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# The relationship between dental students' perceptions of their educational environment and their life satisfaction and psychological resilience

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## ABSTRACT

**Aims:** Students' positive perceptions of the learning environment increase learning efficiency by contributing to increased participation. The purpose of this study is to examine the relationship between students' perceptions of the educational environment and life satisfaction and psychological resilience.

**Methods:** As part of the research, students were asked questions including age, gender, parents' health status, education level, number of siblings, family income level, systemic diseases, if any, and their impressions of the faculty. In addition, life satisfaction and psychological resilience scales were administered face-to-face. Chi-square and Kruskal-Wallis tests were used to analyse the data. The significance level was determined as  $p < 0.05$ .

**Results:** A majority of undergraduate students (90.8%) reported positive initial impressions of their educational institutions. Additionally, a considerable proportion (93.4%) indicated satisfaction with the physical infrastructure, including the number of classrooms and laboratories. While 68.4% of respondents indicated that the intensity and cost of the educational process was negative, 77.6% reported that dental education was stressful. The psychological resilience of the students was examined, and it was found that 44 (57.8%) exhibited low resilience, 23 (30.2%) exhibited medium resilience, and 9 (11.8%) exhibited high resilience. In terms of life satisfaction, 26 (34.2%) of the participants were found to be at a medium level, 13 (17.1%) at a high level, and 3 (3.9%) at a very high level. Nevertheless, 36 (47.3%) of the participants exhibited a low level of life satisfaction.

**Conclusion:** Despite the generally positive perceptions of the faculty held by students, they perceive the cost of dentistry education as high and the stress associated with it as considerable. Given that students' life satisfaction is low, and their psychological resilience is moderate to weak, it is necessary to review educational programmes and psychological support systems.

**Keywords:** Dentistry, education, psychology

## INTRODUCTION

The concept of student learning has been the subject of research for many years. These factors are generally classified as personal/psychological factors (e.g. student age, intelligence, personality, previous experience) or relational/contextual factors (e.g. perceived quality of teaching and assessment, perceived workload, learning methods, participation).<sup>1</sup> Positive perceptions of the learning environment increase participation and make learning more effective. Similarly, increased participation promotes better learning outcomes, which motivates students to continue to participate.<sup>2</sup> It has been shown that there is a relationship between students' perceptions of education, their satisfaction with the educational environment, perceived well-being, aspirations and academic success.<sup>3,4</sup> It is widely accepted that an unhealthy educational environment has a negative impact

on students' performance and emotional state, leading to ineffective engagement and poor learning outcomes.<sup>5,6</sup> On the other hand, the learning process of university students is a complex process resulting from the interactions between instructors, students' individual characteristics and learning domains.<sup>7</sup>

The concept of quality of life is associated with positive elements such as happiness, success, wealth, health, and satisfaction. Quality of life also affects individuals' overall life satisfaction, emotional well-being, and functionality.<sup>8</sup> Life satisfaction is a cognitive or judgmental process in which individuals evaluate their quality of life based on their chosen criteria.<sup>9</sup> Studies on life satisfaction are becoming increasingly common due to the use of scales in languages



other than those in which they were developed. It has been observed that such studies contribute to the diversification of research data and are employed in comparative studies between cultural and ethnic groups.<sup>10</sup>

Psychological resilience is a concept of significant interest in the field of behavioural sciences. It is defined as a personality trait that facilitates coping with stress and combating adverse events.<sup>11</sup> From an environmental perspective, psychological resilience examines the various impact areas of challenges and threats encountered throughout an individual's life.<sup>12</sup> Those with high levels of psychological resilience tend to be emotionally attached to their jobs and daily activities, which adds meaning to their lives. Such individuals demonstrate greater confidence in their capacity to control their lives, a sense of trust in their ability to effect positive change, and a perception of themselves as the agents of their own lives. They perceive unexpected changes as opportunities for growth.<sup>13</sup> A variety of assessment tools are available for measuring psychological resilience, including the brief resilience coping scale<sup>14,15</sup> and the Connor-Davidson resilience scale.<sup>16</sup>

It was deemed valuable to investigate the factors that may be related to students' expectations and their perceptions of the current situation, as these could impact their academic success. The aim of this study was to assess dental students' perceptions of education and their potential relationships with life satisfaction and psychological resilience.

The null hypothesis for this study is that there is no statistically significant difference between dental students' perceptions of education and their life satisfaction and psychological resilience.

## METHODS

The research was conducted with voluntary students from the Faculty of Dentistry at Niğde Ömer Halisdemir University during the 2023-2024 academic year. Prior to the commencement of the research, the Non-Interventional Clinical Research Ethics Committee of Niğde Ömer Halisdemir University Faculty of Medicine (Date: 14.12.2023 Decision No: 2023/104) granted the necessary ethical approval. The participants were informed about the study and provided with an opportunity to consent to their participation. The research questions and the life satisfaction and psychological resilience scales were administered in person. The survey instrument, which solicited opinions on the educational environment, was developed by revising research questions from the literature.<sup>17</sup> The questionnaire comprised seven sections, each addressing a specific topic. These were: age, gender, the survival status of parents, parental education levels, number of siblings, family income levels, and impressions of the faculty.

Furthermore, participants completed a five-item life satisfaction assessment and a four-item brief version of the psychological resilience scale.

In the life satisfaction scale, the values 1, 2, 3, 4, 5, 6, and 7 represent, respectively, the following levels of suitability: not at all suitable, not suitable, somewhat unsuitable, neither suitable nor unsuitable, somewhat suitable, suitable, and very suitable.<sup>18</sup>

The total score is calculated for the life satisfaction assessment. The scores are categorised as follows: The

participants were then classified according to their scores on the aforementioned scale. Those who scored between 31 and 35 points were classified as having 'very high life satisfaction'. A score between 26 and 30 points indicates "high life satisfaction". The "moderate life satisfaction" category is defined by a score between 21 and 25 points. A score of 20 points or less indicates "low life satisfaction".<sup>18</sup>

The total score on the psychological resilience scale is categorised as follows: 4-13 indicates low resilience, 14-16 indicates moderate resilience, and 17-20 indicates high resilience.<sup>15</sup>

Furthermore, students were asked to provide their opinions about dental education and the faculty in general. Their responses were recorded as either "yes" or "no".

My initial impression of the faculty is quite positive.

The physical structure and number of classrooms and laboratories are sufficient for the current student population.

The faculty building is of an antiquated design and is not conducive to the modern educational environment.

The student affairs office at the faculty is severely lacking in both resources and efficiency.

The academic life at the dental faculty is perceived to be both arduous and expensive.

To what extent do you consider dental education to be a stressful experience?

## Statistical Analysis

The statistical analysis was conducted using the Jamovi statistical software (Version: 2.3.28). Descriptive statistics were employed. Categorical data were subjected to a chi-square test for comparison. The Kruskal-Wallis test was employed for the purpose of comparing ordinal data and categorical variables. The significance level was set at  $p < 0.05$ .

## RESULTS

The results of the research, conducted with the participation of 76 students, indicate that the average age of the students was 19.4 years old, with a standard deviation of 1.3 years. In terms of gender distribution, the study involved 42 female and 34 male students. Upon examination of the educational attainment of the students' mothers, it was found that 34.2% (26) had obtained at least a bachelor's degree. It was observed that all participants' mothers were alive at the time of the study. The education level of fathers was also evaluated, with the result that 36.8% (28) of the students' fathers had an undergraduate or higher education. It was determined that 98.7% (75) of the fathers were alive. The mean number of siblings was calculated to be 2.4, with a standard deviation of 1.4. Upon evaluation of family income, it was determined that 69.7% of the participants were from middle-income families. It was determined that 93.4% of the participants did not have any systemic diseases (Table 1).

The results of the research indicated that when examining the psychological resilience levels of the participating students, 57.8% (44) exhibited low resilience, 30.2% (23) demonstrated moderate resilience, and 11.8% (9) exhibited high resilience. In terms of life satisfaction, the results indicated that 34.2%





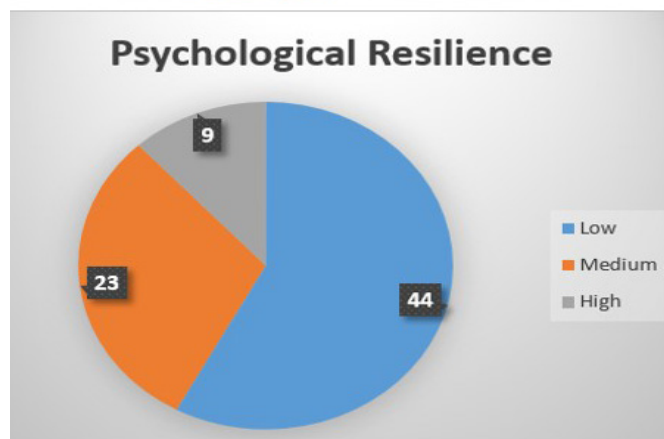
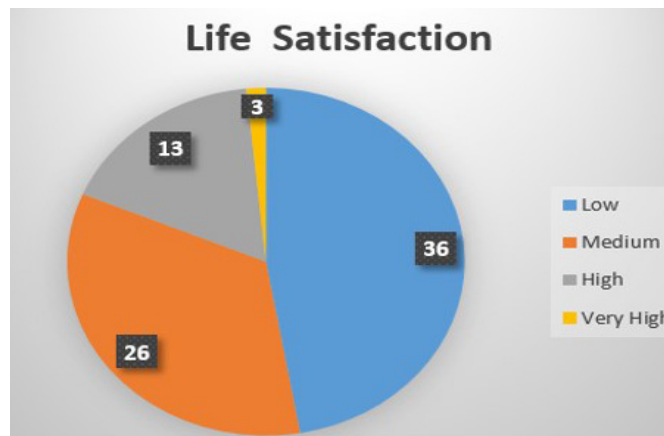
**Table 1. Analysis of various demographic and socioeconomic characteristics among students**

| Characteristic             | Value       |
|----------------------------|-------------|
| <b>Overall (n=76)</b>      |             |
| <b>Age</b>                 |             |
| Mean (SD)                  | 19.4 (1.3)  |
| Range                      | 17.0-23.0   |
| <b>Gender</b>              |             |
| Female                     | 42 (55.3%)  |
| Male                       | 34 (44.7%)  |
| <b>Mother's education</b>  |             |
| None                       | 3 (3.9%)    |
| Primary school             | 19 (25.0%)  |
| Middle school              | 7 (9.2%)    |
| High school                | 21 (27.6%)  |
| University                 | 26 (34.2%)  |
| <b>Is mother alive?</b>    |             |
| Yes                        | 76 (100.0%) |
| <b>Father's education</b>  |             |
| None                       | 1 (1.3%)    |
| Primary school             | 11 (14.5%)  |
| Middle school              | 10 (13.2%)  |
| High school                | 26 (34.2%)  |
| University                 | 28 (36.8%)  |
| <b>Number of siblings</b>  |             |
| Mean (SD)                  | 2.4 (1.4)   |
| Range                      | 0.0-8.0     |
| <b>Is father alive?</b>    |             |
| Yes                        | 75 (98.7%)  |
| No                         | 1 (1.3%)    |
| <b>Family income level</b> |             |
| Low                        | 15 (19.7%)  |
| Medium                     | 53 (69.7%)  |
| High                       | 8 (10.5%)   |
| <b>Systemic disease</b>    |             |
| None                       | 71 (93.4%)  |
| Ankylosing spondylitis     | 1 (1.3%)    |
| Asthma                     | 2 (2.6%)    |
| Myopia                     | 1 (1.3%)    |
| Type 1 diabetes            | 1 (1.3%)    |

SD: Standart deviation

(26) of the participants exhibited moderate life satisfaction, 17.1% (13) exhibited high life satisfaction, and 3.9% (3) exhibited very high life satisfaction. Nevertheless, it was established that 47.3% (36) of the participants exhibited low life satisfaction (Figure).

The statistical analysis revealed no significant correlation between the variables of gender, parental education level, health status, family income level, number of siblings, and life satisfaction with psychological resilience (Table 2, 3). A total of 90.8% of the faculty students indicated that their initial perceptions of the institution were positive. Furthermore, 93.4% of the students indicated that the physical structure and number of classrooms and laboratories were sufficient.



**Figure.** Students' scores on the psychological resilience scale and students' life satisfaction scale scores

A total of 96.1% of students indicated that the faculty building met modern standards. Nevertheless, 10.5% of the students indicated that the student affairs office was inadequate. The proportion of students who found the educational process both intensive and costly was 68.4%, while the proportion of those who found dental education stressful was 77.6% (Table 4). No correlation was observed between dental education stress and life satisfaction or psychological resilience ( $p=0.19$  and  $p=0.131$ ) (Table 2, 3).

## DISCUSSION

It can be argued that students' perceptions of the educational environment have a significant impact on their personal development, social well-being, and future professional success. A number of studies in the literature have evaluated the perceptions and satisfaction of dental students regarding their educational environments in different countries.<sup>19-23</sup> In some of these studies, the Dundee ready education environment measure (DREEM) scale has been employed. The scale assesses students' perceptions of learning, perceptions of teachers, academic self-perceptions, perceptions of atmosphere, and social self-perceptions.<sup>19-22</sup>

Some researchers have examined similar topics using different approaches and methodologies.<sup>23,24</sup> Furthermore, the educational perceptions of students from different disciplines, including nursing and medical students, have been examined.<sup>25,26</sup> This study employed a seven-question survey to evaluate the educational environment perceptions of dental students.

The findings indicated that 44 students exhibited low levels of psychological resilience, 23 exhibited moderate levels,



**Table 2. Analysis of various demographic and socioeconomic characteristics among students**

| Characteristic                 | Low          | Medium       | High         | Very high   | p-value                   |
|--------------------------------|--------------|--------------|--------------|-------------|---------------------------|
| <b>Gender</b>                  |              |              |              |             | <b>0.4481<sup>1</sup></b> |
| Female (n=42)                  | 17.0 (40.5%) | 14.0 (33.3%) | 8.0 (19.0%)  | 3.0 (7.1%)  |                           |
| Male (n=34)                    | 16.0 (47.1%) | 12.0 (35.3%) | 6.0 (17.6%)  | 0.0 (0.0%)  |                           |
| <b>Mother's education</b>      |              |              |              |             | <b>0.7811<sup>1</sup></b> |
| None (n=3)                     | 1.0 (33.3%)  | 2.0 (66.7%)  | 0.0 (0.0%)   | 0.0 (0.0%)  |                           |
| Primary school (n=19)          | 10.0 (52.6%) | 7.0 (36.8%)  | 2.0 (10.5%)  | 0.0 (0.0%)  |                           |
| Middle school (n=7)            | 2.0 (28.6%)  | 4.0 (57.1%)  | 1.0 (14.3%)  | 0.0 (0.0%)  |                           |
| High school (n=21)             | 10.0 (47.6%) | 6.0 (28.6%)  | 4.0 (19.0%)  | 1.0 (4.8%)  |                           |
| University (n=26)              | 10.0 (38.5%) | 7.0 (26.9%)  | 7.0 (26.9%)  | 2.0 (7.7%)  |                           |
| <b>Father's education</b>      |              |              |              |             | <b>0.8361<sup>1</sup></b> |
| None (n=1)                     | 1.0 (100.0%) | 0.0 (0.0%)   | 0.0 (0.0%)   | 0.0 (0.0%)  |                           |
| Primary school (n=11)          | 3.0 (27.3%)  | 5.0 (45.5%)  | 3.0 (27.3%)  | 0.0 (0.0%)  |                           |
| Middle school (n=10)           | 4.0 (40.0%)  | 4.0 (40.0%)  | 2.0 (20.0%)  | 0.0 (0.0%)  |                           |
| High school (n=26)             | 10.0 (38.5%) | 11.0 (42.3%) | 4.0 (15.4%)  | 1.0 (3.8%)  |                           |
| University (n=28)              | 15.0 (53.6%) | 6.0 (21.4%)  | 5.0 (17.9%)  | 2.0 (7.1%)  |                           |
| <b>Family income</b>           |              |              |              |             | <b>0.7361<sup>1</sup></b> |
| Low (n=15)                     | 9.0 (60.0%)  | 4.0 (26.7%)  | 2.0 (13.3%)  | 0.0 (0.0%)  |                           |
| Medium (n=53)                  | 20.0 (37.7%) | 19.0 (35.8%) | 11.0 (20.8%) | 3.0 (5.7%)  |                           |
| High (n=8)                     | 4.0 (50.0%)  | 3.0 (37.5%)  | 1.0 (12.5%)  | 0.0 (0.0%)  |                           |
| <b>Number of siblings</b>      |              |              |              |             | <b>0.6672<sup>2</sup></b> |
| Mean (SD)                      | 2.3 (1.5)    | 2.6 (1.1%)   | 2.2 (1.8%)   | 2.4 (1.4%)  |                           |
| <b>Is dentistry stressful?</b> |              |              |              |             | <b>0.1191<sup>1</sup></b> |
| Yes                            | 28.0 (47.5%) | 20.0 (33.8%) | 10.0 (16.9%) | 1.0 (1.6%)  |                           |
| No                             | 5.0 (29.4%)  | 6.0 (35.2%)  | 4.0 (23.5%)  | 2.0 (11.7%) |                           |
| Total (n=76)                   | 33.0 (43.4%) | 26.0 (34.2%) | 14.0 (18.4%) | 3.0 (3.9%)  |                           |

SD: Standard deviation, <sup>1</sup>Chi-square test, <sup>2</sup>Kruskal-Wallis test

and 9 exhibited high levels. In terms of life satisfaction, 26 participants exhibited moderate levels, 13 exhibited high levels, and three exhibited very high levels. Nevertheless, it was observed that 36 participants exhibited low levels of life satisfaction. A study conducted in India reported that 62.1% of dental internship students exhibited moderate resilience levels. Furthermore, the study identified a significant correlation between personal academic success and perseverance and resilience. This indicates that there may be a significant correlation between students' perceptions of the educational environment and their personal resilience levels.<sup>27</sup>

A study examining the psychological resilience of medical and dental students in Saudi Arabia revealed that 66.3% of students exhibited below-average resilience, while 24.7% demonstrated below-average life satisfaction. The study revealed that resilience levels were higher among female dental students and students with higher family incomes compared to other subgroups. The findings indicate that students with higher resilience are happier and more satisfied. Consequently, it is recommended that programs be developed to enhance students' resilience.<sup>28</sup> In a dental school in Thailand, it was found that only 8% of students exhibited resilience levels above the normal range.<sup>29</sup> This study corroborates the findings of another study which demonstrated that first-year Turkish health sciences students exhibited low psychological resilience.<sup>30</sup> The results demonstrate that resilience levels vary among students from different countries and disciplines, with some groups

exhibiting low resilience levels. Consequently, the necessity of strategies to enhance students' psychological resilience is underscored.

The study found no significant correlation between students' ages, genders, and academic years and psychological resilience. Nevertheless, divergent findings have emerged in the literature regarding the variation of psychological resilience by gender.<sup>14,30</sup> No statistically significant relationship was found between factors such as gender, parental education level, health status, family income level, number of siblings, and life satisfaction and psychological resilience. A study conducted in France revealed that psychological resilience increased with age, education level, and income level.<sup>31</sup> Conversely, it has been posited that as students' psychological resilience and basic satisfaction increase, their capacity to adapt to university life also increases. It is posited that the capacity to cope with challenging mental and environmental conditions encountered during university life facilitates the adaptation of students to university life.<sup>32</sup>

It is proposed that high resilience is associated with stronger academic performance in dental faculties and provides protection against emotional exhaustion. Well-being is negatively correlated with burnout and stress, and positively correlated with resilience.<sup>33,34</sup> In light of these findings, it becomes clear that the development of various interventions and programmes designed to support students' psychological resilience in universities is a necessity. Education seminars and workshops can enhance students' stress management skills, improve their emotional well-being, and facilitate





**Table 3. Analysis results comparing psychological resilience scale results with various demographic and socioeconomic parameters**

| Characteristic                           | Low          | Medium       | High        | p-value             |
|--|--------------|--------------|-------------|---------------------|
| <b>Gender</b>                            |              |              |             | 0.3401 <sup>1</sup> |
| Female (n=41)                            | 25.0 (61.0%) | 10.0 (24.4%) | 6.0 (14.6%) |                     |
| Male (n=33)                              | 19.0 (57.6%) | 12.0 (36.4%) | 2.0 (6.1%)  |                     |
| <b>Mother's education</b>                |              |              |             | 0.9201 <sup>1</sup> |
| None (n=3)                               | 2.0 (66.7%)  | 0.0 (0.0%)   | 1.0 (33.3%) |                     |
| Primary school (n=19)                    | 12.0 (63.2%) | 5.0 (26.3%)  | 2.0 (10.5%) |                     |
| Middle school (n=6)                      | 3.0 (50.0%)  | 2.0 (33.3%)  | 1.0 (16.7%) |                     |
| High school (n=20)                       | 12.0 (60.0%) | 6.0 (30.0%)  | 2.0 (10.0%) |                     |
| University (n=26)                        | 15.0 (57.7%) | 9.0 (34.6%)  | 2.0 (7.7%)  |                     |
| <b>Father's education</b>                |              |              |             | 0.9131 <sup>1</sup> |
| None (n=1)                               | 1.0 (100.0%) | 0.0 (0.0%)   | 0.0 (0.0%)  |                     |
| Primary school (n=11)                    | 6.0 (54.5%)  | 3.0 (27.3%)  | 2.0 (18.2%) |                     |
| Middle school (n=10)                     | 6.0 (60.0%)  | 2.0 (20.0%)  | 2.0 (20.0%) |                     |
| High school (n=25)                       | 14.0 (56.0%) | 9.0 (36.0%)  | 2.0 (8.0%)  |                     |
| University (n=27)                        | 17.0 (63.0%) | 8.0 (29.6%)  | 2.0 (7.4%)  |                     |
| <b>Family income</b>                     |              |              |             | 0.4011 <sup>1</sup> |
| Low (n=15)                               | 8.0 (53.3%)  | 5.0 (33.3%)  | 2.0 (13.3%) |                     |
| Medium (n=51)                            | 29.0 (56.9%) | 17.0 (33.3%) | 5.0 (9.8%)  |                     |
| High (n=8)                               | 7.0 (87.5%)  | 0.0 (0.0%)   | 1.0 (12.5%) |                     |
| <b>Number of siblings</b>                |              |              |             |                     |
| Mean (SD)                                | 2.3 (1.5)    | 2.6 (1.1)    | 2.2 (1.8)   |                     |
| <b>Is dentistry education stressful?</b> |              |              |             |                     |
| Yes                                      | 35 (59.3%)   | 20 (33.8%)   | 4 (6.7%)    | 0.6672 <sup>2</sup> |
| No                                       | 9 (52.9%)    | 2 (3.3%)     | 4 (23.5%)   | 0.1311 <sup>1</sup> |

SD: Standard deviation, <sup>1</sup>Chi-square test, <sup>2</sup>Kruskal-Wallis test

**Table 4. Responses of students to questions regarding their perceptions of the faculty and dental education**

|   | Yes        | No         |
|---|------------|------------|
| 1. First impression of the faculty is positive/happy  | 69 (90.8%) | 7 (9.2%)   |
| 2. The physical structure and number of classrooms and laboratories are sufficient                | 71 (93.4%) | 5 (6.6%)   |
| 3. The faculty building is very old and not suitable for modern conditions                        | 3 (3.9%)   | 73 (96.1%) |
| 4. The student affairs department is very inadequate and very slow                                | 8 (10.5%)  | 68 (89.5%) |
| 5. The life of education and training in the faculty of dentistry seems very tiring and expensive | 52 (68.4%) | 24 (31.6%) |
| 6. Do you find dental education stressful?  | 59 (77.6%) | 17 (22.4%) |

their adaptation to university life in a healthier manner. Consequently, universities that implement programmes designed to enhance students' psychological well-being can enhance their students' success and contribute to a more positive university experience. In evaluating students' responses to questions measuring their perceptions of dental education, over 90% of respondents expressed a positive impression of the faculty. They found the physical structure, number and capacity of classrooms and laboratories, and student services to be sufficient. In contrast, another study

reported lower satisfaction rates (56.3%) and a higher proportion of students who perceived the buildings to be old and the lecture halls to be overcrowded.<sup>17</sup>

It is of the utmost importance to carefully consider the choices of students who initially hold negative impressions of the faculty. It would be beneficial to analyse the changes in these students' opinions in later classes.

Conversely, 68.4% of the students indicated that dental education is costly and intense, and 77.6% found it stressful. A few studies have indicated that dental students experience higher levels of stress, burnout, anxiety, and depression compared to the general population.<sup>35-40</sup> In a recent study evaluating the factors influencing the career choices of Turkish dental students, it was reported that 78.3% of the students found the education process to be highly stressful. The study emphasized the need to identify the problems faced by the students in order to reduce their stress and anxiety.<sup>41</sup> A review of stress levels and risk factors in dental students revealed that stress was associated with tendencies towards perfectionism, fear of failure, exam stress, curriculum intensity, workload, and limited free time.<sup>40</sup> Nevertheless, this study did not identify a significant correlation between dental education-related stress and students' life satisfaction or psychological resilience. The lack of statistical significance may be attributed to the relatively small sample size.



## Limitations

The limited sample size may limit the generalisability of the results and negatively affect the statistical significance. The utilisation of a general educational environment assessment tool that incorporates the perspectives of students from diverse faculties or geographical regions could enhance the generalisability of the data. Furthermore, the study may have failed to consider the influence of factors such as students' personality traits, family relationships, past experiences, or external factors on life satisfaction and psychological resilience.

## CONCLUSION

Although students tend to hold positive views of their faculties, they perceive dental education to be costly and stressful. Given that students exhibit low life satisfaction and moderate to weak psychological resilience, it is necessary to review educational programmes and support systems. The implementation of measures for stress management and psychological support is of paramount importance if academic success is to be enhanced and a healthy learning environment established.

## ETHICAL DECLARATIONS

### Ethics Committee Approval

The study was carried out with the permission of Ethical Committee of Niğde Ömer Halisdemir University (Date: 14.12.2023, Decision No: 2023/104).

### Informed Consent

All patients signed and free and informed consent form.

### Referee Evaluation Process

Externally peer-reviewed.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Financial Disclosure

The authors declared that this study has received no financial support.

### Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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# Revolutionizing dental education: harnessing the power of ChatGPT for personalized learning in dentistry

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## ABSTRACT

With the advancements in modern technology, educators in the field of dentistry are exploring innovative and new ways to enhance the learning experience for students. This journal article integrates ChatGPT, a state-of-the-art language model OpenAI developed into dental education. By leveraging the capabilities of ChatGPT, educators can provide personalized and interactive learning experiences, fostering a deeper understanding of dental concepts and improving the overall educational outcomes in dentistry for both teachers and dental students. By embracing this transformative tool, dental education is poised to adopt a new era of engagement, adaptability, and efficacy in preparing future dental professionals for the challenges ahead. This is an overview of current and future dental education strategies, limitations, and challenges. The data and information reflected and summarized in this article are gathered and extracted from recently published articles, especially a search of online databases. In conclusion, while using ChatGPT in dental education offers substantial benefits in personalized learning, virtual patient interactions, and knowledge reinforcement, ethical considerations and potential disadvantages highlight the need for a balanced and responsible integration.

**Keywords:** Dental education, artificial intelligence, ChatGPT, personalized learning, virtual patient interactions, knowledge reinforcement, ethical considerations

## INTRODUCTION

The rapid advancement of artificial intelligence (AI) has led to the development of increasingly sophisticated and versatile language models.<sup>1</sup> Despite the introduction of numerous classification methods for AI, one such categorization includes artificial general intelligence, artificial narrow intelligence, and generative artificial intelligence.

Generative AI encompasses artificial intelligence models capable of producing novel data by discerning patterns and structures from existing datasets. These models demonstrate the ability to generate content across a wide array of domains, including text, images, music, and beyond.<sup>2</sup> Generative AI models utilize deep learning methods and neural networks to analyse and comprehend data, producing outputs that closely mimic humans' creations. Among these, the Chat Generative Pre-trained Transformer (ChatGPT) is one of the cutting-edge language models developed by OpenAI, that represents a transformative advancement in the natural language process to generate responses to user prompts with a human-like quality. ChatGPT is based on the GPT-3.5 architecture, which

is a modified version of the GPT-3 model released by OpenAI in 2020, and the currently available GPT-4 is a multimodal large language model launched in March 2023.

ChatGPT aims to enhance these AI bots' computational linguistics, communication competence, and overall responsiveness through techniques like machine learning, deep learning, and neural networking are used via text-based interfaces.<sup>3,4</sup> This journal article discusses ChatGPT as a versatile teaching and learning tool, exploring its potential educational applications. As a modern conversational agent, ChatGPT offers opportunities to enhance the educational experience across various disciplines.<sup>5</sup> The traditional methods of dental education are evolving to meet the demands of the modern era. AI technologies, such as ChatGPT, offer a unique opportunity to revolutionize how dental students acquire knowledge and skills. The potential applications of ChatGPT in dental education are focused on its role in personalized learning, virtual patient interactions, and knowledge reinforcement.





ChatGPT holds promise for various applications in dental education due to its advanced natural language processing capabilities. It can serve as a virtual tutor, providing personalized feedback and explanations tailored to individual learning styles for dental students. By understanding the personalized needs and learning styles of students, ChatGPT can generate targeted explanations, quizzes, and interactive modules.<sup>6</sup> This personalized approach enhances engagement and facilitates students to progress at their own pace, ensuring a comprehensive understanding of complex dental concepts. ChatGPT can simulate patient interactions, allowing students to practice communication skills and treatment planning in a controlled environment. ChatGPT can create virtual patients, enabling students to practice communication skills, case presentations, and treatment planning in a controlled environment.<sup>4</sup>

While integrating ChatGPT in dental education offers numerous benefits, ethical considerations must be addressed. Further, concerns may arise about the precision of the generated output and the risk of perpetuating biases in diagnoses.<sup>7</sup> Therefore, it is significantly important of human supervision is essential when using ChatGPT to maintain patient privacy, ensure responsible AI use, and implement safeguards to prevent the misuse of AI-generated content in dentistry.<sup>4,6</sup> AI includes developing specialized ChatGPT models for various dental specialties, collaborative research projects, and ongoing efforts to align AI advancements with the evolving needs of the dental community.

## OVERVIEW

### Advantages of ChatGPT Involvement in Dental Education

Integrating artificial intelligence, particularly ChatGPT, into dental education presents several noteworthy advantages. ChatGPT's ability to understand personalized learning styles and generate customized content allows students to progress at their own pace, reinforcing their comprehension of complex dental concepts.<sup>5,8</sup> This individualized approach enhances engagement and supports a more effective learning journey.

This tool facilitates virtual patient interactions, a critical aspect of dental education. Simulating patient scenarios with ChatGPT enables students to practice and refine their communication skills, case presentations, and treatment planning in a controlled environment.<sup>8,9</sup> The interactive nature of this tool allows students to receive instant feedback, enhances their clinical communication abilities, and provides a safe space for skill development before interacting with patients.

ChatGPT can be used as a valuable tool for reinforcing theoretical knowledge in dentistry. It can generate interactive study materials in related to dental undergraduate and postgraduate research endeavors.<sup>10</sup> It can assist in literature reviews by rapidly analyzing vast amounts of dental literature and extracting relevant information, aiding researchers in identifying gaps and formulating research questions. This tool can be used to generate hypotheses based on existing data and assist in experimental design, optimizing research methodologies.<sup>11,12</sup> Additionally, it can aid in data analysis, interpretation, and result dissemination, enhancing the efficiency and accuracy of research outcomes. Furthermore, ChatGPT can facilitate collaboration among researchers by providing a platform for sharing ideas and feedback.<sup>1</sup> These

capabilities empower dental undergraduates to conduct rigorous and impactful research in the field. This feature extends the learning experience beyond the classroom, empowering students to delve deeper into foundational concepts and stay connected with the latest developments in the field. Furthermore, it can aid in diagnosis and treatment planning by analyzing patient data and providing evidence-based insights.<sup>4</sup>

Further, ChatGPT can be used to assist with test preparation by providing personalized recommendations for study materials, test-taking strategies, and practice exams.<sup>1,9</sup> By analyzing data on the student's performance on previous exams and their learning preferences, ChatGPT can provide tailored recommendations that can help students prepare for tests more effectively.

### Disadvantages and Limitations of ChatGPT in Dental Education

Despite the promising advantages, incorporating AI in dental education using ChatGPT raises ethical considerations and potential disadvantages. One notable concern is the need to address patient privacy when virtual patients are created for simulation purposes, it is crucial to ensure that the data used to develop these scenarios is de-identified and that the privacy of actual patients is not compromised.<sup>13</sup>

Another challenge involves the responsible use of AI-generated content. Educators must be vigilant in monitoring and verifying the accuracy of information provided by ChatGPT to avoid disseminating misinformation.<sup>11</sup> The potential for biases presents in the training data also necessitates careful consideration to prevent perpetuating inequalities or inaccuracies in dental education.<sup>6</sup>

Moreover, an overreliance on AI for personalized learning could lead to a lack of human interaction in the educational process. While ChatGPT can provide valuable support, face-to-face interactions, mentorship, and guidance from experienced educators should be considered.<sup>14,15</sup>

## DISCUSSION

Dentistry is a highly skilled base clinical field. The big question is, "How can we engage the ChatGPT to enhance the practical knowledge and skill in dental education?" In dentistry, a field renowned for its reliance on hands-on clinical skills, the integration of ChatGPT presents a unique opportunity to augment practical knowledge and skills in dental education.<sup>4,9</sup> While ChatGPT may not replace the tactile aspects of hands-on training, its potential lies in its ability to serve as a virtual tutor, offering instant feedback, answering queries, and engaging in interactive discussions.<sup>1</sup>

Dental students can leverage ChatGPT for scenario-based simulations, virtual patient interactions, and problem-solving exercises, reinforcing their understanding of complex procedures and decision-making processes.<sup>16</sup> Additionally, ChatGPT can provide personalized learning experiences, adapt to individual learning styles, and cater to dental students' diverse needs.<sup>14</sup> With its capacity to simulate conversations and provide context-specific information, this tool holds promise in supplementing traditional practical training methods, offering an innovative approach to enhance the overall educational experience in dentistry.<sup>14</sup>



Nonetheless, the ethical use and responsible integration of ChatGPT in dental education must be carefully considered, recognizing its supportive role in conjunction with traditional hands-on training methodologies.

Integrating artificial intelligence (AI) into dental education holds significant promise for enhancing practical knowledge and skills.<sup>16</sup> Virtual simulations and AI-powered patient cases offer a risk-free environment for dental students to practice and refine their clinical skills, improving dexterity and decision-making.<sup>17</sup> Interactive training modules incorporating AI provide real-time feedback, allowing students to identify particular areas for improvement and hone their techniques.

Currently, augmented reality (AR) and virtual reality (VR) technologies create immersive experiences, enabling students to interact with 3D models of teeth and oral structures for a more hands-on learning experience.<sup>18</sup> AI algorithms can aid in diagnosis and treatment planning by analyzing patient data, X-rays, and other diagnostics, fostering a comprehensive understanding of cases.<sup>19</sup> Virtual patient interactions, facilitated by AI-driven scenarios, assist in honing communication skills, patient counseling, and case presentations.<sup>20</sup>

Additionally, AI contributes to objective skill assessment and proficiency tracking, offering insights into individual student performance. Remote learning and telementoring, supported by AI, provide students with guidance from experienced practitioners regardless of geographical constraints.<sup>21</sup> Personalized learning paths, tailored based on AI analysis of individual performance, ensure targeted support for practical skill enhancement.

Digital patient records managed by AI systems contribute to evidence-based decision-making, and AI-driven analytics identify patterns in patient data.<sup>19,22</sup> Continuing education is facilitated through AI, keeping practitioners and students updated on the latest advancements in dentistry. While integrating AI requires careful consideration of ethical implications, validation, and collaboration, it undoubtedly has the potential to revolutionize the teaching and mastery of practical skills in dentistry.<sup>10</sup>

## CONCLUSION

In conclusion, while using ChatGPT in dental education offers substantial benefits in personalized learning, virtual patient interactions, and knowledge reinforcement, ethical considerations and potential disadvantages highlight the need for a balanced and responsible integration. Achieving the optimal equilibrium between harnessing the power of AI and preserving the human touch in education will be crucial for the success of this revolution in dental learning. The integration of ChatGPT into dental education holds significant promise for transforming the learning experience. By embracing AI technologies responsibly, educators can prepare dental professionals for future challenges, fostering a new era of personalized, interactive, and effective dental education.

## ETHICAL DECLARATION

### Referee Evaluation Process

Externally peer-reviewed.

## Conflict of Interest Statement

The authors have no conflicts of interest to declare.

## Financial Disclosure

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## Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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# The use of PEEK material as an occlusal splint

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## ABSTRACT

Occlusal splint is a treatment alternative that gives positive results in reducing the symptoms of temporomandibular diseases. This treatment involves placing an appliance made of various materials specifically for the cutting and chewing surfaces of the teeth. The most popular materials used in the construction of occlusal splints are soft and hard acrylic-based materials such as polymethylmethacrylate, ethylene vinyl acetate, polycarbonate, polyethylene terephthalate and polyetheretherketone. PEEK is a high performance, semi-crystalline, thermoplastic and thermally stable polymer belonging to the polyaryletherketone family. PEEK, which has very good dimensional stability against intraoral temperature changes, is not affected by the intraoral chemical environment. Since PEEK material is chemically stable, has high biocompatibility and abrasion resistance, its use as an occlusal splint material has become widespread today. The aim of this review is to provide information about occlusal splints produced using PEEK material and digital procedures, which are becoming increasingly popular in dentistry, and to contribute to the literature.

**Keywords:** Polyetheretherketone, PEEK, occlusal splint, TME

## INTRODUCTION

Temporomandibular disorders are a collective term for dysfunction and pain of the temporomandibular joint (TMJ) and masticatory muscles.<sup>1</sup> Symptoms of temporomandibular disorders include myofascial pain, restriction of jaw movement and mouth opening, and sounds heard during function. Pain is often the hallmark of this disease and can be exacerbated by palpation of the TMJ or surrounding muscles.<sup>2</sup> The prevalence ranges from 3.2% to 17.6%, with a 2.1 times higher incidence in women than in men.<sup>3</sup> The most common types of TMJ disorders include pain-related disorders (e.g. myalgia, headache and arthralgia) and TMJ-related disorders (primarily disc displacements and degenerative diseases).<sup>4</sup>

The aims of the treatment of temporomandibular disorders are: to reduce joint and muscle pain, to reduce the limitation of movement of the mandible, and to prevent soft tissue degeneration of the TMJ.<sup>5</sup> Treatment options for these disorders include physical therapy, occlusal splints and/or occlusal adjustments, pharmacologic therapy and surgical approaches.<sup>5,6</sup> Occlusal splints, also known as interocclusal splints, night guards, oral appliances, oral orthoses and bite guards, and the use of the bite plane are treatment alternatives that give positive results in reducing the symptoms of temporomandibular disorders. This treatment involves the placement of an appliance made of various materials specifically for the cutting and chewing surfaces of the teeth.<sup>6</sup>

Indications for occlusal splint use are joint sounds due to temporomandibular disorders, disc slippage and displacement, myofascial arthritis and dysfunction syndrome, osteoarthritis, retrodiscitis, bruxism, hypertonic facial muscles, parafunctional habits, vertical dimension determination and change, recurrent chronic sinusitis and postoperative care.<sup>7-11</sup>

## HISTORY OF STABILIZATION SPLINT

Oral appliances were first used by Karolyi in 1901 for the treatment of bruxism. After 1901, many types of occlusal splints were produced for different purposes. In 1950, Posselt presented the current version of occlusal appliances. Posselt aimed to solve the problems associated with temporomandibular disorders in occlusal dysfunction with an orthosis applied to both jaws simultaneously.<sup>12</sup> The stabilization splint designed by Shore in 1959 is the most common appliance in the literature.<sup>13</sup>

While previous studies often described bruxism as a type of “disorder”, Lobbezoo et al.<sup>14</sup> in a 2018 review suggested that bruxism should be considered a type of “behaviour” in healthy individuals. Although the absolute pathogenesis of nocturnal bruxism is still unclear, many studies have shown that bruxism is the result of many factors, including



anatomical structure and mental state.<sup>15,16</sup> Researchers have various opinions regarding nocturnal bruxism, but the consensus is that occlusal splinting should be used for treatment. It has been confirmed as a preferred treatment by the majority of the literature and is recommended for use at night.<sup>17</sup>

The most popular materials used to make occlusal splints are soft and hard acrylic-based materials. Generally, polymethyl methacrylate (PMMA), ethylene vinyl acetate (EVA) polycarbonate (PC) and polyethyleneterephthalate (PETG) are commonly used. Polyetheretherketone (PEEK), on the other hand, has found its place among occlusal splint materials by expanding its use in dentistry.<sup>18</sup>

Currently used appliances relax the temporomandibular muscles and maintain the condyle in the centric relationship and protect the teeth in bruxist patients with clenching.<sup>9</sup> Splints are produced conventionally by a dental technician, usually with plaster models taken on a semi-adjustable articulator. The conventional method is a time-consuming process that depends on the experience of the technician and is prone to errors.<sup>19</sup>

Advances in computer-aided design/computer-aided manufacturing (CAD/CAM) and intraoral scanning (IOS) technologies may have the capacity to overcome the shortcomings of conventional splinting and provide better results. In addition, the workflow is simpler than conventional methods. Many studies have shown that CAD/CAM splints have superior properties compared to conventional ones.<sup>20,21</sup>

## PEEK MATERIAL

PEEK is a high-performance semi-crystalline thermoplastic polymer belonging to the polyaryletherketone family.<sup>22</sup> It is a material with high thermal stability. Its dimensional stability against intraoral temperature changes is very good.<sup>23</sup> Being an inert material, PEEK is not affected by the chemical environment in oral conditions. The chemical stability of PEEK material ensures that it does not undergo oxidation and toxic by-products are not released.<sup>24</sup>

PEEK material is available in powder and granular forms. Materials such as ceramics, glass or carbon can be added to PEEK, which can also be produced as bees, to increase its physical and chemical properties. Material addition can be done before or after polymerization.<sup>25</sup>

Thanks to its stability, PEEK is not affected by some sterilization processes. Processes such as ethylene oxide, gamma and steam sterilization do not change the physical properties of the material.<sup>26</sup> PEEK is a biologically compatible, tissue-friendly material. Clinical applications have shown that it has no mutagenic and toxic effects. In addition, it does not cause inflammatory response in tissues.<sup>27</sup> As a result of studies with PEEK material, it has been reported that the tissue response is very low, it does not have a negative effect on cell culture, and does not show cytotoxicity on cells with proliferation and repair ability such as osteoblasts and fibroblasts.<sup>28</sup>

The elastic modulus of PEEK material is low without the addition of filler and is approximately 3-4 GPa. By adding various additives, the elastic modulus of PEEK is brought closer to cortical bone (10-19 GPa). In this way, dental implants prepared with PEEK are a good alternative with

good cortical bone compatibility and similar properties.<sup>29</sup>

It has been claimed to absorb masticatory forces due to its elastic modulus being close to the bone. For this reason, it prevents crestal bone resorption in the preimplant area by absorbing the incoming forces.<sup>30</sup> PEEK also has a low rate of allergic reaction, very good polish ability and therefore low plaque retention.<sup>31</sup>

Bacterial adhesion is influenced by the surface energy and chemical structure of the material, as well as the presence of surface defects that favour microorganism growth.<sup>31</sup> Hahnel, Wieser, Lang, and Rosentritt<sup>33</sup> compared biofilms on different abutment materials in an in vitro study and found that the amount of biofilm on PEEK was equal to or lower than the biofilm formation on titanium and zirconia. Studies have shown that an increase in surface roughness facilitates bacterial adhesion and biofilm formation. In support of this, the PEEK surface used in Hahnel's<sup>33</sup> study was significantly rougher than titanium and zirconia. The high polish ability of PEEK allows for less biofilm formation.

It is good at absorbing incoming forces with adequate fatigue strength and low yield strength. PEEK material has high mechanical strength, good dimensional stability, no polymerization shrinkage, and the material has low water absorption.<sup>34</sup> It is very lightweight, so prostheses made of PEEK material are reported to be comfortable to use by patients.<sup>35</sup>

PEEK is radiolucent, making it compatible with X-ray imaging and magnetic resonance imaging. Since it is radiolucent, changes in bone tissue can be easily visualized.<sup>36</sup> By adding barium sulphate, its radiological visibility and contrast can be changed.<sup>37</sup> PEEK in its pure state is skin-coloured. PEEK material changes colour according to the fillers added. Pure PEEK scaffolds have a greyish and very opaque appearance.<sup>38</sup>

The wettability of PEEK material is low, so modification of the PEEK surface is necessary to increase its bond strength to materials.<sup>26</sup> To ensure adequate adhesion, mechanical and chemical pretreatments such as laser and plasma roughening, sulfuric acid treatment, sandblasting, etching with piranha solution, followed by the application of an adhesive containing methyl methacrylate (MMA), 10-methacryloyloxydecyl dihydrogen phosphate (MDP) or acetone are recommended.<sup>39</sup>

One of the main reasons why PEEK material is preferred is that it does not cause damage to the antagonist teeth. In an in-vitro study by Muhsin et al.,<sup>40</sup> it was determined that PEEK caused less wear on the enamel of the antagonist natural tooth and had better wear resistance compared to PMMA and nanohybrid composites.

In today's dentistry, PEEK is used in fixed prostheses, removable partial dentures, implant supported prostheses, telescopic overdenture prostheses, occlusal splints.

## USE OF PEEK MATERIAL IN OCCLUSAL SPLINT CONSTRUCTION

The disadvantages of conventional acrylic occlusal splints have led to the search for alternative materials. These disadvantages include leaving residual monomers, poor taste, volumetric changes, color changes over time, fragility, irritation of the oral mucosa and allergic reactions in some patients. These reasons cause patients to experience difficulties



in daily use.<sup>41</sup> PEEK material is lighter than PMMA, EVA, PC, PETG splints and has higher abrasion resistance and force absorbing properties against excessive occlusal loads, making it possible to use it in occlusal appliance construction.<sup>41,42</sup>

In their study, Wang et al.<sup>43</sup> compared the preclinical effects of digitally prepared occlusal splints and conventionally prepared rigid splints in patients with nocturnal bruxism. While the digitally prepared PEEK splints saved time, they also showed ease of use and clinically less wear. However, because of the study, both conventionally prepared splints and digitally prepared PEEK occlusal splints were found to be clinically usable. As a result, they stated that the occlusal appliances prepared from PEEK material showed less wear at the end of the 12<sup>th</sup> week compared to the conventionally prepared splints and had the qualities to meet the clinical requirements. In addition, due to their superior physical properties, occlusal splints made of PEEK material were produced thinner, increasing patient satisfaction.

In the study by Wang et al.<sup>43</sup> it was seen that with the advancement of digital technology, the accuracy of design and production has been greatly improved. As a result of the study by Dedem et al.<sup>44</sup> in which they compared occlusal splints produced by digital technique and those produced by conventional impression method, the main advantages of splints produced by digital technique over impression-based production were found to be time saving, high material quality and the opportunity to produce multiple copies of splints.

Waldecker et al.<sup>45</sup> produced an interocclusal splint with a completely digital procedure using an intraoral scanner and 3D printed resin. They tested the comfort of use, occlusion, and fit of the splint and concluded that although only minor occlusal abrasions were required, the digital method is suitable for the production of occlusal splints. PEEK occlusal splints are also designed and produced with this production technique.

Although materials routinely used for splinting such as EVA, PC and acrylic resin have good impact resistance, controlling their shape in the heat moulding procedure is not simple. However, PEEK is an engineering plastic with almost perfect qualities such as excellent biocompatibility, lubricity, heat resistance and wear resistance.<sup>46</sup> The main component of acrylic resins used to make hard splints is PMMA, and the molecular mass of PEEK is approximately three times that of PMMA. In a study on the wear of dental materials in clinical use, some researchers claimed that the greater the mass of the material, the better the toughness and wear resistance of the material.<sup>47</sup> In their study, Wang et al.<sup>43</sup> found that because of its excellent properties, the ability to produce a thinner thickness of PEEK occlusal splint increased patient comfort and reduced foreign body sensation.

Digitally produced interocclusal splints for nocturnal bruxism patients have features such as a faster workflow, simpler working method, improved occlusal surface design compared to conventional production and saving medical resources. In addition, the digital workflow gives physicians the opportunity to archive patients' dental data. Furthermore, since the STL format is widely used, interocclusal appliances can also be manufactured by additive manufacturing methods (e.g. 3D printing) using PEEK.<sup>43</sup>

In the study by Benli et al.<sup>18</sup> in which they investigated the wear resistance of different occlusal splint materials, the changes in the surface roughness of different materials against upper molar teeth and volume losses after wear were investigated by two-body wear simulation. As a result, the results of PEEK material were found to be higher than PMMA, EVA, PC, PETG materials whose wear resistance and volume losses were investigated. As a result of this study, Benli et al.<sup>18</sup> concluded that PEEK material is suitable for making occlusal splints.

Grymak et al.<sup>48</sup> looked at the wear resistance of occlusal appliances produced by various methods. While vacuum-formed materials showed the highest wear rate among all other groups, no significant difference was found between materials produced by computer-aided milling, heat polymerization, or 3D printing. As a result, PEEK material showed the best properties in both in vitro and in vivo studies.

In a case study by Delrieu et al.<sup>49</sup> a PEEK occlusal splint was used in a patient with histaminases. PEEK material is considered hypoallergenic because it is biocompatible and contains no residual monomers compared to other splint materials such as PMMA, EVA, PC. They concluded that PEEK material is suitable for occlusal splinting because it is hypoallergenic and has superior properties compared to other materials.

## CONCLUSION

In our review, we have mentioned that it is possible to use PEEK material produced by digital procedure as an occlusal splint material and its advantages and disadvantages compared to frequently used materials. Studies on the subject are insufficient. Clinical follow-up and in vitro studies should support the use of PEEK material as an occlusal splint.

## ETHICAL DECLARATIONS

### Referee Evaluation Process

Externally peer-reviewed.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Financial Disclosure

The authors declared that this study has received no financial support.

### Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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# Regressed lichen planus: a case report

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## ABSTRACT

Lichen planus is a chronic inflammatory autoimmune disease. The incidence of the disease is higher than other dermatoses. Clinically, it may present in different forms, the most common being the reticular form. Lichen planus may be precancerous and may develop into a malignant lesion. Although topical corticosteroids are the first choice for treatment, many different topical or systemic agents can be used. The aim of this case report is to discuss the clinical features of lichen planus.

**Keywords:** Regressed lichen planus, malignant transformation, etiology of LP

## INTRODUCTION

Lichen planus (LP) is a chronic inflammatory disease of unknown etiology that commonly affects mucous membranes, skin, genital mucosa, scalp and nails. It was first described by Erasmus Wilson in 1869.<sup>1</sup> Individuals aged fifty and over are more affected.<sup>2</sup> The disease affects women twice as often as men. Lichen planus affecting the oral mucosal area is called oral lichen planus (OLP) and can be seen alone or in combination with skin lesions. The incidence of LP is 1.9%, which is more common than the cutaneous form (0.23%). Clinically, LP can be seen in six types: papules, reticular, plaque-like, atrophic, erosive and bullous.<sup>3</sup> The most common type is the reticular pattern of fine white lines known as “Wickham’s striae”. LP may be associated with systemic diseases such as diabetes mellitus, hepatitis-C and hypertension. Lichenoid lesions can be caused by various medications such as antibiotics, antihypertensives, anti-inflammatory drugs and antimalarial drugs. Metal restorations can also trigger lichenoid reactions in the adjacent oral mucosa.<sup>4</sup> Treatment of LP is usually performed when erosive lesions or ulcerations are present. Before starting a local or systemic treatment, it is important to eliminate all factors that may be responsible. Topical or systemic corticosteroid therapy is recommended for erosive lesions.<sup>4</sup>

## CASE

A 28-year-old woman presented to Kırıkkale University, Faculty of Dentistry, Department of Periodontology with complaints of pain and redness in the buccal mucosa and gingiva. In the anamnesis, it was learned that he started complaining of pain and burning in the mouth after having a dental scaling 3 months ago and that he did not have any systemic disease. The patient does not smoke. Intraoral examination revealed lesions and white striae on the gums (Figure 1A, 1B).



Figure 1A. Redness of the patient's gingiva



Figure 1B. White striae on the gums



For definitive diagnosis, one histopathology and one direct immunofluorescence were performed by punch biopsy from the gingival area where the lesion was most severe.

Histopathologic examination of the tissue showed mucosal tissues in which epithelium and connective tissue were seen separately from each other. In the fragment of parakeratinized mucosal epithelium, degeneration and loss of basal layer cells were observed and inflammatory cells penetrated into the epithelium. In the connective tissue fragment, there was band-shaped lymphocytic infiltration in the lamina propria. In the material sent for frozen section, limited connective tissue was seen under the edematous epithelium. Immunofluorescence studies revealed focal positive fibrinogen, negative C3, IgG, IgM and IgA. As a result of clinical and histopathologic evaluations, regressed lichen planus was diagnosed. The patient was recommended periodontal treatment with tartar removal, oral hygiene education and mouthwash containing 0.2% chlorhexidine gluconate.

## DISCUSSION

Although the etiology is unknown, the disease is thought to be caused by a specific antigenic mechanism or non-specific mechanisms including autoimmune response triggered by epithelial basal cell modification and multifactorial factors. Antigen-specific mechanisms may include limited antigen presentation by lesional keratinocytes including MHC class-I and MHC class-II, activation of antigen-specific CD4+helper T cells and CD8+cytotoxic T cells, clonal expansion of antigen-specific T cells and keratinocyte apoptosis triggered by antigen-specific CD8+cytotoxic T cells. Many non-specific mechanisms may play a role, including heat shock proteins, reactive oxygen products, stress, mast cell chemotaxis.<sup>5</sup> The incidence of the disease is higher than in other dermatoses and is more common in older women than in men. It is reported that the lesion may be precancerous and may transform into a malignant lesion. The incidence of malignant transformation varies between 0.5-2.5% in studies. However, there are some authors who do not consider lichen planus lesions as malignant.<sup>6</sup>

LP affecting the gingiva is characterized by the presence of diffuse erythematous areas that are desquamative or ulcerated. Lesions may occur along keratinized gingiva, hyperkeratotic reticulated lines may be present on the periphery of erosive areas and may facilitate the diagnosis. This clinical appearance is not specific only for LP. It is possible to find similar clinical appearance in many diseases such as cicatricial pemphigoid, lupus erythematosus, pemphigus vulgaris, linear IgA dermatosis. In addition, diseases such as hormonal dysfunction, candidiasis, lichenoid lesions and vulvo-vaginal-gingival syndrome should be kept in mind in the differential diagnosis of lichen planus.<sup>7,8</sup>

Our definitive diagnosis was made after biopsy. In our case, direct immunofluorescence (DIF) was performed for the differential diagnosis of pemphigus group diseases (paraneoplastic pemphigus) and pemphigoid (mucous membrane pemphigoid).<sup>9</sup> IgG, C3 were negative. Pemphigus group diseases can be diagnosed by detection of antibodies against keratinocyte cell surface. Detection of specific antibodies against the squamous intercellular intermediate (matrix) in the tissue and serum of the patient

with pemphigus is necessary for definitive diagnosis. Immunofluorescence methods are currently one of the most important diagnostic methods of immunobullous diseases.<sup>10</sup> In IgA pemphigus, intercellular IgA deposition is observed in 50% of cases in DIF. In our case, IgA was negative in direct immunofluorescence for linear IgA.

The aim of treatment of symptomatic LP is to relieve painful ulcerations or burning sensation. A stepwise approach should be adopted. Topical corticosteroid therapy is the mainstay of treatment for ulcerative disease. There is limited evidence from randomized controlled trials on the definitive efficacy of the various commonly used preparations. In addition to treatment, patients should also be counseled about the need to maintain a high standard of oral hygiene and eliminate any causes of mucosal trauma, such as unsuitable dentures, sharp spikes and poor dental restorations. Patients should be informed that there is a very small risk of malignancy associated with LP and that long-term follow-up is appropriate.<sup>11</sup>

## CONCLUSION

As the cause of LP is currently unknown, there are no specific preventive regimens for this disease. The pathogenesis of LP may involve both antigen-specific and non-specific mechanisms. However, regular clinical follow-ups should be performed against the risk of malignancy. Careful, regular and long-term follow-up of patients with LP is necessary for early detection of oral squamous cell carcinoma. Follow-up intervals of 2 months or 12 months can be adjusted according to the patient.

## ETHICAL DECLARATIONS

### Informed Consent

The patient signed and free and informed consent form.

### Referee Evaluation Process

Externally peer-reviewed.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Financial Disclosure

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### Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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# A new anatomical variation in ramus: the sigmoid canal

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## ABSTRACT

During the radiological examination with cone beam computed tomography of the patient who complained of joint pain, a structure with a length of 8.1 mm and a diameter of 0.6 mm was detected, starting from the sigmoid notch and descending down the ramus. The patient was unaware of the existence of this structure, and moreover, the patient did not show any symptoms. There was doubt as to whether the observed structure was an anatomical variation or a pathological phenomenon, and magnetic resonance imaging (MRI) was used to determine its content. It was realized that the structure imaged by MRI carried a branch of the maxillary artery. This structure was called the sigmoid canal. It was noteworthy that this anatomical structure was likely to cause complications in surgical interventions.

**Keywords:** Anatomical variation, ramus, sigmoid notch, mandible

## INTRODUCTION

Various anatomical variations can be observed in the human mandible, as seen throughout the entire body.<sup>1,2</sup> Awareness of these variations not only ensures accurate diagnosis but also influences the design of treatment plans.<sup>1</sup> Before the development of imaging systems, anatomical variations were recognized only through surgical procedures and examinations on cadavers; however, with the advancement of imaging systems today, the discovery and evaluation of anatomical variations have become much easier and more widespread.<sup>3,4</sup> Cone beam computed tomography (CBCT) is a highly useful imaging technique for assessing hard tissues due to its high resolution, detail power, and relatively low radiation dose.<sup>5</sup> Additionally, the ability to perform cross-sectional examinations, in addition to multiplanar (axial, sagittal, and coronal) assessments, provides an advantage.<sup>6</sup>

The mandible is the bone that comprises the lower 1/3 of the face. It carries the coronoid process and condylar process on the mandibular ramus. The coronoid process is a triangular structure that protrudes slightly upward from the ramus. The condylar process is a projection on the posterior aspect of the ramus that articulates with the temporal bone, making the mandible the only movable bone in the face. The indentation on the close faces of the coronoid process and condylar process where they join with the ramus is called the sigmoid notch.<sup>7</sup>

Various anatomical variations have been described previously in the human mandible, such as variations in the

temporal crest canal, lingual canal, coronoid foramen, and mandibular canal.<sup>8-10</sup> In this case presentation, we aimed to describe a canal starting from the sigmoid canal, which has not been previously described in the literature, and extending inferiorly along the mandibular ramus.

## CASE

The patient, a 24 years old female of Turkish descent, reported experiencing difficulty opening her mouth fully and localized pain in her right temporomandibular joint (TMJ) region. Upon detailed examination, clinical findings revealed limited mandibular movement during mouth opening, with tenderness noted upon palpation of the right TMJ area. Additionally, a review of the patient's medical history revealed no significant systemic illnesses or prior surgical interventions related to the maxillofacial region.

## Clinical Findings

The patient's medical history does not reveal any surgical operations, medication use, or any pathology. No extraoral asymmetry was observed in the face. Intraoral examination revealed that tooth 46 was extracted 9 years ago, and tooth 47 was mesialized with a periodontal pocket mesially. The lower left dental arch has shifted towards the extraction space. Tooth 13 in the upper right jaw was observed to be rotated. Intraoral examination also revealed cavities at the enamel level on teeth



16, 26, and 27 occlusally. Occlusal decay reaching dentin was detected on teeth 17, 47 and 37. A composite restoration was found on tooth 36, done 3 years ago and now showing signs of poor adaptation. Tooth 38 exhibits partial mucosal retention and mild pericoronitis. In joint examination, deviation to the left side and a clicking sound during opening and closing of the mouth were noted once. Considering the oral findings and the patient's preference, a comprehensive treatment plan was desired.

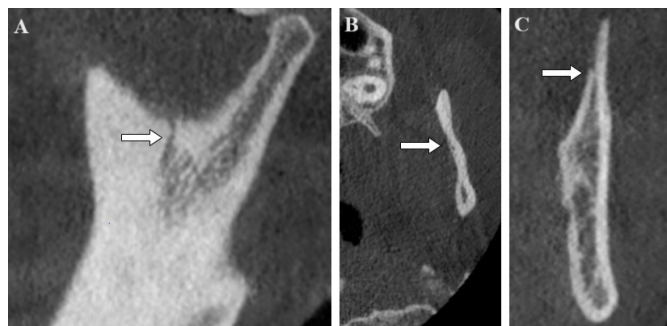
## Reviews

Examinations such as panoramic imaging and periapical imaging were performed initially. CBCT was requested to evaluate the bony components of the TMJ for complaints related to TMJ, and magnetic resonance imaging (MRI) was requested to evaluate the soft tissue components of the TMJ. All imaging and examinations were performed by the authors of this study.

**Periapical radiograph evaluation:** Incompatibility in the filling of tooth number 36 was confirmed.

**Orthopantomography evaluation:** It was observed that teeth numbers 18 and 28 were impacted vertically in the patient's panoramic evaluation. A radiolucency consistent with pericoronitis was observed distal to tooth number 38.

**CBCT evaluation:** Images were obtained using the Castellini X-Radius trio plus (Imola, Italy) dental tomography device with a slice thickness of 1 mm and a voxel size of 0.3 mm, using exposure parameters of 16 mAs and 90 kVp. The patient's images were evaluated in sagittal, horizontal, and coronal sections using IRYS viewer 15.1 software. A full HD screen with a screen size of 15.6 inches and a maximum screen resolution of 1920x1080 was used during the evaluation. No pathology was encountered in the bony components of both TMJs in the patient. A canal with a length of 8.1 mm and a diameter of 0.6 mm, starting from the patient's left sigmoid notch and extending down the ramus, was detected (Figure 1). This canal was called the sigmoid canal. This observed canal was considered an anatomical variation. An MRI examination was considered appropriate for a more extensive investigation and a better understanding of the observed structure. The patient was informed that this structure observed in the bone might affect future surgical interventions, and with the patient's consent, MRI images were obtained.



**Figure 1.** Cone beam computed tomography scan images (A) sagittal section image of sigmoid canal (B) horizontal section image of sigmoid canal (C) coronal section image of sigmoid canal

**MRI evaluation:** Imaging parameters included a field of view of 200\*230, a matrix of 256\*256, and slices with a thickness of 3 mm, using a 3.0 Tesla MRI device (Magnetom Skyra; Siemens Medical Solutions, Erlangen, Germany). The images consisted of T1-weighted images (666/11 TR/TE) obtained in closed and

open mouth positions. MRI, an image with well defined borders was observed, consistent with the hypointense vascular structure extending downwards from the sigmoid notch (Figure 2).



**Figure 2.** Magnetic resonance scan images of sigmoid canal in sagittal section

## DISCUSSION

While some anatomical variations are known, new variations are continually being added to the literature as medical imaging techniques advance.<sup>11</sup> With evolving medical imaging techniques, even the slightest changes in observed structures can be detected. When two-dimensional medical imaging techniques are insufficient, three-dimensional imaging methods are employed.<sup>12</sup> CBCT provides advantages in imaging hard tissue variations due to its ease of use, sectional examination capability, short scanning time, and relatively low radiation dose compared to computed tomography (CT).<sup>12-14</sup> MRI is a popular imaging modality for observing soft tissue due to its non-ionizing radiation, ability to provide sectional images, tissue type differentiation, and absence of known biological damage.<sup>15</sup>

Slight variations from typical anatomical descriptions can be observed in all structures of the body. However, the presence of these differences does not necessarily imply a pathological condition within that structure.<sup>11</sup> Nevertheless, some anatomical variations containing neurosensory bundles may not only lead to anesthesia failure or difficulties in bleeding control due to containing vascular bundles but also facilitate tumor spread.<sup>16</sup> The ease of tumor spread due to certain intraosseous anatomical variations is assumed to be related to these variations being directly associated with cancellous bone.<sup>17</sup> Some other variations also exist in the ramus region of the mandible. For instance, Vascular structures passing through some anatomical variations can cause various complications. For example, in the case report of Naitoh et al.,<sup>18</sup> a total of 4 bone canals, 3 of which were temporal crest canals, were observed in the imaging of 3 patients. It was mentioned that these bone canals may cause complications in surgical procedures. Similar to Naitoh et al.,<sup>18</sup> in two studies



on the mandibular ramus, anatomical variations in this region were analysed and it was stated that these variations may cause complications in surgical procedures.<sup>19,20</sup> Ossenberg<sup>21</sup> published the first case report on the temporal crestal canal, stating that the buccal nerve could pass through this canal and that damage to this structure could lead to various complications. Although the studies have examined the anatomical variations on the ramus, the canal on the sigmoid notch has not been examined.<sup>18-21</sup> It is not possible to observe the content of this canal with CBCT. Therefore, detecting the canal content with MRI is important. MRI examination revealed that the maxillary artery had a branch starting from the sigmoid notch and extending to the ramus. It is possible that unwanted bleeding may occur in this area during surgical interventions on the ramus. It is possible that this branch of the maxillary artery also contains a nerve bundle. It is recommended to conduct further evaluation with CT angiography and histological studies for more detailed examination in future studies.

## CONCLUSION

The sigmoid canal is likely to be confused with the fracture line. Therefore, it is important to know the sigmoid canal in order to prevent possible complications, to make the correct clinical diagnosis and to plan the surgical intervention. In addition, there are no research articles in the literature on this variant canal. It would be beneficial to determine the frequency of this canal in different populations.

## ETHICAL DECLARATIONS

### Informed Consent

The patient signed and free and informed consent form.

### Referee Evaluation Process

Externally peer-reviewed.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Financial Disclosure

The authors declared that this study has received no financial support.

### Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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