

Comparison of Bite Force and the Influencing Factors Pre- and Post-cementation of Stainless Steel Crown in Children Using T-Scan

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ABSTRACT

Background: In children, stainless steel crowns (SSCs) have become an invaluable restorative option for grossly decayed primary teeth. The crowns are manufactured in different sizes with preformed anatomy which requires trimming or contouring as a necessary step to fit an individual tooth. Initially, this may produce variation in the occlusal contact points yet may not result in pain or discomfort. Little research exists regarding bite force equilibration measurements in children after placing SSC, and its influencing factors such as age and gender.

Aim and objective: To evaluate and compare the measurements of bite force pre- and post-cementation of SSC using the conventional technique at maximal intercuspal position (MIP) on primary molars at different time intervals and whether age and gender influence bite force measurements.

Design: Bite force and occlusal contacts during occlusion were made using T-Scan III. Twenty children scheduled for treatment who needed SSCs were included. T-Scan measurements of the bite force and occlusal contacts of the maxilla and mandibular teeth were recorded and analyzed before and immediately after cementation of SSC later 4 weeks during the follow-up period. These measurements were correlated with age and gender influence.

Results: There was no significant result in the percentage of bite force on the crowned tooth (placement of SSC) at different time intervals. Prematurities were present in all the groups but a significant reduction was seen on the crowned tooth from baseline to 1-month follow-up ($p = 0.03$). Also, a statistically significant increase in the bite force was seen in >7 years of age ($p = 0.006$) and no statistical significance among the gender.

Conclusion: Following the standard tooth preparation, the SSC will continue to appear clinically acceptable for many years. Our study children showed an adaptable masticatory system irrespective of age and gender during growth and development.

Keywords: Bite force, Maximal intercuspal position, Stainless steel crown, T-scan.

International Journal of Clinical Pediatric Dentistry (2021): 10.5005/jp-journals-10005-1900

INTRODUCTION

Mastication provides the stimulus and proper function to the normal development of the maxilla and mandible when it is adequate. The relationship of maximum bite force and the masticatory system is well documented in the literature to indicate the health of the stomatognathic system. Several factors like occlusal contact area, number of functional teeth and bite force potentially influence masticatory efficiency, and areas of contact between occluding teeth determine the area available for shearing food during each chewing cycle.¹ Extensive carious teeth will compromise the contact between occluding teeth hence it affects masticatory efficiency. In such compromised pediatric dentition, stainless steel crowns (SSCs) are the choice of restoration since 1950.²

In restorative dentistry, the search for minimally invasive treatment options to contribute to atraumatic dental occlusion is increasing. It constituted a great difficulty to analyze the problems arising from occlusal origins due to the complex nature of the human occlusal system. Hence, three-dimensional occlusal analysis on par with reality, no doubt it is placed at the pinnacle of our dental profession.³ Bite force evaluation helps to understand the mechanics of mastication, muscle activity during mastication, and the influence of physiological factors during the masticatory performance.⁴ Different bite force recording devices are commercially available and the most advanced being the T-Scan. In the literature, it is apparent that bite force increases

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How to cite this article: Aishwarya N, Nagarathna C, Poovani S, et al. Comparison of Bite Force and the Influencing Factors Pre- and Post-cementation of Stainless Steel Crown in Children Using T-Scan. *Int J Clin Pediatr Dent* 2021;14(1):46–50.

Source of support: Nil

Conflict of interest: None

throughout growth and developmental period, hence correlation of age and gender is significant in growing children. However, little research exists regarding bite force equilibration measurements in children after placing SSC, and its influencing factors such as age and gender.

This study aims to evaluate and compare the bite force pre and post cementation of SSC with the conventional technique of tooth

preparation on primary molars using T-Scan III and compare age and gender influence on bite force measurements.

MATERIALS AND METHODS

Ethical Considerations

The study protocol was approved by the institutional ethical committee Ref: RRDC&H/PG-135/2016-2017 and if the child matches the inclusion criteria, informed consent was obtained from the parent.

Study Design and Participants

This study was carried out in the Department of Pedodontics and Preventive Dentistry, in collaboration with Orofacial pain clinic, RajaRajeswari Dental College and Hospital, Bengaluru. Twenty children aged 6–10 years with good general health, intact dentition with normal molar relation requiring unilateral placement of SSC for primary molar due to multi-surface caries, wide proximal carious lesion, requiring pulp therapy were included. Children with differentially abled children, TMJ problems, and pernicious oral habits were excluded from the study.

Clinical Study

The demographic detail which includes age and gender was recorded. A digital bite analyzer (T-Scan III, Tekscan Corp, Boston, Mass., USA) was used to measure the bite parameters. The bite was recorded using the multi-bite analysis setting on the software.

T-Scan sensor was customized to the size of the child’s mouth and measurements were taken for calibration.

Subjects were asked to sit upright in a dental chair with the Frankfurt Horizontal (FH) plane parallel to the floor to avoid the effect of head posture on the occlusal contact pattern. Each patient was assigned with their own sensor and an individualized sensor was used for all three readings (preoperative, postoperative, and 1-month follow-up) during evaluation.

Each child was asked to bite on a sensor and occlusion was confirmed. A single examiner recorded all three readings.

The outcome measure for each molar was the percentage of the total force in the mouth that occurred on the tooth (Fig. 1). The single closure that contained the maximum recorded occlusal force was selected for analysis. Later all the patients were treated and restored with SSC using conventional technique. After completion of the required treatment procedure, bite force and premature contacts in occlusion if any were recorded immediately after cementation of SSC (Fig. 2) and 1 month follow-up period (Fig. 3) as mentioned in the baseline evaluation.

Data Analysis

Friedman’s test was used to compare the mean percentage of force on the crowned tooth at different time intervals pre- and postoperatively. Cochran’s Q test followed by McNemar’s test as *post hoc* analysis was used to compare the prematurities between different time intervals. Student’s paired t-test was used to compare the mean percentage of force on the left and right sides of the

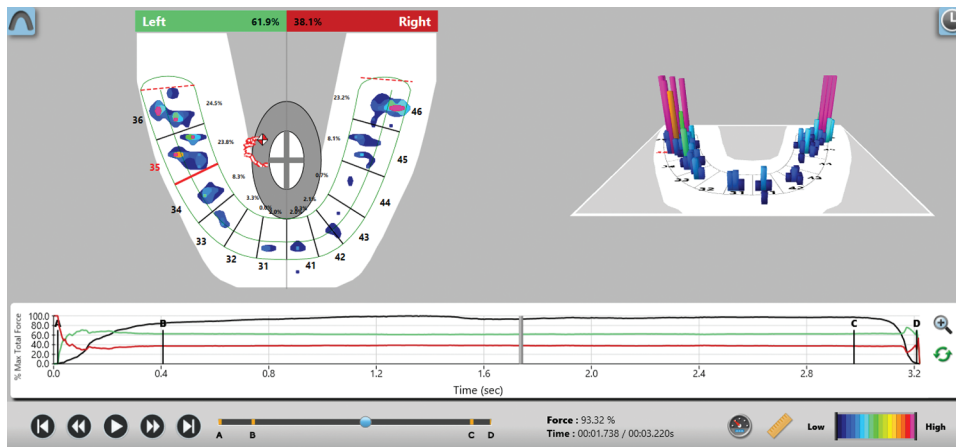


Fig. 1: Pretreatment multi-bite image at maximal intercuspal position

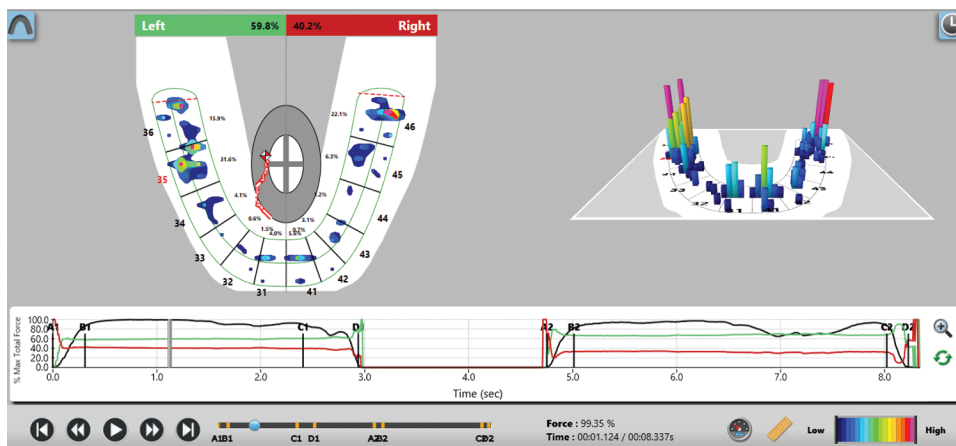


Fig. 2: Posttreatment multi-bite image at maximal intercuspal position

arch at different time intervals. Mann–Whitney *U*-test was used to compare the mean percentage of force on the crowned tooth at different time intervals based on their age and gender. All analyses were carried out using SPSS 22.0 software (IBM Corp., Armonk, N.Y., USA), and the level of significance for all tests was set at $p < 0.05$.

RESULTS

The study included 20 children with equal distribution among girls and boys with a mean age of 7.35 years (range 6–10 years) (Table 1). Bite force was calculated on the crowned tooth at all the three visits, no statistically significant differences were evident ($p = 0.17$) (Table 2). Mean of bite force distribution on the left and right side of the arch at various time intervals compared, and the difference was

not significant (Table 3). Prematurities on crowned tooth between various time intervals were compared, at baseline, 60% of the children had the presence of prematurities, which reduced to 35% of the children 1 month postoperatively. These differences were found to be statistically significant ($p = 0.03$) (Table 4). Age- and gender-wise comparison of values were given in Tables 5 and 6.

DISCUSSION

The use of SSCs as the full-coverage restoration of choice for teeth with restorations with three or more carious surfaces is a fact that has been documented extensively in the literature.⁵ The occlusal implications of placing SSCs in children have received little attention in the literature.^{5,6} At the time of this study, there were only two

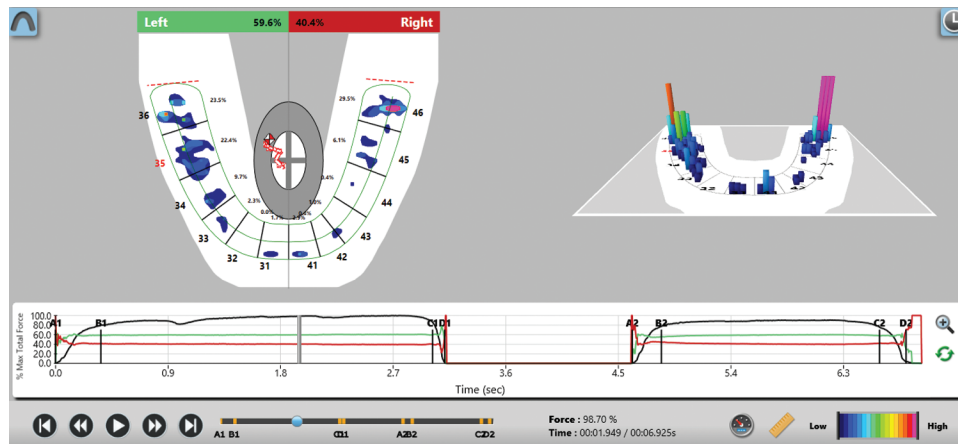


Fig. 3: Posttreatment after one month follow-up multi bite image at maximal intercuspal position

Table 1: Age and gender distribution among study subjects

Variables	Category	N	%
Age	<7 years	11	55
	>7 years	9	45
	Mean ± SD	7.35	1.31
	Range	6–10	
Gender	Male	10	50
	Female	10	50

Table 2: In group comparison of mean percentage of bite force on the crowned tooth b/w different time intervals using Friedman's test

Time	N	Mean	SD	Min	Max	H	p value
Baseline	20	15.66	11.67	1.5	45.9	3.600	0.17
Immediate	20	18.85	11.48	3.3	38.1		
1 month	20	14.75	9.13	2.4	41.1		

Table 3: Comparison of mean percentage bite force distribution on the left and right side of the arch at different time intervals using Student's paired test

Time	Arch side	N	Mean	SD	Mean diff.	T	p value
Baseline	Left	20	49.15	9.86	–1.71	–0.388	0.70
	Right	20	50.86	9.86			
Immediate	Left	20	49.31	12.61	–1.39	–0.246	0.81
	Right	20	50.70	12.61			
1 month	Left	20	50.65	10.96	1.33	0.270	0.79
	Right	20	49.33	11.00			

Table 4: Comparison of prematurities on crowned tooth between different time intervals using Cochran's Q test followed by McNemar's test as post hoc analysis

Prematurity	Baseline		Immediate		1 month		p value	Significance difference		
	N	%	N	%	N	%		B vs I	B vs 1	I vs 1
Yes	12	60	12	60	7	35	0.02*	1.00	0.03*	0.06
No	8	40	8	40	13	65				

Table 5: Age-wise comparison of mean percentage of bite force on the crowned tooth at different time intervals using Mann-Whitney U test

Time	Age-group	N	Mean	SD	Mean diff.	Z	p value
Baseline	<7 years	11	9.29	5.55	-14.14	-2.773	0.006*
	>7 years	9	23.43	12.70			
Immediate	<7 years	11	14.12	9.18	-10.52	-2.013	0.04*
	>7 years	9	24.63	11.80			
1 month	<7 years	11	10.24	6.31	-10.02	-2.737	0.006*
	>7 years	9	20.26	9.27			

Table 6: Gender-wise comparison of mean percentage of bite force on the crowned tooth at different time intervals using Mann-Whitney U test

Time	Gender	N	Mean	SD	Mean diff.	Z	p value
Baseline	Male	10	12.83	7.10	-5.65	-0.378	0.71
	Female	10	18.48	14.81			
Immediate	Male	10	19.99	11.40	2.28	-0.227	0.82
	Female	10	17.71	12.06			
1 month	Male	10	13.90	6.98	-1.69	-0.038	0.97
	Female	10	15.59	11.20			

studies that had attempted to digitally record the impact of the placement of SSC in children.^{5,7} Digital bite analysis has been used in the fields of prosthodontics and orthodontics, but in the field of pedodontics, it is relatively new and unexplored.

The analyses showed no significant result in the percentage of bite force on the crowned tooth and bilateral force distribution at different time intervals pre- and postoperatively. In our study, we have done conventional tooth preparation for SSC, this itself reduced the likelihood of occlusal disturbance. Second, the balanced distribution of forces maintained as children were in Angle's class I molar relation with good occlusion. Other studies showed that the presence of malocclusion influenced the maximum bite force on the posterior region based on the number of teeth present and occlusal contacts.^{8,9} Apart from studies with relation to bite force and its equilibration in literature, it has been suggested that in children interferences <1 mm are well tolerated with dentoalveolar compensation and young children have an adaptable masticatory system in which changes occur quickly for the stability of occlusion.⁷ Recent clinical trial has shown that SSCs will adapt themselves into normal occlusion within 3 months of placement due to the developing nature of dentition in children.^{5,10} One study found a statistically significant increase in the percentage of bite force on the left side of the dental arch for all the studied groups, i.e., individuals with normal occlusion and Angle's malocclusion classes II and III.¹¹

However, parental reporting of high points or difficulty in mastication in children who have received SSC restoration has been previously documented in the literature.^{6,12} These studies have shown that these complaints have disappeared after 3 months. In this study, prematurities were present in all the groups but a significant reduction was seen on the crowned tooth from baseline to 1-month follow-up. The increased number of outliers

in the first week postoperatively is in keeping with the previously reported incidence of occlusal disturbances in children receiving SSC restoration.^{5,6} The reduction in these prematurities by the 4th week was due to the changes in occlusion caused by SSCs were well tolerated with dentoalveolar compensation, the eruptive potential of teeth in younger children, treatment of the carious tooth, psychological accommodation to the testing procedure over time and learning capabilities on how to be more effectively produce bite force according to examiner's instructions.

This study reported greater bite force with subjects older than 7 years of age on the crowned tooth, which could be related to the further development of the masticatory system, increase in the number of occlusal contacts during the transition period which improves the masticatory performance on a treated carious tooth. This is in agreement with the literature, where maximum bite force increases progressively between 7 years and 17 years of age¹³ as a greater increase in the molar bite force can be explained biomechanically due to greater mechanical advantage but it stabilizes once the growth spurt ceases and stays fairly constant from 20 to 40 years^{9,14,15} then declines due to tooth decay^{8,16} and reduced androgenic hormones.^{8,17} In contrast, some studies had shown a relatively small effect of age on bite force.^{8,18,19}

This study result also showed that there is no statistically significant bite force between males and females in the crowned tooth. This result was in agreement with several studies in the literature²⁰⁻²² due to similar body structure and muscle strength in the study subjects but males on average had greater bite force than females^{8,11,23,24} which was due to the greater muscular potential,^{11,23,24} masseter muscle of males have type II fibers with a larger diameter and greater sectional area than those of females,²⁵ men's teeth are 1-4% larger than those of females thus have a supportive tissue to tolerate higher value of bite force in the molar

region²⁶ and also reported that males have larger periodontal ligament area which can give a greater bite force.^{24,27} On the other hand, few studies reviewed females have greater bite force than males during the pubertal period.^{28,29}

The results of this study should be viewed with certain limitations in mind. The small sample size made it difficult for bite force comparison with age and gender association after the placement of SSC. The intervention has been done on anyone's primary molar present on both the sides of the upper and lower arch hence increase or decrease in the bite force cannot be purely attributed to a particular molar. Further research should focus on the possible changes of occlusion in other age groups where SSCs have been placed. Research is also needed to check the role of newer pediatric tooth-colored crowns and restorations on occlusion of children and their muscle activity using electromyography.

CONCLUSION

Based on this study's results, the following conclusions can be made:

- The mean occlusal bite force was not statistically significant following dental restoration with SSC of primary molars.
- The change in occlusion caused by SSCs was transient and disappears with time as there was a significant reduction in prematurities from baseline to 4th week follow-up period following restoration with SSC.
- Bite force in children increased progressively after 7 years of age.
- There was no effect of gender on bite force in all the subjects between the age group of 6 and 10 years.

Why is this Article Important to Pediatric Dentists?

- Bite force measurement using T-Scan will give evidence-based results to explain the self-correction of dentition after the treatment with SSC.

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