Comparison of crown dimensions of 3M ESPE stainless steel crowns for mandibular first permanent molars with population average: A cross sectional study in a group of male children of Belagavi city

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Abstract

Background: The clinical success of SSCs depends on selection of appropriate crown.

Objective: To compare the bucco-lingual dimensions of 3M ESPE stainless steel crowns sizes 2, 3 and 4 with that of mandibular right first permanent molars in a group of male children of Belagavi city.

Materials and Methods: This was a cross – sectional study. Rubber base impressions of mandibular arch of 300 healthy boys (age 9-14 years) were made. Casts poured in die stone. Standardized images of the occlusal surfaces of mandibular dental casts were made with a digital camera (Nikon D7000) and transferred to the computer software for measurement (Corel DRAW graphics suite X15, Corel corporation, New York, USA). All the images were enlarged to 1600%. Mesio-distal and bucco-lingual dimensions of mandibular right first permanent molar and SSCs were measured using ruler in software. Three lines were drawn and the average of which was considered. Mandibular right first permanent molars were grouped into group I, II and III corresponding to the mesio-distal dimensions of size 2, 3 and 4 3M ESPE SSCs respectively.

Statistical analysis: Mean BL dimensions of population and corresponding SSCs were analyzed using one sample t- test.

Results: The BL dimension of 3M ESPE SSCs size 2, 3, 4 were 9.51 ± 0.07 , 10.18 ± 0.05 , 10.41 ± 0.04 respectively. The BL dimension of corresponding right mandibular first permanent molar were 10.04 ± 0.52 ($p < 0.0001$), 10.48 ± 0.57 ($p = 0.0006$), 10.71 ± 0.52 ($p = 0.016$) respectively.

Conclusion: Bucco-lingual dimensions of right mandibular first permanent molars of population were greater than bucco-lingual dimensions of corresponding SSCs.

Keywords: Dimensions; Bucco-lingual, Mesio-distal, First permanent molar, Stainless Steel Crowns.

Introduction

The first permanent molar has a key role in occlusion and mastication. It's several pits and fissures makes them susceptible to dental caries.^[1] As per national oral health survey 2002-03, overall caries prevalence in India was 53.8% at the age of 12 years.^[2] Mandibular first permanent molar have higher caries prevalence of 81.3%.^[3] Many of these would require pulp therapy followed by full coverage restoration.^[4] The most common full coverage restoration is stainless steel crown as an interim restoration.^[5]

Amongst different brands of stainless steel crowns available 3M ESPE SSCs are most popular. SSCs are manufactured based on the epidemiologic data of the manufacturing country and may not be suited for the population where it is intended to be used, as the dimensions of tooth varies in the population of different countries & ethnicities.^[6] It is important that SSCs should fit both mesio-distal and bucco-lingual dimension for a predictable clinical outcome.^[7] Hence it is desirable that the manufacturers of SSCs provide information regarding bucco-lingual dimensions for each mesio-distal dimension.

Therefore, the purpose of this study was to compare bucco-lingual dimensions of right mandibular first permanent molar with corresponding bucco-lingual dimensions of sizes 2, 3 and 4 of 3M ESPE SSCs in a group of male children. Null Hypothesis to be tested was that there was no difference in mean bucco-lingual dimensions of the population and given bucco-lingual dimensions of SSCs.

Materials and Methods

The study was conducted on 300 boys aged 9-13 years who reported to the department of Pediatric and Preventive Dentistry, after obtaining informed written consent. Fully erupted and healthy right mandibular first permanent molars were included in the study. Children suffering from severe systemic condition, malposed, carious, hypoplastic first permanent molar was excluded from the study.

Rubber base impressions (Aquasil, Dentsply, New Delhi, India) of mandibular arch were made, washed under running water and disinfected with 2% Glutaraldehyde solution. Dental casts were poured using type III dental stone

(die stone) and base were poured in base former with dental plaster.

The occlusal plane of the dental casts were defined using mesial cusps and distal most cusps of mandibular first permanent molar. The casts were oriented in such a way that the occlusal plane were parallel to the lower border of the base. Standardized images of the occlusal surfaces of mandibular dental casts were made with a digital camera (Nikon D7000). It was ensured that the angle of incidence between the camera (mounted on a tripod) and the occlusal plane was always be 90° and it was centered over occlusal surface. The distance between the camera and the occlusal plane were kept at 23 cms and photographs were shot with maximum (105 mm) focal length. Also, a millimetre graph paper was pasted just adjacent to the buccal surface of the mandibular first permanent molar to facilitate calibration of the image while recording the measurements on the computer screen (Fig1).

Each digital image of the dental casts were transferred to the computer software for measurements. All the images were enlarged to 1600% (one of the standard settings in computer software, Corel DRAW graphics suite X15, Corel corporation, New York, USA) for calibration (Fig2). Mesio-distal measurements were done from the greatest convexity on the mesial surface to the greatest convexity on the distal surface using the ruler in the software that is calibrated to the mesio-distal magnification of millimeter graph paper. Three lines were drawn and the average of three were taken into account (figure 3). Based on obtained mesio-distal dimensions teeth were grouped as follows:

S. No	Groups	Dimensions
1	Group I (Corresponding to size 2 3M ESPE SSCs)	10.8 ± 0.2 mm
2	Group II (Corresponding to size 3 3M ESPE SSCs)	11.2 ± 0.2 mm
3	Group III (Corresponding to size 4 3M ESPE SSCs)	11.6 ± 0.2 mm

Then for each mesio-distal dimension its bucco-lingual dimension were assigned to respective group. Bucco-lingual dimensions were considered from greatest convexity on the buccal surface to greatest convexity on lingual surface. Three

lines were drawn and the average of three were considered (Fig3).

To simulate the free gingival margin around teeth sprue wax (Renfert, Germany) with 1mm dimension was adapted to the margin of 3M ESPE SSC size 2, 3 and 4. The bucco-lingual dimension of the SSCs were then measured as the greatest bucco-lingual dimension at one millimeter above the crown margin. Three lines perpendicular to mesio-distal dimension were drawn and the average of three were considered (Fig4).

Statistical analysis

The mean and standard deviations of mesio-distal dimension and bucco-lingual dimensions were tabulated. Bucco-lingual dimensions of population with bucco-lingual dimensions of SSCs were analyzed by using one sample t-test. The level of significance were set at $\alpha=0.05$.

Results

The purpose of this study was to compare bucco-lingual dimensions of right mandibular first permanent molar in the population with bucco-lingual dimensions of SSCs in boys. Table 1 shows number of teeth assigned to size 2,3 and 4 SSCs groups, which were based on the measured mesio-distal dimension of right mandibular first permanent molars. Mean and standard deviation of measured bucco-lingual dimensions of right mandibular first permanent molar in the population corresponding to size 2, 3, 4 3M ESPE SSCs were as follows: Group I (size 2) - 10.04±0.52, Group II (size 3) - 10.48±0.57, Group III (size 4) - 10.71±0.52.

Table 2 shows mean and standard deviation of measured bucco-lingual dimensions of 3M ESPE SSCs size 2, 3, 4 for right mandibular first permanent molar as follows Group I (size 2) - 9.51±0.07 mm, Group II (size 3) - 10.18±0.05 mm, Group III (size 4) - 10.41±0.04mm.

One sample t-test was used to compare bucco-lingual dimensions of sample mean values with bucco-lingual dimensions of SSCs. It was found that group I, group II and group III had greater bucco-lingual dimensions (10.04mm, 10.48mm, 10.71mm respectively) than 3M ESPE SSCs (9.51mm, 10.18mm, 10.71mm respectively). The difference was statistically significant ($p < 0.0001$, $p = 0.0006$ and $p = 0.016$ respectively).(Table 3)

Table 1: Mean and standard deviation of measured bucco-lingual dimensions of the grouped population corresponding to size 2, 3, 4 3M ESPE SSCs for right mandibular first permanent molar.

Total sample	MD dimensions of 3M ESPE SSCs studied (mm)	Range of MD dimensions of population included (mm)	Number of teeth assigned according to MD dimension	Mean ± SD of measured bucco-lingual dimensions population studied
300	10.8	10.6-11.00mm	n=98	10.04±0.52
	11.2	11.01-11.40mm	n=47	10.48±0.57
	11.6	11.41- 11.80mm	n=21	10.71±0.52
	Un assigned	<10.6 mm & >11.80mm	n= 134	

Table 2: Details of measured bucco-lingual dimensions of 3M ESPE size 2, 3 and 4 SSCs for right mandibular first permanent molar.

Groups of 3M ESPE SSCs studied	Measured Bucco-lingual dimensions (mm)			Mean $\pm$ SD
	BL1	BL2	BL3	
Group I (Corresponding to size 2 3M ESPE SSCs)	9.44	9.59	9.50	9.51 $\pm$ 0.07
Group II (Corresponding to size 3 3M ESPE SSCs)	10.23	10.18	10.13	10.18 $\pm$ 0.05
Group III (Corresponding to size 4 3M ESPE SSCs)	10.45	10.43	10.37	10.41 $\pm$ 0.04

Table 3: Comparison of bucco-lingual dimensions of 3M ESPE SSCs for right mandibular first permanent molar and the mean bucco-lingual dimensions of the right mandibular first permanent molar of the grouped population.

Groups of 3M ESPE SSCs studied	Mandibular First permanent molar					
	Mean BL dimensions of SSCs	Mean BL dimensions of the population	S.E	Df	t- value	One sample t test
Group I : (Corresponding to size 2 of 3M ESPE SSCs) 10.8 $\pm$ 0.2 mm	9.51	10.04 (n=98)	0.053	97	10.10	p< 0.0001
Group II: (Corresponding to size 3 of 3M ESPE SSCs) 11.2 $\pm$ 0.2 mm	10.18	10.48 (n= 47)	0.083	46	3.68	p=0.0006
Group III: (Corresponding to size 4 of 3M ESPE SSCs) 11.6 $\pm$ 0.2 mm	10.41	10.71 (n= 21)	0.11	20	2.62	p=0.016

Fig. 1: Photographic set up (distance of camera lens from the cast set at 23 cms) **Fig. 2:** Calibration of the ruler in the tool box option of the software (corel Draw Graphics suit X15, Coral corporation, New York, USA) **Fig. 3:** Measurement of the mesio-distal and bucco-lingual dimensions of the Mandibular right first permanent molar

using the ruler in the software (Corel Draw graphics suite X15, Corel Corporation, New York, USA).

Fig. 4: Measurement of bucco-lingual dimensions of the 3M ESPE SSC using the ruler in the software (Corel Draw graphics suite X15, Corel corporation, New York, USA) after calibration of the scale in bucco-lingual direction.

Discussions

SSCs introduced by Engel & Humphrey in 1950,^[7] are commonly used for the restoration of primary and as interim restoration for permanent posterior teeth. They had 88 % success rate as an interim restoration at the end of 45.18 months and are best in terms of durability and longevity.^[5] The success of SSCs depends on proper selection of appropriate crown for the respective tooth.^[7] SSCs are manufactured based on the epidemiologic data of the manufacturing country.^[6] An important issue that needs to be taken into account is that dimension of SSCs manufactured by particular company may not be suited for population of different countries & ethnicities, as the size of tooth varies in the population of different countries & ethnicities.^[6] The manufactures provides information regarding mesio-distal dimensions of SSCs available in the market.^[6] The main area of concern is whether the bucco-lingual dimensions of the SSCs are similar to the bucco-lingual dimensions of molars in various groups of population. In order to answer this question, we compared the bucco-lingual dimensions right mandibular first permanent molar with corresponding bucco-lingual dimensions of sizes 2, 3 and 4 of 3M ESPE SSCs in the group of male children. It was interesting to know that bucco-lingual dimensions of population were larger than bucco-lingual dimensions of SSCs in the all three group studied.

There are very few studies reported in the literature which have compared bucco-lingual dimensions of SSCs with different population. This study was performed in boys as literature reports sexual dimorphism were in male had larger mean measurement than female.^[8,9] The present study found to have larger bucco-lingual dimensions of right mandibular first permanent molar than bucco-lingual dimensions of SSCs. Afshar et. al. compared the bucco-lingual and mesio-distal dimensions of primary molars with those of 3M SSCs in Iranian population. The best fit was seen with mandibular second molars and poor fit was seen with maxillary first and second molars.^[6]

Proper fit and marginal adaptation is the important criteria in selection of crown.^[7] The selected crown should fit both in bucco-lingual and mesio-distal dimensions. While adapting the accurately selected SSC for the given mesio-distal dimension, it has been observed that it would not fit bucco-lingually and require more bucco-lingual reduction or clinician tend to select larger crown in mesio-distal dimension to cover the dimension bucco-lingually. Improper fit may lead to plaque accumulation, marginal gingivitis and improper proximal contact. In order to avoid these difficulties and to reduce chairside time while selecting the crown clinician should consider bucco-lingual dimension of SSCs along with its mesio-distal dimension.

In most of the earlier reported studies, dental casts were poured in dental stone and dimension were measured manually with divider or caliper which is subject to human error.

In the present study we have tried to minimize the errors by following mechanism:

1. Impression were made with rubber base material and cast poured in die stone to reduce distortion.
2. The photographic set up was standardized, thus repetitive images could be taken.
3. Measurements were done using computer softwares, Corel DRAW graphics suite X15, Corel corporation, New York, USA. All the images were magnified at 1600% for accurate measurement.

The limitation of the study is that, the outcome of the study based on convenience sample of male children visiting the institute for routine dental treatment. Further studies involving larger representative samples of broader geographical areas including both girls and boys can be carried out to ascertain or confirm the findings of the present study.

Conclusion

Within the limitations of the study, following conclusions can be drawn:

1. Among the population, teeth assigned to group I, group II and group III found to have greater bucco-lingual dimensions compared to the 3M ESPE SSCs,
2. For proper fit, marginal adaptation and successful clinical outcome of SSCs, it is important to consider bucco-lingual dimensions along with mesio-distal dimensions.
3. The manufacturers of SSCs, need to provide information regarding bucco-lingual dimensions (greatest bucco-lingual dimension in middle third of the crown) for each mesio-distal dimension, which will help the clinician for accurate crown selection. By doing so, there is no need for excess tooth preparation and time is saved which is particularly important in children.

List of abbreviation

BL -	Bucco-lingual dimension
MD -	Mesio-distal dimension
DF -	Degree of freedom
SD -	Standard deviation
S.E -	Standard error
SSCs -	Stainless Steel Crowns

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Conflict of Interest

None.

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