Comparative evaluation of bite force in paediatric patients

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ABSTRACT

Aim: The present study aimed at analysing the probable effects of full mouth oral rehabilitation on bite forces at their maximum extent in young paediatric patients with primary as well as mixed dentitions. Methodology: The present study is one of a kind and explores the maximum bite forces in young children. A statistically significant number of children (n = 30) with a mean age of 6.54 years. About 44.75% were boys and 55.25% were girls. The maximum voluntary bite force was assessed for each participant immediately before treatment and 1 month (3-5 weeks) following completion of the needful dental treatment. The difference in bite force magnitude before and after dental treatment was analysed statistically. In addition, the correlations of key variables including, age, height, weight, BMI, gender and caries severity or dental status with maximum bite force were statistically analysed. Results: The mean maximum bite force for the total sample (n = 30) prior to treatment was found to be 167.83 N (SD = 65.20). The mean bite force in the male subgroup was 175.39 N (SD = 64.69) while for the females the mean bite force was equal to 166.29 N (SD = 68.93). Following comprehensive dental treatment, the recorded mean maximum bite force for the children (n = 30) who attended the post-treatment review appointment was 182.60 N (SD = 68.58). Conclusion: The essential factors such as the extent of dental caries, their severity, presence of clinical signs and symptoms has a negative impact on maximum bite force.

Keywords: Bite force, dental, paediatric

Introduction

This study showed that bite force in children is negatively impacted by a number of essential factors including, the severity of dental caries as well as the presence of clinical symptoms (i.e. pain and dental abscess). Therefore, the findings can serve as additional supportive evidence to the general public my making sense about the importance of dental treatment for children as it helps to improve the maximum bite force a child can exert.

The maximum bite force is defined as the ability of the mandibular elevation muscles to exhibit maximum strain of lower teeth against upper teeth, under favourable conditions (Calderon et al., 2006).

Aim and Objective

The purpose of the present study was to analyse the probable effects of full mouth oral rehabilitation on bite forces at their maximum extent in young paediatric patients with primary as well as mixed dentitions.

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Methodology

The present study is one of a kind and explores the maximum bite forces in young children. A statistically significant number of children (n = 30) with a mean age of 6.54 years. About 44.75% were boys and 55.25% were girls. (Ethical approval 16-08-2019).

The maximum voluntary bite force was assessed for each participant immediately before treatment and 1 month (3–5 weeks) following completion of the needful dental treatment. A single tooth bite force device was used that has been previously verified for intraoral use in children (Mountain, 2008). The difference in bite force magnitude before and after dental treatment was analysed statistically. In addition, the correlations of key variables including, age, height, weight, BMI, gender and caries severity or dental status with maximum bite force were statistically analysed.

The mean maximum bite force for the total sample (n = 30) prior to treatment was found to be 167.83 N (SD = 65.20). The mean bite force in the male subgroup was 175.39 N (SD = 64.69) while for the females the mean bite force was equal to 166.29 N (SD = 68.93). Following comprehensive dental treatment, the recorded mean maximum bite force for the children (n = 30) who attended the post-treatment review appointment was 182.60 N (SD = 68.58).

Research participants’ inclusion criteria

Young paediatric subjects aged 3–10 years, currently in the primary or mixed dentition period who had been referred to the paediatric and preventive dentistry department for dental treatment, were recruited for the current study.

Following inclusion criteria were taken into consideration during recruitment of deemed or suitable paediatric candidates:

• Medically fit or unaffected by any compromising or debilitating medical condition at the time of treatment.
• Children with at least two opposing molars.
• Subjects who visited the faculty for full comprehensive dental treatment that includes restorations and extractions.

Research participants’ exclusion criteria

The following exclusion criteria were followed:

• Absence of at least two opposing molars, thus preventing bite force measurements to be taken in the molar region.
• Exhibited uncooperative behaviours that could affect measurement procedures and/or compromise their safety.

Anthropometric measurements and intraoral examination

Anthropometric measurements included measurement of height and weight using a portable weight and height scales. These recordings were done for all the participants who met the inclusion criteria. This was done as an attempt to assess variables’ influence and build up of the body. Besides bite force values were also calculated. Using a portable stadiometer, child’s height during standing were measured to the nearest 1.0 mm. Using a standard device helped us not to recalibrate the readings during movement. With their head in Frankfurt plane, back straight and feet properly aligned in relation to the foot positioner, children were made to stand against the measuring rod. Using a calibrated electronic portable device, children’ weight was calibrated.

Body Mass Index (BMI) was then determined by calculating weight and height by a known formula which is:

\[
\text{BMI} = \frac{\text{Weight}}{\text{Height}^2}
\]

Baseline data were gathered regarding the children’s gender and age. In addition, questions regarding the presence of dental pain as well as abscesses or recent facial swelling were queried, with the data subsequently recorded. The side of pain or swelling, if present, was also recorded. Dental examination (standard dental charting) was carried out using disposable dental examination kits (mouth mirror and probe) by the investigator, noting missing, present teeth, as well as any signs of dental abscess. In addition, caries experience at both tooth and surface levels were determined in accordance with the WHO criteria (WHO, 1997). To quantify the level of caries in each child, the dmft/dmfs for primary teeth and DMFT/DMFS for permanent teeth indices (decayed, missing and filled teeth- decayed, missing and filled surfaces respectively) were calculated. Present restorations, overjet and overbite were also noted. The presence and category of any malocclusion were recorded. At this stage, children were excluded from the study if they were found to have missing teeth in areas where the bite force was to be recorded. All data collected were recorded in a specifically designed data collection proforma. Two series of bite force measurements were taken for all participants. The first one was immediately prior to the start of dental treatment, whether the treatment was performed under local anaesthetic or under general anaesthesia. Each series of bite force recording involved the measurement of the maximum comfortable bite force at three different positions along the dental arch, namely anterior and right and left posterior (D/E/6).

The same bite force measurements were repeated 4 weeks ± 7 days post-treatment, as well as the dental charting and anthropometric measurements of height and weight using the same form used for the pre-treatment measurements. In addition, all patients who attended for the post-treatment measurements were given appropriate prevention advice and treatment as necessary, including topical fluoride application where indicated.

Bite force measurement protocol (in accordance with the procedure adopted by Mountain, 2008)²

Bite force magnitude was measured in Newtons (N) with the adoption of a formerly tested and verified prototype bite force measurement instrument. Each of the children was seated in a chair. Their body and head were kept in a natural, upright position, ensuring the Frankfort plane was positioned parallel to the floor. Subsequently, each of the children was asked to carry...
out a maximum voluntary comfortable bite force (MVCBF), lasting 2–3 s, at three different locations (anterior, right posterior and left posterior) within the dental arch, with each recording accompanied by a 5-seconds interval. The bite prongs' nylon protective ends were positioned correspondingly with the occlusal/incisal central incisors' surfaces, right first primary molar and second primary molar; if not present, on the other hand, the right second primary molar and right first permanent molar, with the same applying to the left posterior side. For each of the three positions, the peak bite force was measured and accordingly recorded, with each participant's highest of the three taken as the maximum voluntary comfortable bite force [Tables 1-6].

**Apparatus/instruments used to record bite force**

Through the use of a bite force instrument created by Mountain (2008) as part of his PhD research, bite force was measured, ensuring adherence to best guiding principles. The instrument comprised the main body of hinged stainless steel, housing a Model 13 sub-miniature precision load cell. The main body’s lower and upper arms were made from HSS tool steel, and are single-used and easily removed, such as for sterilisation purposes. The main body of the tool was 112 mm in length, whilst the length of the bite prong was 51 mm. The bite prongs’ ends were covered with tough, hard-wearing nylon, able to decrease the potential of tooth penetration as a result of its thickness, and also reducing any subsequent contact with the prong’s metal part, which may impact the accuracy of the bite force measurement and can cause unnecessary discomfort.

**Statistical tests**

All collected data were entered into SPSS (statistical package for social sciences, version 19) for Windows (SPSS Inc. Chicago, IL), software to analyse data. The first step was to test data for missing values and checking for any errors prior to starting data analysis. Data were tested for normality of distribution using Kolmogorov-Smirnov (K-S) and Shapiro-Wilk (S-W) tests. The following section will detail all the statistical methods employed and the results obtained.

**Discussion**

The basic research findings support that young children showed statistically significant. Rise in maximum bite force. There was a peculiar finding that there was a negative link between caries and severity of dental caries and magnitude of bite force. Previously, three studies have been documented correlating the presence of caries with maximum bite forces and findings of the previous two studies by Tsai[10] and Mountain[11] are in support of the present study.

This study’s main aim was the investigation of possible or potential impacts on the magnitude of bite force following the provision of comprehensive treatment of dental caries. The paired sample t-test suggests that there is a statistically significant increase in the values of mean maximum bite force after the child participant has received comprehensive dental treatment ($P < 0.001$). Despite the fact that there are some earlier studies that have examined the impact of orthodontic problems and different types of malocclusion on the magnitude of bite force in children[8-6] no previous study has specifically analysed

**Table 1: Maximum, minimum, mean, standard deviation (SD) and standard error of means for bite force measurements in all three different positions recorded before treatment**

| Bite force according to position | Maximum (Newtons) | Minimum (Newtons) | Mean (Newtons) | SD | SE |
|-------------------------------|-------------------|-------------------|---------------|----|----|
| Anterior Bite Force           | 94.50             | 1.60              | 31.23         | 18.97 | 3.35 |
| Right posterior bite force    | 310.00            | 36.50             | 149.55        | 76.06 | 13.44 |
| Left Posterior Bite Force     | 312.60            | 40.80             | 154.41        | 66.44 | 11.74 |

**Table 2: Maximum, minimum, mean, standard deviation (SD), standard error (SE) of maximum bite force, age, weight, height and BMI before treatment**

| All participants | Maximum bite force obtained | Age | Weight | Height | BMI |
|------------------|-----------------------------|-----|--------|--------|-----|
| Maximum          | 312.60                      | 9.80| 33.80  | 137.50 | 21.80|
| Minimum          | 48.90                       | 3.80| 15.10  | 97.00  | 13.80|
| Mean             | 169.32                      | 6.45| 23.59  | 118.97 | 16.55|
| SD               | 66.20                       | 1.66| 4.86   | 10.22  | 1.77 |
| SE               | 11.70                       | 0.29| 0.85   | 1.80   | 0.31 |

**Table 3: The mean maximum bite force before treatment distributed according to gender**

| Gender       | n   | Mean | SD  | SE  |
|--------------|-----|------|-----|-----|
| Maximum bite force (pre-treatment) |     |      |     |     |
| Boys         | 14  | 175.39| 64.69| 17.29|
| Girls        | 16  | 166.29| 68.93| 16.24|

**Table 4: Minimum, maximum, mean, standard deviation (SD), and standard error (SE) for all caries indices and the number of decayed surfaces (DS) for all participants**

| All participants (n=30) | DMFT/ dmft | DMFS/ dmfs | DS (Decayed surfaces) |
|-------------------------|------------|------------|-----------------------|
| Minimum                 | 2          | 2          | 2                     |
| Maximum                 | 14         | 31         | 31                    |
| Mean                    | 7.62       | 15.09      | 13.81                 |
| SD                      | 2.79       | 6.91       | 6.34                  |
| SE                      | 0.49       | 1.22       | 1.12                  |

**Table 5: Medians and percentile for DMFS/dmfs, DMFT/dmft and DS (number of decayed surfaces) values for all participants before dental treatment**

| Total sample (n=30) | DMFS/dmfs | DMFT/dmft | DS     |
|---------------------|------------|-----------|--------|
| Median              | 14.00      | 8.00      | 12.50  |
| Percentiles 25      | 11.25      | 6.00      | 10.25  |
| 50                  | 14.00      | 8.00      | 12.50  |
| 75                  | 17.50      | 9.50      | 16.00  |
| 90                  | 26.10      | 12.00     | 24.00  |
| 95                  | 29.05      | 12.70     | 28.40  |
Singh, et al.: Bite force evaluation in pediatric population

the impacts of improving dental status through the restoration and/or extraction of symptomatic non-restorable teeth. It has been reported that masticatory ability has a direct link with and is influenced by the level of bite force with masticatory function similarly affecting food intake in terms of both quantity and quality, and thereby impacting nutritional status. It may be further suggested that there is an interaction between several key factors, i.e. bite force, dental status, and mastication, which will ultimately impact the growth and nutritional status of the children.

**Conclusion**

The present study's findings can be important in the field of paediatric dentistry. In addition to the previously proved positive effects of treating dental caries in children, this study adds that bite force and subsequently chewing function can be improved by comprehensive dental treatment of decayed teeth.

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**Conflicts of interest**

There are no conflicts of interest.

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| Bite force according to position       | Maximum (Newtons) | Minimum (Newtons) | Mean   | SD     | SE    |
|----------------------------------------|-------------------|-------------------|--------|--------|-------|
| Anterior Bite Force (n=21)             | 96.50             | 9.30              | 41.14  | 21.40  | 4.67  |
| Right posterior Bite Force (n=25)      | 315.00            | 60.30             | 167.90 | 69.44  | 13.88 |
| Left Posterior Bite Force (n=25)       | 323.30            | 57.37             | 168.15 | 63.52  | 12.70 |
| Maximum bite force (n=26)              | 323.30            | 63.80             | 182.60 | 68.58  | 12.91 |