A study of maximum bite force during growth and development

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Clinical and animal experiments have demonstrated the role of masticatory muscle function in normal and abnormal dentofacial development. Various techniques have been used to clinically evaluate the physiological characteristics of the muscles of mastication. One method is the measurement of maximum bite force.

In two earlier studies, correlations of maximum bite force with body type, gender, age, weight, history of prior orthodontic treatment, history of TMJ symptoms, and various cephalometric measurements were reported by the authors.[1,2] In this paper, the relationship of maximum bite to growth and development is studied.

Materials and methods

Four hundred fifty-seven students (231 males and 226 females), ages 6 years through 20 years, participated in the study. The students were volunteers from various schools in the vicinity of Vienna, Austria.

Each subject was instructed to bite as hard as possible on a calibrated bite force transducer three times in succession, resting 2 to 5 seconds between each bite. The largest value was selected as the maximum bite force. This transducer was used by the authors in the two earlier studies cited above. Each subject was standing with a relaxed head posture with Frankfort horizontal approximately parallel to the floor. The transducer was positioned across the arches in the maxillary deciduous first molar or first premolar region, depending on dental maturation, and maintained approximately parallel to the floor in the frontal view. Subjects were excluded from this study if they were missing teeth in these regions or if they experienced local pain related to deciduous teeth about to exfoliate or successor teeth not sufficiently erupted.

Abstract

Bilateral bite force was measured in a sample of 457 subjects (231 males and 226 females) from 6 years through 20 years. The mean maximum bite force was found to increase from 78 Newtons at 6 to 8 years to 176 Newtons at 18 to 20 years. While earlier studies have shown adult males have a greater mean bite force than females, this difference is not evident during growth and development. Gender-related bite force difference likely develops during the postpubertal period in association with greater muscle mass development in males.

Key Words

Bite force • Gender • Growth and development

Submitted: February 1995 **Revised and accepted:** June 1995 Angle Orthod 1996;66(4):261-264.

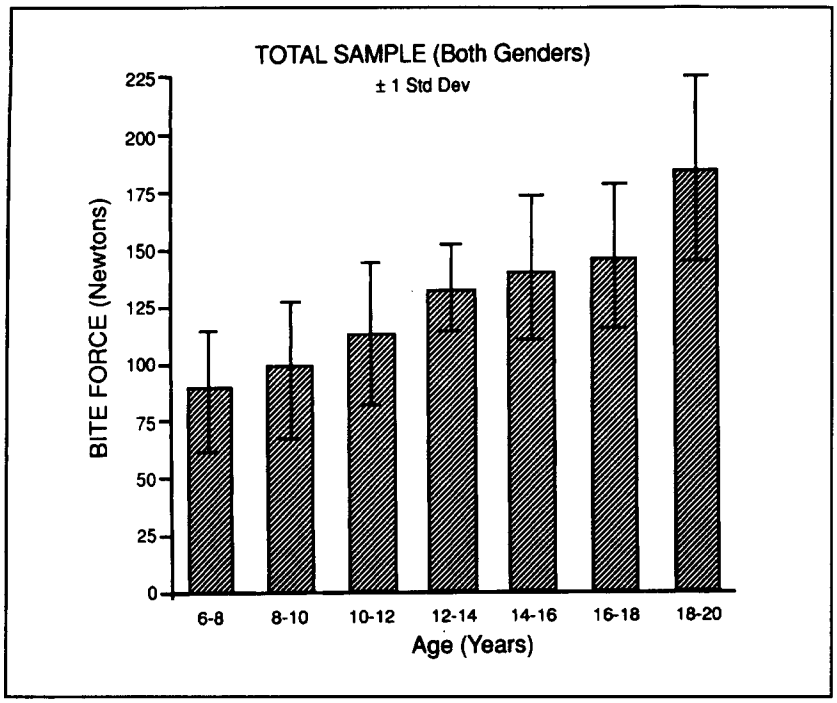

Figure 1

Figure 1
Bite force (N) vs. age of complete sample

Results

The mean maximum bite force of the entire sample, in Newtons, (1 Newton = 102 grams) with one standard deviation versus age is illustrated in Figure 1. The mean maximum bite force for each gender in the sample is shown in Figure 2. It should be noted that the calculation of one standard deviation for male participants from 16 through 18 years was not performed because there were insufficient participants in this age group. Additionally, females 18 through 20 years old were not available for this study.

The linear regression equations for the complete sample and for each gender are as follows: Complete sample: force (N) = 7.00 (age) + 36.41, r = 0.62, P = 0.0001; males: force (N) = 6.85 (age) + 39.35, r = 0.67, P = 0.0001; females: force (N) = 7.32 (age) + 31.07, r = 0.57, P = 0.0001.

When the *t*-test was applied to each age group (adjusted where necessary when the variances were unequal), it indicated no statistical significance of the difference of the means between each gender.

Discussion and conclusions

Earlier studies[3-5] have shown that mean maximum bite force correlates with gender in the adult population. Additionally, a recent study by Bakke et al.[6] found a positive correlation between masseter muscle thickness and maximal bite force. The current study indicates that correlation of maximum bite force to gender is not evident up to age 18. This is supported by studies of Tanner et al.[7] and others[8-10] who have shown the excretion of ketosteroids in postpubertal young men is related to the increase of muscle mass. Beyond age 16, muscle mass increases in males at a significantly greater rate than in females. Thus, continued muscle development may account for gender-related bite force differences in the postpubertal population.

The mean maximum bite force increased throughout growth and development (see regression equations). The maximum mean bite force of 176 Newtons occurred in the age range of 18 to 20 years. This bite force is considerably below that found by the authors in an earlier

study,[1] using the same transducer on a group of adults whose ages ranged from 26 to 41 years. It is important to consider the fact that variations in the maximum bite force have been shown to be associated with instrumentation design and transducer position related to the dental arch.[11-13] A more posteriorly positioned transducer yields a greater bite force. This is likely due to the mechanical lever system of the jaws.[14]

In this study, the most comfortable position of the transducer in the younger patients dictated its position in the first premolar—deciduous first molar region. Thus, it is not surprising to find maximum bite forces that are somewhat lower than those obtained in the authors' earlier study of adults where the transducer was located in the first molar region.

Based on this investigation, it is apparent that maximum bite force increases throughout growth and development without gender specificity. During the postpubertal period, maximum bite force increases at a greater rate in males than in females, and thus becomes gender related.

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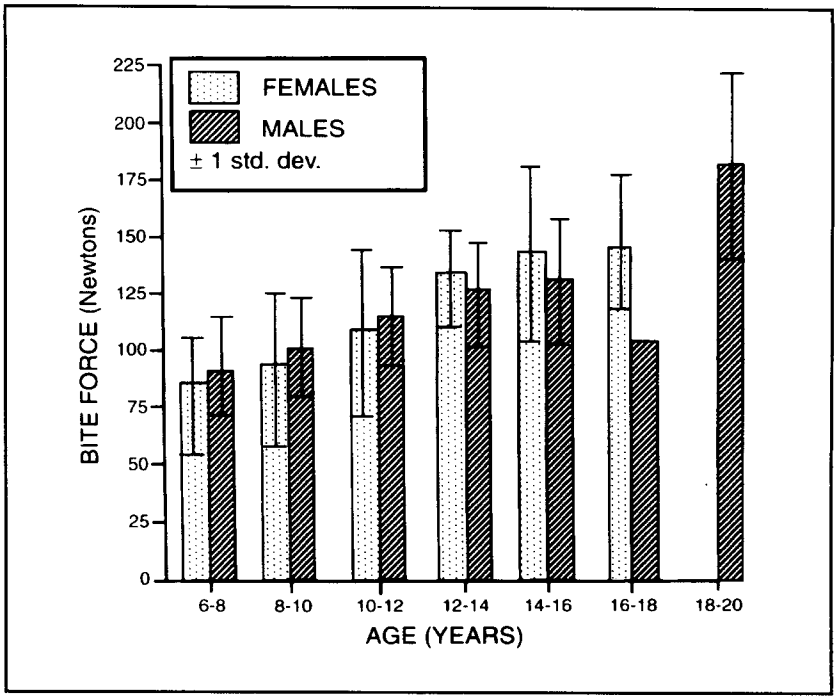

Figure 2

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Figure 2
Bite force (N) vs. age for males and for females

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