepared teeth were embedded in resin blocks and duplicated 9 times using additional silicone [Aquasil™ Putty and Aquasil™ ultra LV Dentsply DeTrey, Germany] to achieve a total of 36 die stone models [Japan stone, Dr Bohme and Schops Dental, BorsigstraBe]. The die stone models were coated with die hardener solution [Hardening bath, Renfert® Germany]. Three models of individual tooth preparations were allotted equally into three luting media groups namely AZ, AG, and AR [$n = 12$].

3.4 Fabrication of Procera® AllCeramic crown copings

The Procera® AllCeramic crown copings [densely sintered aluminous oxide ceramic] were ordered from the Procera® Piccolo scanner [Nobel Biocare, Goteborg Sweden] situated at the teaching hospital dental laboratory. The four prepared scanning models were scanned. And 32 AllCeram crown copings of 0.6 mm thickness were procured. The predetermined cement space was 50 μm thickness.

3.5 Seating the crown copings

a) **AZ group,** Adhesor® zinc phosphate cement [Spofa Dental, Czech Republic]

Zinc phosphate cement was mixed according to the manufacturers directions on frozen glass slab. The mixed cement was coated with micro brush [Ishikiriama technique] and seated onto the individual dies with load of 50 N force during the setting time [5 minutes] of the cement. All the remaining copings were fixed onto die model with same method.

b) **AG group,** Kavitan®Cem, glass ionomer cement [Spofa Dental, Czech Republic]

The glass ionomer cement was dispensed and manually mixed according to the manufacturers instructions. The mixed cement was applied in very thin coating to copings, and seated onto individual dies with load of 50 N force till the setting of cement completed. All the remaining copings were fixed onto die model with same method.

c) **AR group,** Dual® Cement, [Ivoclar Vivadent, Liechtenstein]

The two-component catalyst and base paste were dispensed to equal length, and mixed till the uniform colour. The thin layer of cement was applied onto fitting surface of the coping, and seated with load of 50 N force. Excess cement was removed with cotton pallet. The margins were cured with curing light for 40 to 60 seconds. All the remaining copings were fixed onto die model with same method.

3.6 Scanning electron microscopy (SEM) analysis of marginal discrepancy

The die models with luted copings were sputter coated using sputter coater for 4 minutes [Poloron, Sussex, UK]. The absolute marginal discrepancy was measured with the help of scanning electron microscope [Leica Leo S 440I, Cambridge, UK]. The strategy used for measurements were four potential measuring locations selected exactly mid-buccal, mesial, lingual and distal and indented. The individual spots were analysed using SEM for measurement of marginal gap. The distance from the internal surface of the crown coping margins to the cavosurface of finish line, was measured in one-dimensionally using SEM.

The indented predetermined measuring point on the individual axial surface was located at 50X magnification in SEM. The four reading spots were selected around the mid axial surface, at an interval of 200 µm. Individual spots were further magnified and measured using digital measuring bar of SEM. In SEM, the electronic measuring bar provides actual distance in microns at the individual spot, taking actual magnification factor into account. Finally, 16 total readings per tooth were measured and recorded.

3.7 Statistical analysis

In current investigation, in all the groups, the mean of four measurements from individual axial surface was calculated first. Then mean of all the mid-buccal, mesial, lingual and distal were used to calculate the mean of individual tooth. Finally this means were used to calculate the mean absolute marginal discrepancy of individual cement group.

Mann-Whitney U test was applied to find out the significant difference between independent groups. Kruskal-Wallis test was applied to find out significant difference between the study groups. In both the above test p value less than **0.05** was taken to be statistically significant. The data was analysed using **SPSS** package.

4 RESULTS

The mean absolute marginal adaptation of incisors and molars (n = 6) did not show any statistical significance ($p \leq 0.05$) in all study groups (Tab. 1). But inter luting agent comparison (n = 0.05) of mean absolute marginal adaptation, showed the significant difference (Tab . 2). Furthermore, we did find significant difference between resin cement V/s glass ionomer cement and glass ionomer cement V/s zinc phosphate over marginal fit (Tab. 3). However, all the mean values of study groups were within the 100 µm.

Group	Tooth	N	Mean	Standard deviation	Median	Min	Max	Z value	*p* value
AZ	Incisors	6.0	59.0	13.0	60.0	42.4	73.2	.200	.240
	Molars	6.0	48.8	11.7	50.4	30.6	65.0		
AG	Incisors	6.0	37.9	13.5	34.9	23.3	57.6	-1.281	.240
	Molars	6.0	27.0	9.4	27.0	17.1	41.8		
AR	Incisors	6.0	44.4	7.1	44.3	32.4	52.6	-.801	.485
	Molars	6.0	50.2	10.8	45.7	39.2	65.3		

Table 1. *Intra-group data comparison of "mean absolute marginal adaptation" of incisors and molars.*

Group	N	Mean	Standard deviation	Median	Min	Max	Chi square value	*p* value
AZ	12	53.92	12.95	53.37	30.63	73.15	13.317	.001
AG	12	32.48	12.46	29.304	17.08	57.64		
AR	12	47.35	9.02	44.71	32.37	65.34		

Table 2. *Comparing the "median absolute marginal adaptation" among the group.*

Surface	Comparison	Z value	*p* value
Absolute marginal discrepancy	Resin cement V/s Glass ionomer cement	-2.887	**0.003**
	Resin cement V/s Zinc phosphate	-1.270	0.219
	Glass ionomer cement V/s Zinc phosphate	-3.175	**0.001**

Table 3: *Median mean marginal adaptation comparison among the inter group.*

5 DISCUSSION

In this study, the parameter used for the measurement of the marginal misfit was absolute marginal discrepancy. This is an angular combination of the marginal gap and an extension in the vertical and horizontal direction. According to the Holmes *et al.* (8) the consideration of measurement of absolute marginal discrepancy was defined as from the margin of the casting to the cavosurface angle of the chamfer preparation. Furthermore, the absolute marginal discrepancy would reflect the total misfit of the crown at the given spot, and finally around the crown margin.

The reported mean absolute marginal discrepancy for incisor teeth of **AZ**, **AG**, and **AR** groups were (mean) 60, 38, 44 µm, while molars had a gap of 49, 27, 50 µm respectively. We did not find the significant difference between incisors and molars in the same groups. The values of incisors and molars of all the study groups were within the clinically accepted marginal fit value of 100 - 120 µm (10). The results were not in accordance with the value of study conducted by Bindl *et al.* (3) for molars 17±16 µm.

Further interpretation of data revealed that the absolute marginal discrepancy of incisors of all the respective groups was lower than that of the molars, except for **AG** group. This could be explained by the presence of larger surface area of the molars compared to the incisors, against the static finger load of 50 N during cementation procedure.

Incisors showed highest marginal gap on "mid-buccal" [85.4 µm] and "mid-lingual" [60.8 µm] surfaces when compared to the mid-mesial and mid-distal surfaces. However, for molars the "mid-lingual" [59.8 µm] and "mid-distal"[57.3 µm] surfaces had the highest marginal gap value when compared to mid-buccal and mid-mesial surfaces. The results of the present study are in accordance with the study results of Sulaiman *et al.* (17).

The effect of luting cements over the "median absolute marginal adaptation" of the Procera® AllCeram copings, independent of the tooth type were compared. This analysis showed that, there is significant difference [$p = 0.001$] between the three luting cement groups over the mean marginal gap of the Procera® AllCeram copings. When the specific cement groups were compared, it revealed that there were significant differences between AR and AG [$p = 0.003$], AG and AZ [$p = 0.001$] group, with one exception, AR and AZ

group [p = **0.219**]. This confirmed the overall effect of luting agents over the mean absolute marginal adaptation of Procera® AllCeram copings.

The median absolute marginal discrepancies values of our study [n =**12**] were depicted in the reducing order, zinc phosphate cement (53 µm), resin cement (44 µm), and glass ionomer cement (29 µm). We compared our results with the study results of the Quintas *et al.* (13), who documented that there was no significant effect of the luting cement over the vertical marginal discrepancies of Procera® AllCeram copings. In the same study, he presented the vertical marginal discrepancy after cementation in the reducing order i.e., glass ionomer cement (46 µm), resin cement (45 µm), and least was zinc phosphate cement (41 µm).

The type of the cementation force used was static finger pressure of 50 N/cm with standardization. This procedure was comparable to the clinical situation. However, the static force may not be powerful enough when compared to dynamic force (15, 20), and ultrasonic vibration to transform the highly viscous luting agents into low viscosity, under the present experimental condition. This could have prevented the complete marginal adaptation of the zinc phosphate cement and resin cement group copings.

The zinc phosphate cement [AZ] group demonstrated the highest median absolute marginal discrepancy of 53 µm in comparison to other groups. Study result of intracoronal pressure during cementation of cast crowns demonstrated that, zinc phosphate cement produced the greatest peak of hydrostatic pressure in the centre of the occlusal surface (7). This was further supported by the study of Wilson (19), who suggested the venting of the crowns in order to relieve the stress concentration of casted crowns. This could be partially responsible for the wider absolute marginal discrepancy of AZ group. Yu *et al.* (20) also asserted that there is definitive interaction between the type of cement used and cementation technique. While this investigation was not a comparison of the cementation technique, there was a fundamental focus to measure the marginal gap of Procera® AllCeram copings.

Further research should focus on an increased number of specimens while evaluating the effect of tooth group over the marginal adaptation. Furthermore, measuring the in vitro and in vivo internal gap of the crowns with the identical methodology would disclose the total quantification of the 'misfit' of Procera®AllCeramic copings.

6 CONCLUSIONS

Within the limitation of this in vitro experiment, the following conclusions were drawn:

1. Scanning electron microscope [SEM] measurement of the mean absolute marginal discrepancy of Procera AllCeram copings [$n = 6$] were as follows:
    - AG [I] - 37.9 μm, AG [M] - 27 μm. AR [I] - 44 μm, AR [M] - 50 μm, AZ [I] - 59 μm, AZ [M] - 48 μm.
    - All the absolute marginal adaptation gap size was within the biologically acceptable standards of all-ceramic restorations.
    - Incisors showed wide marginal gap on mid-buccal and mid-lingual surface, but for molars there was wider marginal gap on mid-lingual and mid-distal surfaces.
    - Incisors showed wider absolute marginal gap than the molars in the entire group.
2. There was no statistically significant difference [$p<0.05$], in absolute marginal discrepancy of incisor and the molar tooth Procera® AllCeram copings as a **function of tooth group variation.**
3. There was statistically significant difference [$p<0.05$] in median absolute marginal adaptation of Procera® AllCeram copings as a **function of affect of luting media [$n = 12$].**
    - AZ group -53 μm; AR group – 44.5 μm; AG group - 29 μm.
    - The **AR** group showed the significantly smaller [$p<0.05$] and homogeneous absolute marginal gap than the **AZ** group. The **AR** group presented significantly larger [$p<0.05$] and variable marginal gap dimension compared with AG group. There was no significant difference in absolute marginal discrepancy between **AR** group and **AZ** group at the $p = 0.05$ level.
    - Glass ionomer cement group demonstrated the least absolute marginal discrepancy in this study, compared to zinc phosphate cement and resin cement.

7 REFERENCES

1. Andersson M, Oden A. A new all-ceramic crown: a dense-sintered, high purity alumina coping with porcelain. Acta Odont Scand 1993; 51: 59-64.
2. Beschnidt SM, Strub JR. Evaluation of the marginal accuracy of different all-ceramic crown systems after simulation in the artificial mouth. J Oral Rehab 1999; 26: 582-593.
3. Bindl A, Mormann WH. Marginal and internal fit of all-ceramic CAD/CAM crown copings on chamfer preparations. J Oral Rehab 2005; 32: 441-447.
4. Christel P, Meunier A, Heller M. Mechanical properties and short term in-vivo evaluation of yttrium-oxide-partially-stabilized Zirconia. J Biomed Mat Res 1989; 23: 45-61.
5. Gardener FM, Margins of complete crowns-Literature review. J Prosthet Dent 1982; 4: 396.
6. Goldman M, Laosonthorn P, White RR. Microleakage –full crowns and the dental pulp. J Endod 1982; 18: 473.
7. Hoard RJ, Caputo AA, Contino RM, Koenig ME. Intracoronal pressure during crown cementation. J Prosthet Dent 1978; 40: 520.
8. Holmes JR, Bayne C, Holland GA, Sulik WD. Considerations in measurement of marginal fit. J Prosthet Dent 1989; 62: 405-408.
9. Kelly JR, Nishimura I, Campbell SD. Ceramics in dentistry: historical roots and current perspectives. J Prosthet Dent 1996; 75: 18-32.
10. McLean JW, VonFraunhofer JA. The estimation of cement film thickness by an in vivo technique. Br Dent J 1971;131: 107-111.
11. McLean JW, Hughs TH. The reinforcement of dental porcelain with ceramic oxides. Br Dent J 1965; 119: 251-67.
12. Muller HP. The effect of artificial crown margins at the gingival margin on the periodontal conditions in a group of periodontally supervised patients treated with fixed bridges. J Clin Priodontol 1986; 13 (2): 97-102.

13. Quintas AF, Oliveira F, Bottino MA. Vertical marginal discrepancy of ceramic copings with different ceramic materials, finish lines, and luting agents: an in vitro evaluation. J Prosthet Dent 2004; 92 (3): 250-257.
14. Riley EJ. Ceramo-metal restorations-state of the science. Dent Clin North Amer 1977; 21: 669-682.
15. Rosenstiel SF, Gegauff AG. Improving the cementation of complete cast crowns: A comparison of static and dynamic seating methods. J Amer Dent Assoc 1988; 117: 845-848.
16. Silness J. Periodontal conditions in patients treated with dental bridges. The relationship between the location of the crown margin and periodontal condition. J Periodontol Res 1970; 5: 225-229.
17. Sulaiman F, Chai J, Jameson LM, Wozniak WT. A comparison of the marginal fit of In-ceram, IPS Empress, and Procera crowns. Int J Prosthodont 1997; 10: 478-484.
18. Walton TR. An up to 15-year longitudinal study of 515 metal-ceramic FPDs: Part- I. Outcome. Int J Prosthodont 2002; 15: 439-45.
19. Wilson PR. Low force cementation. J Dent 1996; 24: 269-276
20. Yu Z, Strutz JM, Kipnis V, White SN. Effect of dynamic loading methods on cement film thickness in vitro. J Prosthod 1995; 4: 251-255.
21. Zarone F, Sorrentino R, Vaccaro F, Russo F, De Simone G. Retrospective clinical evaluation of 86 Procera AllCeram anterior single crowns on natural and implant-supported abutments. Clin Implant Dent Res 2005; 7 (1): 95-103.

8 BIOGRAPHY

8.1 Chapters in text books

1. Pilathadka S: **Contemporary all-ceramic materials in implant dentistry.** (Chapter). In: Šimůnek A et al: **Dentální implantologie**. Nucleus HK 2008, 2nd ed.

2. Pilathadka S: **Custom abutments and implant supported bridges**. (Chapter). In: Šimůnek A et al: **Dentální implantologie**. Nucleus HK 2008, 2nd ed.

8.2 Original articles

1. Pilathadka S, Slezák R, Vahalová D, Vavřičková L, Dufková D, Ramanathan Ch, Bittner J: **Méně obvyklá postižení ústní sliznice vyvolaná snímatelnými zubními protézami.** Quintessenz 17, 2008, (2): 1-6.

2. Slezák R, Dufková D, Vavřičková L, Pilathadka S, Kopecký O: **Kontaktní stomatitida jako důsledek protetického ošetření. Kazuistika.** LKS 18, 2008, (2), CD Suppl: 1-6.

3. Šimůnek A, Kopecká D, Somanathan RV, Pilathadka S, Brázda T: **Deproteinized bovine bone versus beta-tricalciumphosphate in sinus lift surgery.** Int J Oral Max Impl. **IF 1.705** In press.

4. Jacob V, Vellapally S, Smejkalova J, Rajkumar K, Cermakova E, Fiala Z, Somanathan RV, Pilathadka S: **Tobacco use and its effect on periodontal health in India.** Centr Eur J Med. In press.

5. Vellapally S, Jacob V, Fiala Z, Smejkalova J, Pilathadka S: **Tobacco habits and oral health status in selected Indian population.** Centr Eur J Public Health. In press.

6. Pilathadka S, Slezák R, Srinivasan V, Ivančaková R: **Precision of Marginal Adaptation of the Incisor and Molar Procera® AllCeram Crown Copings.** Prag Med Report. In press.

7. Pilathadka S, Slezák R. Vahalová D, Kudiyirickal MG, Sukumar S: **Influence of different luting agents on the marginal discrepancy of Procera® AllCeram alumina crown copings – an experimental study.** Acta Med (Hradec Králové). In press.

8.3 Reviews

1. Pilathadka S, Vahalová D, Vosáhlo T: **The zirconia: A new dental ceramic material. An overview.** Prag Med Report 2007;108 (1): 5-12.

2. Vellapally S, Fiala Z, Smejkalova J, Jacob V, Pilathadka S: **Influence of tobacco use in dental caries development.** Centr Eur J Public Health 2007, 15 (3): 116-121.

3. Pilathadka S, Vahalová D: **Contemporary all-ceramic systems. A review. Part 1.** Acta Med (Hradec Králové) 2007, 50 (2): 101-104.

4. Pilathadka S, Vahalová D: **Contemporary all-ceramic systems. A review. Part 2.** Acta Med (Hradec Králové) 2007, 50 (2): 105-107.

5. Pilathadka S, Vahalová D, Sukumar S, Vosáhlo T: **A new oxide based high strength all-ceramic material. An overview.** J Ind Prosthod Soc. In press.

8.4 Abstracts

1. Pilathadka S, Vahalová D, Ševčíková J: **"Procera"- A simple technique for complex esthetic problem.** Sborník přednášek Sazamovy dny, Oct 23-24, 2005, Hradec Králové.

2. Vahalová D, Dufková D, Pilathadka S: **Aesthetic comparison of various types of full veneer crowns in anterior teeth.** Abstract book 24th International AIOP congress. Nov 18-19, 2005, Bologna, Italy.

3. Pilathadka S, Vahalová D, Vavřičková: **Qualitative comparison or first-year dentistry teaching curriculum of Czech Republic and India.** Abstract book 11th European Association of Dental Public Health (EADPH) annual conference. Sept 7-9, 2006, Prague.

4. Pilathadka S, Vahalová D, Lukl P, Dufková D, Sobotka M, Vavřičková L. **Optimization of Aesthetics with All-Ceramic Restorations.** Abstract book Annual conference of the European Prosthodontic Association (EPA). Nov 2-4, 2006. London, UK.

5. Sobotka M, Pilathadka S, Dufková D, Kopecká D, Brázda T: **Immediate loading of implant in aesthetic zone. A case report.** Abstract book 11th European Association of Dental Public Health (EADPH) annual conference. Sept 7-9, 2006, Prague.

6. Vavřičková L, Vahalová D, Pilathadka S: **Wax-up technique of dental pre-graduate curriculum.** Abstract book Annual conference of the European Prosthodontic Association. Nov 2 -4, 2006, London, UK.

7. Vahalová D, Dufková D, Pilathadka S: **Aesthetic comparison of various types of full veneer crowns in anterior teeth.** Sborník přednášek Sazamovy dny 2006, Nov 10-11, 2006, Hradec Králové.

8. Pilathadka S, Vahalová D. **CAD-CAM dental restorations: A new approach.** Sborník přednášek "2. Morfologický postgraduální kurz", Faculty of Pharmacy and Faculty of Medicine in Hradec Králové. Dec 14-15, 2006, Hradec Králové.

9. Pilathadka S, Vahalová D, Slezák R. **Marginal accuracy of Procera®AllCeram copings with different luting media.** Abstract book Proceedings of 47th Continental European and Israeli division IADR conference. Sept 26-29, 2007, Thessaloniki, Greece.

10. Pilathadka S, Slezák R, Vahalová D, Kudiyirickal MG, Sukumar S. **Marginal adaptation of Procera® AllCeram incisior and molar crown copings.** Abstract book, 3. fakultní konference studentů doktorského studia. Oct 22, 2007, Hradec Králové.

8.5 Presentations and posters

1. Pilathadka S, Vahalová D, Ševčíková J. **"Procera"- A simple technique for complex esthetic problem. Case report.** Sazamovy dny, Oct 23-24, 2005, Hradec Králové.

2. Vahalová D, Dufková D, Pilathadka S. **Aesthetic comparison of various types of full veneer crowns in anterior teeth.** 24 International AIOP congress, Nov 18-19, 2005, Bologna, Italy.

3. Pilathadka S, Vahalová D, Slezák R. **Development of all-ceramic systems in dentistry**. Dept. of Dentistry, Teaching hospital Hradec Králové, Apr 24, 2006, Hradec Králové.

4. Pilathadka S, Vahalová D, Slezák R. **Pilot Study result of marginal and internal fit with metal ceramic copings**. Dept. of Dentistry, Teaching hospital Hradec Králové, Jun 7, 2006, Hradec Králové.

5. Pilathadka S, Vahalová D, Slezák R. **CAD/CAM produced all-ceramic restorations. Dept. of Dentistry,** Teaching hospital Hradec Králové, Dec 4, 2006, Hradec Králové.

6. Pilathadka S. **CAD/CAM produced dental restorations.** 2. Morfologický postgraduální kurz at Faculty of Pharmacy and Faculty of Medicine in Hradec Králové. Charles University in Prague, Dec 14-15, 2006, Hradec Králové.

7. Pilathadka S, Vahalová D, Vavřičková L. **Qualitative comparison or first-year dentistry teaching curriculum of Czech Republic and India.** 11th European Association of Dental Public Health (EADPH) annual conference, Sep 7-9, 2006, Prague.

8. Pilathadka S, Vahalová D, Lukl P, Dufková D, Sobotka M, Vavřičková L. **Optimization of Aesthetics with All-Ceramic Restorations.** Annual conference of the European Prosthodontic Association, Nov 2-4, 2006, London, UK.

9. Sobotka M, Pilathadka S, Dufková D, Kopecká D, Brázda T. **Immediate loading of implant in aesthetic zone - A case report.** 11th European Association of Dental Public Health (EADPH) annual conference Sep 7-9, 2006, Prague.

10. Vavřičková L, Vahalová D, Pilathadka S. **Wax-up technique of dental pre-graduate curriculum.** Annual conference of the European Prosthodontic Association, Nov 2 -4, 2006, London, UK.

11. Vahalová D, Dufková D, Pilathadka S. **Aesthetic comparison of various types of full veneer crowns in anterior teeth.** Sazamovy dny 2006, Nov 10-11, 2006, Hradec Králové.

12. Pilathadka S, Vahalová D, Slezák R. **Marginal accuracy of Procera®AllCeram copings with different luting media.** 47th Continental European and Israeli division IADR conference, Sept 26-29, 2007, Thessaloniki Greece.

13. Pilathadka S., Slezák R, Vahalová D, Kudiyirickal MG, Sukumar S. **Marginal adaptation of Procera® AllCeram incisior and molar crown copings.** 3. fakultní konference studentů doktorského studia, Oct 22, 2007, Hradec Králové.

9 SUMMARY

During the past years introduction of high strength oxide based all-ceramic system made metal free ceramic restorations a popular aesthetic alternative in anterior and posterior region of the mouth. One of the materials is the Procera® AllCeramic densely sintered alumna [Nobel Biocare AB, Goteborg, Sweden]. All the studies regarding the very quality of restorative material such as strength, biocompatibility, aesthetics and fit have been done. Long-term survival qualities of the materials are partially related to the marginal adaptation of the crown to the margins of the crown preparations. *In vitro* studies need to confirm such quality of the Procera® AllCeram crown coping.

Aims of the studies
One of the aim of the thesis was to investigate the mean absolute marginal fit of Procera® AllCeramic [densely sintered alumna] copings. The second aim of the study was to investigate the whether vertical marginal fit of Procera® AllCeram copings can be influenced by the tooth groups [incisors, molars]. The additional aim was to investigate the marginal gap value differences depending upon their location within the tooth. The final aim of the study was to investigate whether the cementing media can influence the mean absolute marginal adaptation of the Procera® AllCeram copings.

Materials and methods
In this in vitro study investigated the Procera® densely sintered alumina coping's vertical marginal fit with chamfer finishing line. Two incisors and two molars typodont teeth were prepared for all-ceramic crown according to manufacturers instructions. 0.8 mm width of chamfer finish line was prepared. These four individual teeth were duplicated nine times [9] to obtain total 36 die models. 36 Procera® AllCeramic 0.6 mm coping were fixed, first group [AZ] using zinc phosphate cement [Adhesor®] n = 12, second group with glass ionomer cement [Kavitan® Cem] n = 12, and third group dual cured cement [Dual® Cement] n =12. Marginal adaptation was measured using direct scanning electron microscopy [SEM] on all four axial walls with 4 measurements on each wall with total of 16 measurements per tooth. The influence of between coping factors [luting cement] and

within-coping factor [tooth group and axial surface] on the marginal adaptation of the Procera® AllCeram crown copings is assessed.

Results

The mean absolute marginal adaptation value of groups are AG I [n = 6] 37.9 μm, AG M [n = 6] 27 μm. AR I [n = 6] 44 μm, AR M [n = 6] 50 μm, AZ I [n = 6] 59 μm, AZ M [n = 6] 48 μm. There was no statistically significant difference in mean absolute marginal discrepancy between tooth group, and all mean marginal adaptation values were within the acceptable limit of 100 μm. The Kruskal-Wallis test indicated significant difference between groups [$p < 0.05$]. Within the axial surface marginal adaptation gaps comparison revealed that incisors had wide gap on mid-buccal surface [85.4 μm ± 31.5] and mid-lingual [60.8μm ±36], but molars had mid-lingual [59.8 μm ±10] and mid-distal [57.3 μm ± 13] respectively. The median absolute marginal gaps of study groups were compared for significance. AG group had low mean gap [32.5 μm ±12] and high gap was with AZ group [53 μm ±12]. There were significant difference between the luting agent, AR V/s AG and AG V/s AZ except AR V/s AG group.

Conclusions

Absolute marginal discrepancy measurement dimensions of Procera® AllCeram copings of incisors and molars demonstrated the clinical acceptable marginal adaptations value of 100 μm. While tooth group variations [incisors and molars] did not affect the adaptations of Procera® AllCeram copings. Buccal and lingual axial surface of incisors and distal and lingual surface of molars showed the wide marginal gap. Considering the individual factors separately, luting agents appeared to be affecting the mean marginal adaptation. The absolute marginal discrepancies were recorded in ascending order, AZ group - 53 μm; AR group – 44.5 μm; AG group - 29 μm.

10 SOUHRN

Vývoj celokeramických systémů založených na oxidu hlinitém a oxidu zirkoničitém způsobil, že se bezkovové celokeramické korunky a můstky staly žádanou alternativou při ošetřování zubů ve frontálním i laterálním úseku chrupu. Jedním z těchto materiálů je systém PROCERA založený na sintrovaném oxidu hlinitém (Nobel Biocare, Goteborg, Sweden). Bylo provedeno mnoho studií týkajících se vlastnosti tohoto materiálu, jako je pevnost, biokompatibilita, estetika a přesný okrajový uzávěr, což je přesná adaptace cervikálního okraje korunky ke schůdku, kterým je preparace v oblasti krčku zubu ukončena. Tyto faktory ovlivňují dlouhou životnost náhrad v dutině ústní. Právě kvalitu okrajového uzávěru mohou potvrdit *in vitro* prováděné studie.

Cíle studie
Prvním cílem studie bylo zjistit průměrnou absolutní přesnost okrajového uzávěru bazálních kapen zhotovených z materiálu PROCERA AllCeram (denzně sintrovaný oxid hlinitý).
Druhým cílem studie bylo zjistit, zda vertikální přesnost okrajového uzávěru bazálních PROCERA AllCeram kapen může být ovlivněna skupinou zubů (řezáky, moláry).
Třetím cílem studie bylo zjistit, zda rozdíly ve velikosti marginální spáry v oblasti okrajového uzávěru závisí na jejich lokalizaci v rámci jednoho zkoumaného zubu.
Čtvrtým cílem studie bylo zjistit, zda typ cementu použitý k fixaci kapny na zub může ovlivnit „průměrnou absolutní přesnost okrajového uzávěru" PROCERA AllCeram kapen.

Materiál a metody
Vyšetřované zuby – 2 plastové střední horní řezáky a 2 plastové první horní moláry- byly podle instrukcí výrobce kapen preparovány na celokeramickou korunku s ukončením preparace v cervikální oblasti na oblý schůdek šíře 0,8 mm. Tyto 4 zuby byly 9krát duplikovány za účelem získání souboru 36 sádrových replik. Bylo vyrobeno 36 PROCERA AllCeram kapen tloušťky 0,6 mm. Tento soubor byl rozdělen na 3 podskupiny; 12 kapen 1. podskupiny označené AZ bylo fixováno zinkoxidfosfátovým cementem Adhesor. 12 kapen 2. podskupiny označené AG bylo fixováno

glasionomerním cementem Kavitan Cem a 12 kapen 3. podskupiny označené AR bylo nacementováno duálně tuhnoucím cementem Dual Cem. Přesnost marginální adaptace byla změřena pomocí přímého skenování rastrovacím mikroskopem (SEM). Proběhla 4 měření na každé ze 4 axiálních stěn (vestibulární, orální, mesiální a distální) každého zubu. Tímto způsobem bylo získáno 16 měření pro každý zub ze souboru. Hodnocen byl vliv určitých faktorů na přesnost marginální adaptace PROCERA AllCeram kapen. Těmito faktory byly jednak rozdílné typy zubů a fixačních cementů, jednak měření na jednom každém zubu z celého souboru (4 měření na 4 axiálních stěnách).

Výsledky

Hodnota průměrné marginální adaptace souborů je u podskupin AGI (n = 6) 37,9 μm, AGM (n = 6) 27 μm. U podskupin ARI (n = 6) 44 μm, ARM (n = 6) 50 μm, AZI (n = 6) 59 μm, AZM (n = 6) 48 μm. Nebyl zjištěn statisticky významný rozdíl průměrné vertikální marginální adaptace mezi jednotlivými podskupinami zubů a všechny hodnoty průměrné marginální adaptace splňují přijatelný limit 100 μm. Kruskalův-Wallisův test však ukázal statisticky významný rozdíl mezi typy zubů v adaptaci kapen k axiálním stěnám zubů ($p<0,05$). Ukázalo se, že řezáky mají širší spáru ve středu labiálního povrchu zubu (85,4 μm ± 31,5 μm) a ve středu palatinálního povrchu zubu (60,8 μm ± 36,0 μm), kdežto moláry vykazovaly širší spáru ve středu palatinálního povrchu zubu (59,8 μm ± 10,0 μm) a ve středu distálního povrchu zubu (57,3 μm ± 13,0 μm). Průměrné marginální spáry u zubů jednotlivých podskupin byly navzájem statisticky vyhodnoceny. AG podskupina vykazovala úzké spáry (32,5 μm ± 12 μm), naopak široké spáry se objevovaly u podskupiny AZ (53,0 μm ± 12,0 μm). Byl objeven signifikantní rozdíl mezi typem cementu, který byl použit k fixaci kapny na zub, AR V/s, AG a AG V/s s výjimkou podskupiny AR V/s AG.

Závěr

Studie potvrdila, že diskrepance mezi absolutními hodnotami marginálních spár naměřených u PROCERA AllCeram kapen fixovaných na řezácích a molárech poskytují kapnám, resp. korunkám, akceptovatelný okrajový uzávěr (100 μm). Variace v rámci podskupin (řezáky, moláry) neovlivnily adaptace PROCERA AllCeram kapen. Labiálně

a palatinálně u řezáků a distálně a palatinálně u molárů vykazoval okrajový uzávěr kapen široké spáry. Uvážíme-li individuální faktory, zdá se, že zvláště fixační cementy, ovlivňují průměrnou marginální adaptaci použitých kapen. Absolutní marginální spáry byly zaznamenány (v sestupné řadě): AZ skupina – 53,0 μm, AR skupina – 44,5 μm a AG skupina – 29,0 μm.