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# Evaluation of the Pubertal Growth Spurt Times on Different Malocclusions: A Cross Sectional Study

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**ABSTRACT**

**Aim:** This study aims to compare and examine the relationship between pubertal growth spurt time and malocclusion types.
**Methods:** Hand-wrist and lateral cephalometric radiographs of 1500 patients were examined. Among these records, 279 patients in the peak period of the pubertal growth spurt were included in the study. Skeletal malocclusion of the patients was determined with cephalometric analysis via ANB (˚) angle. If the ANB angle was between 0˚ and 4˚, it was recorded as skeletal Class I; if it was greater than 4˚, it was recorded as Class II; and if it was less than 0˚, it was recorded as Class III. Data were analyzed with one-way analysis of variance and Tukey post hoc tests. Kappa test was also performed to check intraobserver reliability.
**Results:** Intraobserver reliability was found to be excellent. The mean age at the pubertal growth spurt was 12.08 ± 0.8 years in girls and 13.71 ± 1 years in boys. When the age of the pubertal growth spurt was examined according to malocclusion, a statistically significant difference was found between the mean ages of Class I, Class II and Class III. When pubertal growth spurt ages were compared between sexes, a statistically significant difference was found between girls and boys in all malocclusion types.
**Conclusion:** Girls in all malocclusion groups started the pubertal growth spurt earlier than boys. Additionally, it was observed that girls with Class III malocclusion reached pubertal growth spurt earlier than other groups.

## Maloklüzyon Tiplerine Göre Pubertal Büyüme Atılım Zamanlarının İncelenmesi: Kesitsel Bir Çalışma

**Makale Bilgisi**

**Makale Geçmişi**

**Geliş Tarihi:** 04.05.2024
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**Anahtar Kelimeler:**
Maloklüzyon,
Puberte,
Radyografi.

**ÖZET**

**Amaç:** Bu çalışmanın amacı pubertal büyüme atılımı zamanının maloklüzyon tipleri ile arasındaki ilişkinin karşılaştırılarak incelenmesidir.
**Gereç ve Yöntemler:** 1500 hastanın el bilek ve lateral sefalometrik radyografileri incelendi. Bu kayıtlar arasından pubertal büyüme atılımının zirve döneminde bulunan 279 hasta çalışmaya dahil edildi. Sefalometrik analiz ile elde edilen ANB değerine göre iskeletsel maloklüzyon sınıflaması yapıldı. ANB (˚) açısı, 0˚- 4˚ arası ise iskeletsel Sınıf I, 4˚'den büyük ise Sınıf II ve 0˚'den küçük ise Sınıf III olarak kaydedildi. Elde edilen veriler tek yönlü varyans analizi ve Tukey post hoc testleri ile analiz edildi. Gözlemci içi güvenirliliğin kontrolü için de kappa testi yapıldı.
**Bulgular:** Gözlemci içi güvenilirliğin mükemmel olduğu bulundu. Pubertal büyüme atılımının zirve zamanındaki ortalama yaş kızlarda 12,08 ± 0,8 yıl, erkeklerde 13,71 ± 1 yıl olarak ölçüldü. Maloklüzyona göre pubertal büyüme atılımı zamanı incelendiğinde yaş ortalaması Sınıf I, Sınıf II ve Sınıf III gruplar arasında istatistiksel olarak anlamlı fark bulundu. Cinsiyetler arasında pubertal büyüme atılım zamanları karşılaştırıldığında ise bütün maloklüzyon tiplerinde kızlar ve erkekler arasında istatistiksel olarak anlamlı fark bulundu.
**Sonuç:** Tüm maloklüzyon gruplarındaki kızlarda, erkeklerden daha önce pubertal büyüme atılımının başladığı bulundu. Ayrıca Sınıf III maloklüzyona sahip kızların diğer gruplardaki kızlara ve erkeklere göre daha erken dönemde pubertal büyüme atılımına ulaştığı görüldü.

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## INTRODUCTION

In orthodontics, addressing various forms of malocclusion is a common and crucial aspect of treatment. One specific challenge is Class II malocclusion, which involves a discrepancy where the mandible is positioned further back than the maxilla. The treatment of Class II malocclusion characterized by mandibular retrognathia with functional appliances is an essential issue in current orthodontics. The use of growth modification to treat such skeletal anomalies encountered during routine orthodontic examination is a prevalent method today. This method aims to correct the existing malocclusion by directing the physiological bone growth during the patient's skeletal development. Likewise, with appliances, such as face masks used in treating Class III malocclusion, the growth of the maxilla can be increased, and the malocclusion can be treated by modifying the growth direction of the mandible.[1]

In this context, determining the age range of growth modification to be applied to the mandible is of clinical importance regarding treatment planning. To achieve the ideal bony response during the growth modification, the patient must be in optimal skeletal maturation.[2] Doctors need to understand how a child's growth works to predict if Class III malocclusion might relapse after treatment during early puberty. However, skeletal development varies among individuals, and the time of onset of pubertal growth spurt (PGS) is affected by factors, such as sex, society, and environment.[3]

Researchers have evaluated many different parameters to determine the growth potential of adolescents. Many methods, such as weight[4], height[5], sex characteristics[6], dental and skeletal development[7], have been used. Hand-wrist radiographs are also a reliable method frequently used for this purpose.[8-10] In this method, the patient's growth spurt is determined by comparing various indicators in the ossification stages of the carpal and phalanx bones.[11]

Researchers have noticed that there may be differences between the pubertal growth spurt times of individuals with different malocclusions.[12] However, to our knowledge, there is no comprehensive study on this subject in the literature.

This study evaluates the relationship between the PGS time obtained from hand-wrist and lateral cephalometric radiographs taken for diagnostic purposes from patients who applied to the orthodontic clinic and the individual's malocclusion type.

## MATERIAL AND METHODS

Ethical approval was received for this study from the Bolu Abant izzet Baysal University Clinical Research Ethics Committee. The material of this retrospective study consisted of hand-wrist and lateral cephalometric radiographs taken routinely at the beginning of treatment from patients who accepted treatment between 2013 and 2022 at Bolu Abant izzet Baysal university, Department of Orthodontics. In our study, the records of 1500 patients were examined. Among these records, patients in the peak period of the PGS were included in the present study. Patients with systemic disease, trauma or injury to the face and wrist area, and congenital or acquired malformations in the hand-wrist area were not included in this study. We conducted this study in accordance with the Principles of the World Medical Association's Declaration of Helsinki.

The skeletal maturation stage of each hand-wrist radiograph was determined using the method described by Björk and Helm,[3] and those at the Mp3 Capping stage were considered peak. With this method, 279 patients (126 girls, 153 boys) were identified at the PGS's peak. The digital cephalometric analysis program

Nemoceph (Nemotec, Madrid, Spain) was used. Malocclusion classification was made according to the ANB value obtained by cephalometric analysis. If the ANB (˚) angle was between 0˚ and 4˚, it was recorded as skeletal Class I; if it was greater than 4˚, it was recorded as skeletal Class II; and if it was less than 0˚, it was recorded as skeletal Class III. In this process, the demographic characteristics of the patients were noted from the archive records and the relationship between age, sex, PGS time and the type of malocclusion was investigated.

### Statistical Analysis

SPSS V. 26.0 (Statistical Package for the Social Sciences, IBM, NY, USA) statistical package program was used to analyze the data in this study. The data showed normal distribution with the Shapiro-Wilk test. One-way analysis of variance was applied to compare skeletal classes according to sex. Tukey post-hoc test was used to determine differences. An independent samples t-test was used to compare the sexes. The significance level was defined as 0.01 and 0.05. Descriptive statistics were obtained for mean ages by malocclusion type and sex. The hand-wrist maturation (HWM) classification of 30 randomly selected patients was repeated one month later by the same researcher to check intraobserver reliability. Measurement error was evaluated using the Kappa test, and the results were interpreted using the Landis and Koch method.[13]

## RESULTS

As a result of the analysis applied to evaluate the consistency between observations, the Kappa value for HWM S5 was statistically significantly higher (Kappa coefficient: 0.880 and $p<0.001$). According to the Landis and Koch [13] scale, weighted kappa coefficients show almost perfect agreement.

In girls, the mean age at the PGS was 12.08 ± 0.8 years (n = 126). The average age of PGS according to malocclusion was 12.27 ± 1.15 years in Class I malocclusion, 11.81 ± 0.99 years in Class II malocclusion, and 11.65 ± 0.90 years in Class III malocclusion, and this was statistically significant ($p<0.05$; Table-1). In post-hoc tests performed to evaluate the difference between groups, the average age of individuals with Class I malocclusion was significantly higher than that of individuals with Class II and III malocclusion. No difference was observed between Class II and Class III groups. Class III malocclusion was observed as the group that entered the earliest pubertal breakthrough.

**Table 1.** *Average age by sex and malocclusion type*

| Sex | | N | Mean | Standard deviation | Minimum | Maximum | p* |
|---|---|---|---|---|---|---|---|
| Female | Class I | 62 | 12.27 | 1.15 | 9.67 | 15.00 | .026* |
| | Class II | 45 | 11.81 | .99 | 9.92 | 14.50 | |
| | Class III | 19 | 11.65 | .90 | 10.25 | 13.67 | |
| | Total | 126 | 12.01 | 1.08 | 9.67 | 15.00 | |
| Male | Class I | 75 | 13.68 | 1.01 | 11.50 | 16.33 | .0897 |
| | Class II | 59 | 13.76 | .97 | 11.17 | 16.33 | |
| | Class III | 19 | 13.67 | 1.12 | 11.67 | 15.42 | |
| | Total | 153 | 13.71 | 1.00 | 11.17 | 16.33 | |

p<0.05*

Age values at the PGS were 13.71 ± 1 year in boys (n = 153). The average age according to malocclusion was 13.68 ± 1.01 years in Class I malocclusion, 13.76 ± 0.97 years in Class II malocclusion, and 13.67 ± 1.12 years in Class III malocclusion, but this was not statistically significant (p>0.05; Table-1). Post hoc tests were not performed because of the statistical insignificance.

When PGS times were compared between sexes, a statistically significant difference was found between girls and boys in all malocclusion types (p<0.01; Figure 1; Table 2). It was observed that the PGS time of the girls was earlier.

**Table 2.** Comparison of male and female groups according to malocclusion class

| | |
|---|---|
| Class I | .000* |
| Class II | .000* |
| Class III | .000* |

*p<0.01

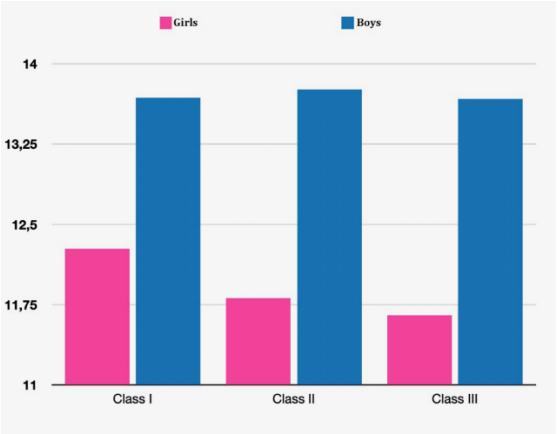


**Figure 1.** Mean age of pubertal growth spurt of girls and boys in different malocclusions.

## DISCUSSION

Knowing the PGS onset and completion times in patients receiving growth modification treatment is crucial in predicting the treatment results.[14] Few studies in the literature examine the PGS duration in different types of malocclusion.[12,15,16] However, to our knowledge, no study has been found comparing the onset time of PGS according to sex for all three types of malocclusion. This study aimed to shed light on this issue.

In their study comparing the PGS time of individuals with Class I and Class II malocclusion, Salazar-Lazo et al.[16] reported that the onset of the growth spurt was similar between both malocclusion types. However, since they did not evaluate the differences between the sexes in their study, their results do not coincide with ours. Our clinical experience is that girls begin the PGS earlier. The results obtained in our study showed that girls entered the PGS earlier than boys in all malocclusion types, and a significant difference was found.

Reyes et al.[15] reported that the PGS lasted longer in individuals with Class III malocclusion and the mandibular length increased more than Class I and Class II individuals. Our study observed that the boys with Class III malocclusion had a growth spurt time similar to other malocclusion types. A significantly earlier pubertal spurt time was detected in girls with Class III malocclusion compared to girls with Class I and Class II malocclusion. This should be kept in mind during the treatment and retention phases if Class III malocclusion treatment will be performed with growth modification.

Kuc-Michalska and Baccetti[12] compared the growth spurt periods of individuals with Class I and Class III malocclusion and reported that the onset of pubertal spurt was similar in both malocclusion types. Additionally, consistent with Reyes et al.,[15] they noted that the PGS lasted an average of 5 months longer in individuals with Class III malocclusion. Since this study also evaluated according to sex, our results differed from those mentioned studies. Although there is no difference in the time of PGS according to malocclusion types in boys, it has been found that in girls, the PGS of individuals with Class III and Class II malocclusion, respectively, starts earlier than individuals with Class I malocclusion.

Hand-wrist radiographs were used to determine the PGS period of the individuals included in our study. As an alternative, the cervical vertebra maturation method developed by Baccetti et al.[2] can also be used. However, some researchers reported that this method is less reliable than hand-wrist radiographs and has moderate repeatability.[17-20] Hand-wrist radiographs were used to determine pubertal growth, even though they required additional radiography examination.

Limitations of this study may include the need for more homogeneity between patients in the determined sample group and patients in different malocclusion groups. According to a meta-analysis published in 2023, 56% of the malocclusions seen in the Turkish population are Class I, 31% are Class II, and 11% are Class III malocclusions.[21] Our study's distribution of individuals according to malocclusion types is also close to the mentioned meta-analysis. Increasing the sample number of the Class III malocclusion group will improve the reliability of this research.

## CONCLUSION

According to the results of this study, it was observed that the PGS started earlier in girls than in boys. Regardless of the appliance used, the patient's growth spurt must be active to achieve an orthopaedic effect through growth modification in treating female patients with Class II malocclusion. Therefore, attention should be paid to the timing of treatment in this patient group. It has been observed that the growth spurt in girls with Class III malocclusion begins earlier than in other groups. It should be considered in clinical practice that the growth of the mandible will accelerate with the growth spurt and that relapse may occur in previously completed Class III malocclusion treatment.

### Ethical Approval

The ethical approval for this study was obtained from Bolu Abant Izzet Baysal University Clinical Research Ethics Committee.

### Financial Support

The authors declare that this study received no financial support.

### Conflict of Interest

The authors deny any conflicts of interest related to this study.

### Author Contributions

Design: MB, YH, Data Gathering: MB, Analysis and Interpretation: MB, YH, Literature Review: MB, YH, Writing: MB.

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