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A Ten-Year Retrospective Research of the Effects of Full Coverage Restorations on Pulp Vitality

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Abstract

Introduction: Full-coverage restorations has been used for thousands of years to reinforce and safeguard teeth following significant caries removal, root canal therapy, or fissures. Information for the present research were gathered from Delta Dental's electronic insurance enrollment and claims database in Bhopal, Madhya Pradesh. Between January 1, 2011 and December 31, 2021, the database includes claims data for 13,329,249 patient interactions. In accordance with the Code on Dental Procedures and Nomenclature (CDT) codes for full-coverage crown shipping, 88,409 patients experienced full-coverage crown deliveries were selected from the dataset.

Results- Following applying the exclusion parameters to the dataset, 88,409 teeth with crowns were discovered. The significant majority of crowns (41.50%) and PFM (49.64%) were all-ceramic. All-metal crowns accounted for only 8.86% of all crowns placed. General dentists performed nearly all of the crowns in the data set, with prosthodontists and "other" providers accounting for the remaining 1.23%. Over half of the patients who received crowns were between the ages of 51 and 70. Conclusion: These findings indicate that leftover dentin thickness at the time of crown prep has a significant effect on the likelihood of adverse occurrences after the crown is delivered.

Keywords: Full Coverage Restorations. Pulp Vitality, Delta Dental Plan

Introduction

Full-coverage restorations have been used for thousands of years to reinforce and safeguard teeth following significant caries removal, root canal therapy, or fissures. Crowns have grown into common treatments for dentists, and significant research and development has recently been dedicated towards making these procedures more convenient, quicker, and reliable. Nevertheless, the process of preparing a tooth for a crown and then restoring it presents numerous potential for pulpal irritation.[1] Crown preparations expose dentinal tubules to the oral environment, giving bacteria access to the pulp chamber. This issue is compounded by ill-fitting provisional crowns, which can leave tubules exposed for days to weeks until the final crown is synthesized. The excessive heat created by high-speed handpieces might permanently destroy pulp tissue. Other irritants, such as cements, can impact pulpal health as well.[2]

It is not unusual for teeth to manifest with symptomatic irreversible pulpitis during the provisional phase or after crown implantation. While previous research has shown that capped teeth have an 8-15.6% chance of developing pulpal pathology after 10 years, these studies were restricted by small sample sizes and inadequate follow-up.[1,2] An additional investigation discovered that being younger and having more coronal tooth damage were significant predictors of RCT after crown installation.3 Nevertheless, no further studies have been conducted to corroborate these findings or to carry out further research into other predictors of pulpal pathology after crown installation. An insurance database search was undertaken to further examine the frequency of root canal therapy after crown installation and related factors. This type of study provides a real-world evaluation of treatment being provided in a private practise setting, as well as a big enough population to yield significant findings. Delta Dental of Bhopal, Madhya Pradesh, offered electronic insurance claims records and enrollment data from 2011 to 2021. These claims were examined in order to forecast particular tooth survival rates following full-coverage restorations. Patient age, tooth location, and crown material were all investigated as potential predictors of adverse outcomes.

Methodology

The data for the present research came from Delta Dental's electronic insurance enrollment and claims database in Bhopal, Madhya Pradesh. Between January 1, 2011 and December 31, 2021, the database includes claims data for 13,329,249 patient interactions. Based on the Code on Dental Procedures and Nomenclature (CDT) codes for full-coverage crown delivery, 88,409 patients underwent full-coverage crown deliveries were selected from the dataset. CDT codes are employed to accurately and consistently mark dental treatment procedures in medical records for patients and to processing insurance claims.

Type of Crown	*CDT Code*
All-ceramic	D2740
Porcelain-fused-to-metal (PFM)	D2750 D2751 D2752
Cast metal	D2790 D2791 D2792

Table 1: Initiating Event CDT Codes

As initiating events, all-ceramic crown (D2740), porcelain fused to metal crown (PFM) (D2750, D2751, and D2752), and cast metal crown (D2790, D2791, and D2792) codes were identified (Table 1). Teeth that received a root canal treatment (RCT) prior to crown implantation were omitted from the study. Teeth that got crowns within the first 12 months of the study

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period were additionally eliminated to avoid crown deliveries conducted as a result of a previous RCT. Unwanted events were described by CDT codes as having received first root canal therapy (D3310, D3320, D3330), extraction (D7140, D7210), endodontic retreatment (D3346, D3347, D3348), or apicoectomy (D3410, D3421, D3425). Treatments were determined successful until an untoward event or a lapse in the patient's enrolment statusoccurred.

Untoward Event	*CDT Code*
Root canal therapy (RCT)	D3310 D3320 D3330
Extraction	D7140 D7210
Endodontic Retreatment	D3346 D3347 D3348
Apicoectomy	D3410 D3421 D3425

Table 2: Untoward Event CDT Codes

During each interaction, information was gathered about the crown material, the patient's age, the precise position of the tooth, and the type of provider who placed the crown. According to the CDT code, crown material was split into three categories: all-ceramic crowns, PFM crowns, and cast metal crowns. Patients were split into six age groups: under 30 years, 31 to 40 years, 41 to 50 years, 51 to 60 years, 61 to 70 years, and 71 years and older. The tooth placement included groupings of anterior teeth, premolar teeth, and molar teeth. According to the Delta Dental database, provider types included general dentists, prosthodontists, and "other" providers. The "other" group included all providers who were not prosthodontists or regular dentists.

SPSS Version 22 was used to analyse the data. Survival time was calculated from the moment the crown was placed to the time an unpleasant event occurred. The influence of predictors on tooth survival was investigated. A univariate Cox proportional hazards regression model was used to compute the hazard ratios. Because the factor of tooth placement failed to meet the model's proportionate hazard assumption, the evaluation was stratified by tooth position. Regarding each variable, Kaplan Meier curves were produced, and log-rank tests were used to discover variations in Kaplan Meier curves within each variable group. A significance level (alpha) of $p < 0.05$ was used throughout all analyses.

Results

Following applying the exclusion parameters to the dataset, 88,409 teeth with crowns were discovered. The significant majority of crowns (41.50%) and PFM (49.64%) were all-ceramic. All-metal crowns accounted for only 8.86% of all crowns placed. General dentists performed nearly all of the crowns in the data set, with prosthodontists and "other" providers accounting for the rest of the 1.23%. More than fifty percent of the patients who received crowns were between the ages of 51 and 70. Molar teeth represented 75.39% of the teeth being crowned, followed by premolars (20.52%) and anterior teeth (4.09%)(Table 3).

	All (n=88409)	
Variable	*N*	*%*
Crown Material		
All-metal	7834	8.86
PFM	36692	41.5
All-ceramic	43883	49.64
Provider Type		
General Dentist	87318	98.77
Prosthodontist	745	0.84
Other	346	0.39
Age Group		
Under 30 years	2472	2.8
31 to 40 years	7269	8.22
41 to 50 years	15862	17.94
51 to 60 years	30317	34.29
61 to 70 years	27377	30.97
71 years and above	5108	5.78
Tooth Location		
Anterior	3617	4.09
Premolar	18144	20.52
Molar	66648	75.39

Table 3: Descriptive Summary Of Initiating Events Based On Variable

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4.82% of the 88,409 crowned teeth experienced an unfavourable occurrence during the study timeframe. Primary root canal therapy was used on 72.41% of the 4,259 teeth that had an unfavourable occurrence. Apicoectomies and non-surgical root canal retreatments accounted for just 5.40% of all adverse events, with extractions accounting for the remaining 22.19%. Table 4 contains a comprehensive review of unfavourable events relating to crown material and patient age.

	Outcome			
Variables	*Total N=4259*	*Extraction N=945*	*Root Canal N=3084*	*Retreatment N=230*
Crown Material				
All Metal	326 (100.0)	104 (32.7)	212 (66.7)	10 (3.1)
All porcelain	1505 (100.0)	267 (18.4)	1166 (80.3)	72 (4.8)
Metal & Porcelain	2428 (100.0)	574 (24.7)	1706 (73.5)	148 (6.1)
Age Group				
Under 30 yrs	112 (100.0)	15 (15.0)	82 (82.0)	15 (13.4)
31 to 40 yrs	427 (100.0)	67 (16.6)	326 (80.7)	34 (8.0)
41 to 50 yrs	941 (100.0)	155 (17.4)	721 (80.7)	65 (6.9)
51 to 60 yrs	1442 (100.0)	301 (21.7)	1070 (77.1)	71 (4.9)
61 to 70 yrs	1102 (100.0)	310 (28.9)	755 (70.3)	37 (3.4)
71 yrs or above	235 (100.0)	97 (41.8)	130 (56.0)	8 (3.4)

Table 4: Descriptive Summary of Untoward Events Based onCrown

Material And Age of Patient

The Cox Regression model findings contrasted tooth survival times according to the variables investigated. Higher hazard ratios indicate a higher risk of an unfavourable outcome in one variable when compared to another (Table 4). Because tooth location did not satisfy the proportionate hazard assumptions in the regression model, the evaluation was stratified by tooth position. When compared to PFM crowns, metal crowns had a hazard radio of 0.73, indicating a 27% lower hazard rate (p0. 0001). When weighed against PFM crowns, all-ceramic crowns have a hazard ratio of 1.09 (p0.01).

Although there was no significant difference in survival rates amongst prosthodontists and general dentists, there was a significant difference between all other providers and general dentists (p0.05). The age range of 51 to 60 years was chosen as a reference group for analysing patient age. The groups 30 and under, 31 to 40 years, and 41 to 50 years had significantly greater hazard rates than the group 51-61 years. Patients aged 61 to 70 years had a significantly reduced hazard risk than those aged 51 to 60 years. When contrasting age groups 71 and older to 51 to 60, there was no significant difference in hazard ratios.

Hazard Ratio and 95% Confidence Interval				
Variable	*Hazard Ratio*	*95% Confidence Interval*		*P-value*
Crown				
All-Metal vs PFM	0.73	0.65	0.82	<0.0001
All-Ceramic vs PFM	1.09	1.03	1.17	0.0081
Provider				
Prosthodontist vs General Dentist	1.10	0.80	1.52	0.5525
Other vs General Dentist	1.55	1.07	2.23	0.0198
Age Group (in years)				
30 and younger vs 51-60	1.38	1.14	1.67	0.0014
31-40 vs 51-60	1.45	1.30	1.61	<0.0001
41-50 vs 51-60	1.30	1.19	1.41	<0.0001
61-70 vs 51-60	0.89	0.83	0.97	0.0049
71 and above vs 50-60	0.94	0.82	1.08	0.3251

Table 5: Hazard Ratios and Confidence Intervals For Variables

The estimated survival of all crowns drops from 97.3% after one year, to 90.4% after 10 years. The overall probability of survival for all teeth with crowns can be seen inTable 6.

Time (years)	*Number at risk*	*Observed Events*	*Survival Probability*
1	62989	17	0.9727
2	48300	5	0.9595
3	36587	0	0.9492
5	20379	1.00	0.9322
9	4087.00	0.00	0.9041

Table 6: Overall estimates for survival of teeth with crowns

The following plots demonstrate the cumulative incidence of the first untoward event occurring over time following placement of a single-unit crown (Figure 1). Plots were created to display survival rates between variables, including crown material, tooth location, provider type, and age of patient (Fig 2. Survival rates varied significantly by age group, tooth position, and crown material (p0.0001).

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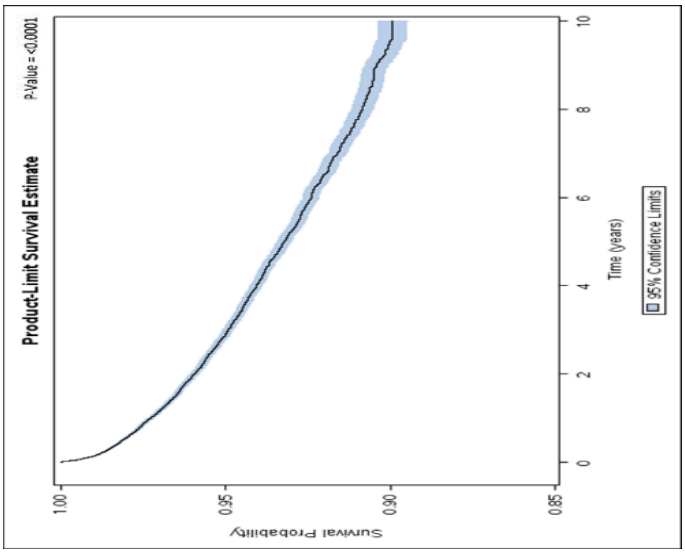

Figure 1: Survival estimates of all teeth after crown placement

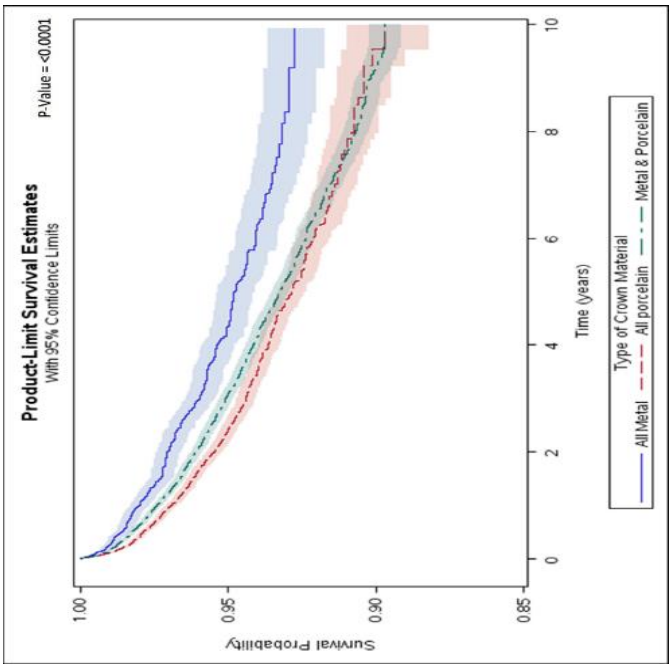

Figure 2: Survival estimates of all teeth after crown placement based on crownmaterial

Discussion

The main aim of the research was to determine factors that influence the likelihood of endodontic treatment following the implementation of a full-coverage, single-unit restoration. A large number of records were available for analysis by utilizing the Delta Dental of Bhopal database, adding significance and power to the findings. Two exclusion criteria were used to our data in order to more nearly resemble a population of teeth with intact pulpal tissues prior to crown implantation. The initial step was to remove any teeth where endodontic therapy had been conducted prior to crown implantation.

It was merely valid for teeth that had the operation done within the ten-year period of our insurance coverage. [4,5] Teeth with crowns implanted in the first year of coverage were also omitted. This procedure intended to remove crowns from teeth that had recently undergone endodontic therapy. Despite these exclusion criteria, several endodontically treated teeth were inextricably linked to the study. This is supported by the few teeth that experienced unfavourable occurrences such as endodontic retreatments and operations (Table 3). Decisions are not possible according to future occurrences in time-to-event analyses, such as a survival analysis, so these data points have to stay in the data set for statistical analysis to be valid.

By eliminating these occurrences, a biassed population of teeth might be exposed to unfavourable events. Keeping these data points, nevertheless, enables for calculation and evaluation of their impact on the total population. Luckily, only 4.50% of all adverse events involved therapies that would suggest root canal therapy prior to crown placement, suggesting that including this category isn't going to have a major effect on the overall outcomes.7,8 Similarly, extractions were included as unfavourable events due to the same rationale, as well as the lack of clinical data that could provide insight into a tooth's prognosis. However, there are several reasons for tooth extraction, and there is no method to identify teeth extracted owing to pulpal pathology from teeth extracted for other reasons using the insurance information provided. A retrospective insurance-based study also makes it impossible to

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standardize providers and comprehend treatment rationale. While one physician might carry out NS-RCT on a pulpal pathology tooth, another may extract the identical tooth and replace it with an implant.[9-13] Even when extractions and endodontic retreatments were included as adverse events, the vast majority (72.41%) of all untoward events were first NS-RCT. There are also some disadvantages to adopting insurance data-based studies.

Only individuals from Bhopal who have Delta Dental insurance were considered, so patient variation is limited. Due to inequalities in access to care and patient expectations, people with private dental insurance may have different outcomes than those without insurance. Crown suppliers were likewise limited to those affiliated with the Delta Dental network. The correctness of coded methods is also critical to the investigation, as inaccurate coding can lead to data misrepresentation and faulty findings. Additional variables that could affect pulpal health, such as remaining dentin thickness, previous restorations, handpiece type, amount of water spray used, marginal finish line design, and pulpal state prior to crown preparation, were not available for investigation. As a result, controlling for these factors is impossible. We can only confirm the presence of pulpal illness in our dataset by coding for NS-RCT. One more restriction is that there is likely a limited population of teeth with pulpal pathology who did not have NS-RCT, as well as teeth who underwent NS-RCT for restorative rather than biologic reasons. Despite these limitations, this is the first large-scale investigation to uncover characteristics associated with the risk of NS-RCT after crown preparation. Of the 88,409 teeth that were crowned, 4.82% teeth underwent an untoward event.[14-18]

The 10-year survival estimate is 90.41%. Although various follow-up lengths and eligibility requirements, this value is comparable to other research (1-3, 84-87). General dentists installed 87,318 of these crowns, accounting for 98.77% of total procedures. Prosthodontists and "other" were among the remaining providers, accounting for only 0.84% and 0.39% of all treatments, respectively. The logrank test results show that there are no significant variations in tooth survival rates between these three groups (Figure 4).

The bulk of crowns were placed on molars, which accounted for 75.39% of all teeth, followed by premolars (20.52% of all teeth) and front teeth (4.09% of all teeth). This variable does not meet the Cox regression analysis's proportional hazard assumption, which asserts that the ratio of the dangers for two individuals remains constant throughout time. This implies that the variable of tooth placement does not contribute linearly to the survival model. As a consequence, no data comparing tooth survival rates based on tooth placement could be found. The analysis was further subdivided determined by tooth placement.[19]

Individuals aged 30 and under were not as inclined to have a crown set up but they also had the greatest probability of failures after crown installation of any age group. In broad terms, the Cox regression findings revealed that younger people were more likely than older people to experience an unfavourable occurrence following crown installation. Particularly the age segments 51 to 60 years and 71 years and beyond did not show a statistically significant difference in survival rates (Table 4). This arrangement could have several interpretations. Younger people have bigger pulp gaps because to less secondary dentin deposition, which brings pulpal tissues closer to the heat and desiccation

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at the cavosurface margin during crown preparation.[5] It may also imply a link among crowns placed at a young age and pulpal disease; crowns implanted at a young age may be essential due to poor oral hygiene, a high caries risk, or unfavourable oral circumstances, all of which can lead to pulpal pathology.

Kirakozova had previously discovered that younger age and more extensive tooth deterioration were significant predictors of root canal treatment after full-coverage restorative delivery.19 The results of this research confirmed these findings; nonetheless, tooth degradation could not be assessed due to a lack of access to radiographs in the current investigation. nevertheless supposing that sufficient preparations were made for each crown category, the current findings show that crown materials that call for greater structural reduction are substantially more likely to experience an unfavourable occurrence.

The major goal of this research was to discover factors that influence pulpal health after crown installation. Because hazard rates rise with age and with crown materials that demand deeper preparations, these findings show that remaining dentin thickness will probably a major contributor in the development of pulpal pathology following crown treatments. More research is needed to better understand the relationship between the characteristics addressed in this investigation, as well as those that cannot be tracked in an insurance database. A large-scale, prospective research that takes into consideration pulpal diagnosis prior to crown implantation, surviving tooth structure, and the status of present restorations, in particular, would make it possible for a more full and accurate evaluation of the components contributing to this pathologic process.

Conclusion

This is the first insurance-based research to determine and analyse the factors that lead to the occurrence of NS-RCT when single-unit full-coverage restorations are delivered. Within the constraints and limitations of this study, the rate of adverse events following crown installation was modest, with a forecasted survival rate of 90.41% after 9 years. The survival rate falls with increasing age at the time of crown implantation, as well as with the use of PFM and all-ceramic crowns. These results indicate that leftover dentin thickness at the time of crown prep has an important effect on the likelihood of adverse outcomes after the crown is placed. Prospective studies to standardize procedure protocol and get findings from pre-operative and post-operative pulpal assessment ought to be the emphasis of future investigations in this field.

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