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# VAN YÜZÜNCÜ YIL ÜNİVERSİTESİ

## Diş Hekimliği Fakültesi Dergisi

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## Van Diş Hekimliği Dergisi Bilim Kurulu

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## Araştırma



## Derleme



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# Evaluating the Effects of Erythritol Air-Polishing Powder on Dental Hard Tissues

## Eritritol Tozunun Diş Sert Dokuları Üzerindeki Etkisinin Değerlendirilmesi

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**ABSTRACT:** This study evaluated the changes in different dental tissue surfaces after applying erythritol air-polishing powder using scanning electron microscopy. Eight single-rooted human teeth extracted due to advanced periodontitis were included. The samples were randomly divided into one experimental group and one control group. The tested air-polishing powder was erythritol, with no powder application in the control group. Evaluations were conducted on scanning electron microscope images. Each sample was photographed at different magnifications from three areas on the tooth: the enamel, cementoenamel junction, and cementum. Hard and soft tissue debris, surface roughness, and polishing powder accumulation levels were evaluated using pre-defined indexes on each tissue surface. Significant differences were found between the experimental and control groups regarding powder accumulation on the cementoenamel junction and cementum surface. No significant difference between the experimental and control groups was found in surface roughness and hard/soft tissue debris level on the tooth surfaces. The results indicated that erythritol oral polishing powder used in periodontal prophylaxis has different effects on the tooth surface.

**Keywords:** Air polishing, erythritol, periodontal treatment

**ÖZET:** Bu çalışmanın amacı, toz püskürtme sistemlerinde kullanılan eritritol tozunun farklı diş dokuları üzerinde meydana getirdiği değişiklikleri taramalı elektron mikroskobu ile değerlendirmektir. Bu çalışmaya ileri periodontal doku kaybı nedeniyle çekilen 8 adet tek köklü insan dişi dahil edilmiştir. Örnekler rastgele bir deney grubu ve bir kontrol grubu olarak ikiye ayrılmıştır. Deney grubundaki örneklere eritritol tozu uygulanırken kontrol grubuna herhangi bir toz uygulaması yapılmamıştır. Değerlendirme taramalı elektron mikroskobundan elde edilen görüntüler üzerinde yapılmıştır. Her numunenin 3 farklı bölgesi (mine, mine-sement birleşimi ve sement) farklı büyütmelerde fotoğraflanmıştır. Sert ve yumuşak doku kalıntı düzeyi, yüzey pürüzlülüğü ve yüzeyde toz birikim düzeyi önceden tanımlanmış indeksler kullanılarak değerlendirilmiştir. Sement-mine birleşimi ve sement yüzeyindeki toz birikimi açısından deney grubu ile kontrol grubu arasında anlamlı farklılık bulunurken mine yüzeyinde anlamlı fark bulunamamıştır. Diş yüzeylerinde yüzey pürüzlülüğü ve sert ve yumuşak doku kalıntı düzeyi açısından deney grubu ile kontrol grubu arasında anlamlı bir fark bulunamamıştır. Sonuçlar eritritol tozunun diş yüzeyinde farklı etkilere sahip olduğunu göstermektedir.

**Anahtar Kelimler:** Eritritol, periodontal tedavi, toz püskürtme sistemi

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## INTRODUCTION

Oral health maintenance is integral to overall well-being, and dental professionals continually seek innovative techniques and technologies to enhance oral hygiene. Among the myriad tools employed in modern dentistry, oral air-polishing systems have emerged as an effective method for removing dental plaque, stains, and biofilm from teeth and other hard surfaces in the oral cavity and interproximal areas. The first air-polishing device (APD) was marketed and introduced to dental professionals in 1970 (1–4). Research has shown that the advantages of this system over polishing with paste and brush are saving time, less dentist fatigue, and more efficiency in stain removal (5). Several air-polishing powders have been used in oral prophylaxis applications previously, including aluminum trihydroxide [Al(OH)3], calcium carbonate (CACO3), calcium sodium phosphosilicate (Ca.2Na.9O.2H3P.H4Si), and sodium bicarbonate (NAHCO3). These molecules cause severe abrasion on tooth surfaces (4,6,7).

As the demand for minimally invasive and patient-friendly dental interventions grows, the quest for superior oral air-polishing powders intensifies, driving researchers and practitioners to explore novel formulations and applications. In recent years, to overcome the disadvantages of sodium bicarbonate powder, other air-polishing materials such as glycine, trehalose, and erythritol have been used (8,9). One of the frequently used modern air-polishing powders is glycine. It is an amino acid with the chemical formula C2H5NO2. It has low abrasiveness and high biocompatibility, is soluble in water, and does not taste salty.

Erythritol, a sugar alcohol with the molecular formula C4H10O4, has attracted attention for its exceptional water solubility. Its low molecular weight and rapid dissolution in water contribute to its unique role in dental prophylactic procedures. Daily intake of erythritol is safe, and it has been reported that it is not metabolized after ingestion and is excreted unchanged in the urine (10,11). Erythritol can be used safely in the oral cavity and is well-tolerated due to its sweet taste (10,11). In recent years, significant attention has been shifted towards using erythritol powder air polishing due to its non-traumatic impact on soft and hard tissues (11–13). The utilization of micron-sized erythritol particles, particularly when combined with a novel plastic nozzle, has been found to enhance safety during subgingival debridement (14). Furthermore, the application of erythritol for air polishing within periodontal pockets has demonstrated microbiological outcomes similar to those attained through subgingival debridement (15–18). However, it should be noted that erythritol exhibits limitations in effectively removing large and firmly attached masses of calculus and other hard deposits (19).

Oral air-polishing applications have found areas of use across various dental disciplines, such as periodontal and peri-implant prophylaxis, orthodontic treatment receiving patients, and cosmetic dentistry.

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Few studies have evaluated the effects of different air-polishing powders on enamel and cementum. This study assessed the changes on different dental tissue surfaces after air-polishing with erythritol powder (EMS Airflow Plus, EMS Electro Medical Systems, Munchen, Germany) using scanning electron microscopy (SEM).

## MATERIALS AND METHODS

The present study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Istanbul University Faculty of Dentistry Scientific Ethics Committee (protocol no: 2022/30 Date: 15.06.2022).

The eight single-rooted human teeth extracted due to advanced periodontal tissue loss were included in this study (grade III mobility, >70% alveolar bone loss). The extracted teeth were washed with distilled water and stored in a 10% formaldehyde solution. Teeth were randomly assigned to two groups, with four teeth in the experimental group and four in the control group. A coin toss was used to randomly assign the extracted teeth to the two groups. Before the air-polishing procedure, all the tooth samples were washed with a saline solution to remove soft tissue residues and plaque from tooth surfaces. The sample sizes obtained from the teeth were large enough for evaluation and fitting into the SEM tray, i.e., 8 mm. The 8-mm area was measured from the mesial and distal surfaces, including 4 mm of enamel and 4 mm of cementum surface, with a Williams periodontal probe (Hu-Friedy, USA). Markings were made with a hard pen, and two samples were obtained from each tooth. The application was made with the tip of the air-polishing device remaining 1 cm from the tooth surface. A 1-cm-thick wooden block with an opening was prepared to standardize this distance. The teeth were positioned behind the wooden block. Air-polishing powder was sprayed on each tooth, first on the mesial surface and then on the distal surface, at a 90° angle for 15 seconds. The Mylunos powder sprayer (Durr Dental, Bietigheim-Bissingen, Germany) was used for this study.

In the experimental group, Erythritol powder with a particle size of 14 µm was applied. In the control group, no powder was applied.

Then, all the teeth were cut horizontally with a diamond-coated bur under copious water cooling at the previously marked locations on the enamel and cementum and then cut longitudinally to obtain two samples from each tooth. A total of 16 samples were obtained. All the previously prepared samples from all the groups were evaluated using SEM images taken at different magnifications: ×500, ×1000, ×2000, and ×4000. The images were recorded and assessed by two researchers regarding surface roughness, accumulation of air-polishing powder on the tooth surface, and hard/soft tissue debris level on the tooth surface.

Before the study, two examiners were trained on 10 SEM root surface images for calibration. Tooth surface roughness index values demonstrated good reproducibility, which was assessed by interexaminer analysis (k = 0.892). In addition to the kappa agreement, the reproducibility assessment showed that, for 90% of

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thesites, the mean of repeated tooth surface roughness index value was within 1.

**Scanning Electron Microscope Analysis**

Following the air-polishing protocol, the samples were stored in saline solution in previously assigned containers and fixed in 99% isopropyl alcohol for two hours before being transported to the Nano & Opto Electronics Laboratory.

The samples were dried with nitrogen gas before being examined with a SEM. After the dried samples were vacuumed, they were placed on carbon plates for SEM analysis (20). Photomicrographs were taken of each sample at various magnifications, including the enamel surface, cementoenamel junction, and cementum surface. On the images obtained, tooth surface roughness, air-polishing powder accumulation, and hard/soft tissue debris levels were evaluated and scored using three different indices. All the evaluations were carried out by two researchers, and the mean scores were used for statistical analyses. These indexes were used based on the study designed by Camboni & Donnet in 2016 (21).

These indices are as follows:

1) Tooth surface roughness scoring range of 0–5, with 0 indicating no roughness on the surface and 5 indicating the highest roughness.

2) Air-polishing powder accumulation on the surface with a score range of 0–5, with 0 indicating no powder accumulation on the surface and 5 indicating the highest powder accumulation.

3) Hard/soft tissue debris level on the tooth surface with a score range of 0–5, with 0 indicating no hard/soft tissue debris on the surface and 5 indicating the highest hard/soft tissue debris.

**Statistical Analysis**

Statistical testing was performed for all indexes using the SPSS statistical software program v.26. Descriptive statistics were computed, including minimum, maximum, mean, and standard deviations. Mean values and standard deviations were used for statistical analyses. The distribution of data was analyzed using the Kolmogorov-Smirnov test. Normally distributed data were evaluated with one-way ANOVA, and the rest were analyzed with the Kruskal-Wallis test. $P<0.05$ was set as statistical significance.

The required minimum sample size was determined at n=8 in statistical analyses based on the significant statistical difference. Along with the specified eight control samples, 16 samples were included in the study. Type I error was set at 5%, type II error was set at 20%, and the power of the study was set at 80%.

**RESULTS**

The results of the statistical analysis of surface roughness created by applying erythritol air-polishing powder are presented in Table 1 and Figure 1. There were no statistically significant differences between the two groups or on different tooth surfaces.

Table 2 and Figure 2 present the statistical analysis results of air-polishing powder accumulation on the tooth surfaces. According to the results, a significant

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difference was found in the statistical comparison of the experimental and control groups on the cementoenamel junction and cementum surface, with no significant difference on the enamel surface.

The statistical analysis results of hard/soft tissue debris levels on the tooth surfaces are presented in Table 3 and Figure 3. The results showed no significant difference between the experimental and control groups on different tooth surfaces.

**Table 1.** Statistical evaluation of tooth surface roughness between groups on different tooth surfaces

| Group | Enamel | Cementum | Cementoenamel junction |
|---|---|---|---|
| **Control & Erythritol** | P = 0.1848 | P > 0.9999 | P = 0.9991 |

No statistically significant differences were observed between the experimental and control groups on different tooth surfaces (P<0.05).

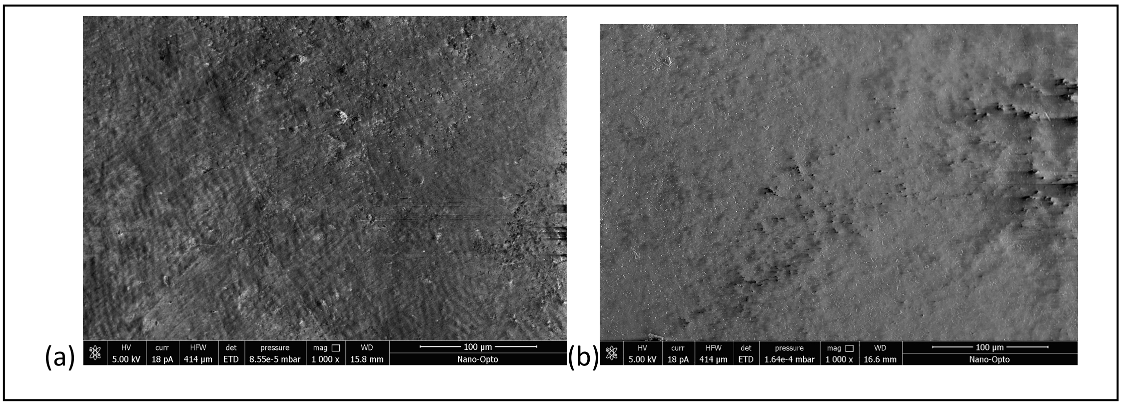


**Figure 1.** Scanning electron microscope images to examine the degree of roughness between the control and experimental tooth surfaces. (a) A scanning electron micrograph to examine the degree of root surface roughness in the control group. (b) A scanning electron micrograph to explore the degree of roughness created by erythritol powder on the root surface

**Table 2.** Statistical evaluation of air-polishing powder accumulation between the groups on different tooth surfaces

| Group | Enamel | Cementum | Cementoenamel junction |
|---|---|---|---|
| **Control & Erythritol** | P = 0.0532 | P = 0.0117* | P < 0.0001* |

No statistically significant differences were observed between the experimental and control groups on the enamel surface. Statistically significant differences were observed between the experimental and control groups on the cementum and cementoenamel surfaces (P<0.05). Significant differences are shown with *.

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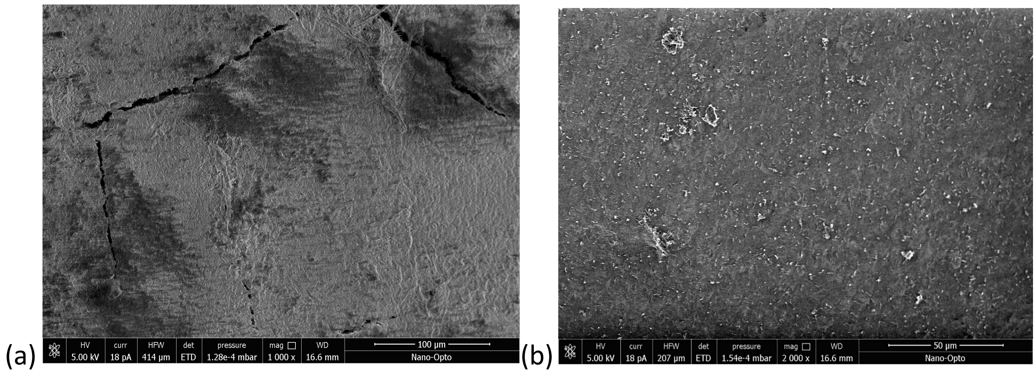

**Figure 2.** Scanning electron microscope images to compare the degree of powder accumulation between the control and experimental tooth surfaces. (a) A scanning electron micrograph to examine the degree of powder accumulation on the root surface in the control group. (b) A scanning electron micrograph to investigate the degree of powder accumulation created by erythritol powder on the root surface.

**Table 3.** Statistical evaluation of hard/soft tissue debris levels between groups on different tooth surfaces

| Group | Enamel | Cementum | Enamel- Cementum junction |
|---|---|---|---|
| **Control & Erythritol** | P = 0.4258 | P = 0.5356 | P > 0.9999 |

No statistically significant differences were observed between the experimental and control groups on different tooth surfaces (P<0.05).

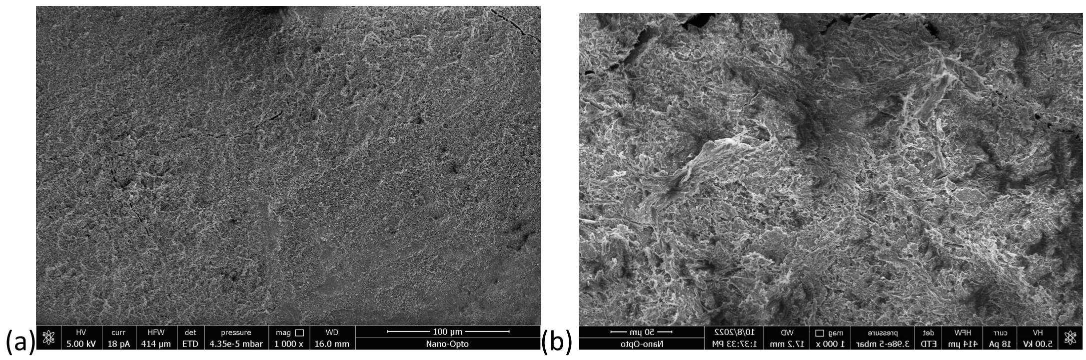

**Figure 3.** Scanning electron microscope images to examine the degree of hard/soft tissue debris levels between the control and experimental tooth surfaces. (a) A scanning electron micrograph to explore the degree of hard/soft tissue debris on the root surface in the control group. (b) A scanning electron micrograph to examine the degree of hard/soft tissue debris created by erythritol powder on the root surface.

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## DISCUSSION

Considering previous studies, a comparison was made between sodium bicarbonate powder and polishing pastes or sodium bicarbonate powder and glycine powder, which were first used in powder spray systems (22,23). The number of studies evaluating trehalose, glycine, and erythritol powders is limited and almost non-existent. Similarly, no study was found in which all three anatomical regions of the tooth, i.e., enamel, cementoenamel junction, and cementum, were included in the study simultaneously. Due to these shortcomings, the present study was designed and conducted by applying erythritol powder separately to three different anatomical regions of the teeth and evaluating the results.

Factors affecting the results of powder spray systems include the application time, the distance between the spray nozzle and the tooth surface, the technique used to apply the powder to the surface, the brand of powder sprayer, the water-to-powder ratio during the application, the airflow and the pressure during the application, the angle between the application head and the tooth surface during application, the chemical structure of the applied powders and the water solubility rate of the applied powders, the particle size determined by variables other than the chemical structure of the powders, the particle size, and the water solubility rate, are kept constant (4, 24–26).

Regarding Table 1 and Figure 1, no significant difference in tooth surface roughness was observed in the present study, possibly due to the sweeping technique used and the duration of application. Statistical studies have illustrated that powder spray systems produce a rougher surface but mimic the naturally rough surface of tooth enamel (21). Camboni (21) reported that the powders used in powder spray systems do not cause defects and scratches on the tooth surface, do not deform the natural morphology of the enamel structure, and can, therefore, be used repeatedly without clinical concerns, consistent with the present study concerning the roughness of the surface. Since the natural roughness of the surface was mimicked after the powder spraying process, no significant difference was found between the control and experimental groups. Furthermore, since the process in the present study was performed using the sweeping technique, the defect rate and roughness were minimized, which is consistent with previous studies. For instance, one study found that a defect occurs with single-point focusing (23). However, with a sweep motion, defect formation is absent or minimal. In addition, the effects of differences in particle size of similar powders are minimized (27).

A previous study expected that the defects would shrink if the distance between the head of the applicator and the root surface increased, with no change in the size of the defects. In other words, the distance between the nozzle and the root surface is inversely proportional to the depth of the defects (3). In the present study, the distance between the application nozzle and the tooth surface was set at 1 cm. This distance

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is longer than for intraoral application, resulting in minimal defects and roughness.

With reference to Table 2 and Figure 2, we can evaluate the results in terms of powder accumulation on the surface separately for three different surfaces. There was no significant difference between the control and erythritol groups when assessing the surface of the enamel. In contrast, a significant difference was found in the cementum and cementoenamel junction. The rougher surface of the cementum can possibly explain this. Enamel consists almost exclusively of inorganic materials, which are mainly carbonated hydroxyapatite crystals (28). In contrast, dentin contains approximately 50 vol% carbonated hydroxyapatite minerals and 30 vol% collagen, which leads to a lower hardness of the substrate, and changes in the surface morphology occur more quickly (28). Cementum structure is softer than dentin; therefore, removing the applied powders from the cementum surface is more difficult, and there is a greater powder accumulation. In a previous study, erythritol powder with a particle size of 11–14 µm was used in the supragingival area. However, due to its low abrasive effect, its use was recommended in the subgingival area where the dentin is exposed (7).

Other studies have reported that powder spray systems are a safe biofilm removal method in periodontitis and peri-implantitis patients and are also comfortable for the clinician and patient. The results of our study on the cementum surface support the results of this study. Powder deposits on the surface of these experimental groups may lead to tubule clogging, resulting in reduced sensitivity, and their use in the subgingival area is safe.

According to Table 3 and Figure 3, examining the hard/soft tissue debris on the surface revealed no significant difference between experimental and control groups on different tooth surfaces. According to our results, in clinical studies, we can use the powders more safely if we apply them with a sweeping motion and from a greater distance rather than focusing on a single point, and the possibility of defects is minimal or non-existent. However, it should not be overlooked that it is difficult to keep the application angle and the distance of the head from the tooth surface constant in the clinical setting.

On the other hand, it was observed that powder accumulates on the tooth surface due to the application of powders. The sensitivity after the procedure is minimal as this blocks the dentinal tubules, forming a protective layer on the tooth surface. At the same time, this powder accumulation mimics the natural prismatic and irregular surface of the enamel but can also increase the risk of bacteria and biofilms attaching to these irregular areas (21).

Other factors, such as the type of blasting material and the quality of the tooth material, could affect the results (9, 18–21). A critical issue is the quality of the specimen. The extracted teeth can be stored in different solutions, such as formaldehyde or chloramine, for disinfection. These solutions might weaken the tooth substance (29–31). For this study, the teeth were stored in formaldehyde solution, which might have affected the surface of the teeth.

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Another important aspect is the effect of air polishing on clean dentin. Usually, every debridement method should be applied only if there is a bacterial biofilm or stain to be removed. It should be remembered that as long as the biofilm is not removed, the procedure cannot damage the tooth surface. Therefore, the manufacturer advises staining the biofilm to perform air-polishing only where necessary. Yet, staining of the biofilm would only be helpful supragingivally but not subgingivally. Moreover, clinically, the adhering biofilm might not always be homogeneous; therefore, the biofilm may remain completely in some places and leak elsewhere.

In clinical settings, it might not be possible to prevent air polishing from affecting already clean surface areas (31). We simulated this situation in our in vitro study by intentionally air-polishing clean tooth surfaces.

In future studies, changes in powder spraying speed, pressure, and water ratio can be made to examine the relationship between surface roughness, powder accumulation, and application pressure and water ratio. A decision can also be made about which device setting will be more appropriate for clinical studies.

## CONCLUSION

The present in vitro study showed that performing air-polishing with erythritol did not cause substance loss or roughness in any part of the tooth surfaces and did not cause any hard or soft tissue loss. Additionally, performing air-polishing with erythritol caused powder accumulation on the rougher surfaces of the cementum and cementoenamel junction. However, considering the limitation of our study regarding the distance between the application nozzle and the tooth surface, which may not be maintained in clinical practice, closer application distances are necessary. Consequently, further research is needed with combinations of different angles and durations at closer distances.

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**Conflict of Interest:** The authors declare no conflicts of interest.

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**Ethical Approval:** Istanbul University Faculty of Dentistry Scientific Ethics Committee (protocol no: 2022/30 Date: 15.06.2022).

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**Derleme/Review**

# Evaluation of Stem Cell Applications in Periodontal Regenerative Therapy: A Current Perspective Between 2003-2022

## Periodontal Rejeneratif Tedavide Kök Hücre Uygulamalarının Değerlendirilmesi: 2003-2022 Yılları Arasında Güncel Bir Perspektif

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**ABSTRACT:** The periodontium comprises the fundamental tissues of the tooth, namely the gingiva, periodontal ligament, cementum, and alveolar bone. Prolonged accumulation of microbial dental plaque on the tooth and gingival margin leads to pathological changes in the periodontal tissues. However, the mechanical and regenerative techniques employed to address the breakdown of periodontal tissue have been unsuccessful in fully restoring the periodontium to its original, disease-free condition. The growing understanding and recognition of the potential uses of stem cell therapy have led to the emergence of new perspectives on periodontal regeneration approaches. This review investigates mesenchymal stem cells and their use in periodontal regeneration treatment.

**Keywords:** Cell transplantation, mesenchymal stem cells, periodontal treatment, tissue engineering

**ÖZET:** Periodonsiyum dişin başlıca temel dokularını, diş eti, periodontal ligament, sement ve alveol kemiğini içerir. Diş ve diş eti kenarlarında mikrobiyal diş plağının uzun süreli birikmesi periodontal dokularda patolojik değişikliklere yol açar. Ancak periodontal dokunun uğradığı bu hasarı gidermek için kullanılan mekanik ve rejeneratif teknikler periodonsiyumu orijinal, hastalıksız durumuna tamamen döndürmede başarısız olmuştur. Kök hücre tedavisinin potansiyel kullanımlarının giderek daha iyi anlaşılması ve tanınması, periodontal rejenerasyon yaklaşımlarına ilişkin yeni bakış açılarının ortaya çıkmasına yol açmıştır. Bu derlemede mezenkimal kök hücreler ve bunların periodontal rejenerasyon tedavisindeki kullanımı araştırılmaktadır.

**Anahtar Kelimeler:** Doku mühendisliği, hücre transplantasyonu, mezenkimal kök hücreler, periodontal tedavi

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## INTRODUCTION

The periodontium is a complex structure that experiences age-related changes, as well as morphological changes associated with functional alterations and changes in the oral environment (1). Its main role is to connect the tooth to the jawbone and preserve the integrity of the surface of the oral cavity's masticatory mucosa. The structure comprises four distinct tissues: the gingiva, the periodontal ligament (PDL), the root cementum, and the alveolar bone.

The long-term accumulation of microbial dental plaque around the tooth-gingiva interface leads to a gradual breakdown of the soft and hard tissues of the periodontal complex (2). This process is influenced by the interaction between imbalanced bacterial populations and immune responses within the gingival and periodontal tissues. As the local oral microbiota becomes imbalanced and inflammatory responses occur, potential periodontal pathogens become more prevalent. This creates a continuous cycle where tissue degradation, inflammation, and enrichment of periodontal pathogens reinforce each other (3).

Periodontal regeneration involves the restoration of the injured periodontium following disturbances to its natural structure and function (4, 5). This process tries to regenerate the alveolar bone and cementum, as well as stimulate the production of new periodontal ligaments (6).

Various techniques have been employed to guarantee the restoration of periodontal tissue. Predisposing conditions are eradicated by the implementation of phase1 therapeutic procedures, such as root surface planning. Additional techniques involve the use of chemical agents to disinfect the root surface, the application of different types of graft materials (such as autogenous, allogeneic, and synthetic), the creation of a physical barrier using membranes, and the use of polypeptide growth factors and attachment factors (7). One specific method is guided tissue regeneration, which combines the use of grafts and membranes. This treatment aims to optimize root surface regeneration by focusing on the specific cell populations responsible for inducing periodontal regeneration. While there have been some clinical successes recorded, the outcomes of this surgery are regarded to be unpredictable (8). Tissue infection may arise during the healing process when the graft material and barrier membrane are applied, leading to a detrimental impact on regeneration. Despite the purpose of the membrane barrier being to impede epithelial migration, numerous histologic studies demonstrate the development of epithelial tissue between the membrane and the tooth surface (9).

Contrary to their intended purpose of periodontal regeneration, the aforementioned treatment modalities are incapable of completely restoring the compromised periodontium to its ideal condition prior to the disease.

The growing understanding and familiarity with the use of stem cell treatments in recent years has resulted in the emergence of new perspectives on periodontal regeneration therapies. Mesenchymal stem cells are distinguished from stromal cells in terms of their ability to undergo self-renewal and division over

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extended periods, their lack of specialization, and their capacity to detect signals of damage and differentiate into specific cell types (10,11). This review covers both preclinical and clinical investigations in the realm of tissue engineering, focusing on the utilization of mesenchymal stem cells (MSCs) derived from teeth and periodontal tissues.

## 1. What is a Stem Cell

A stem cell is characterized as a cell capable of unlimited growth in a controlled environment and has the capacity to differentiate into certain types of adult cells (12). These cells have a significant function in maintaining tissue stability and facilitating continuous regeneration throughout an individual's lifespan. Stem cell plasticity, which refers to their capacity to transform into various tissue types, is a key factor contributing to the growing favor of stem cells in regenerative medicine (10).

Differentiation refers to the process by which an undifferentiated stem cell transforms into a specialized cell with a specific function. These cells undergo mitosis without undergoing functional differentiation and divide in an asymmetric manner. One of the cells resulting from mitosis possesses identical traits to the stem cell, whereas the other cell exhibits the traits of the specific tissue it will eventually specialize into (13).

Stem cells are commonly categorized into three distinct types: embryonic stem cells, adult somatic or postnatal stem cells, and, more recently, induced pluripotent stem cells. Embryonic stem cells are multipotent cells obtained from the early mammalian embryo that have the ability to proliferate and differentiate into cells representing all three embryonic germ layers, namely mesoderm, endoderm, and ectoderm. These cells have the potential to differentiate into almost any form of cell, but they are unable to contribute to further embryonic tissues and hence cannot grow into a fetus or adult animal (14).

New efforts are being made to genetically reprogram somatic cells back to a pluripotent state in response to the significant ethical concerns raised by the use of embryos to derive human embryonic stem cell lines, despite their developmental potential. These endeavors have led to the creation of induced pluripotent stem cells, which exhibit comparable characteristics to embryonic stem cells. These cells are indistinguishable from embryonic stem cells in terms of their morphology, gene expression patterns, proliferation, and differentiation (15).

MSCs originate from the mesoderm layer in the early stages of embryonic development and possess the ability to transform into many mesenchymal tissues, including muscle, cartilage, bone, and fat. These cells are categorized as somatic stem cells and can be obtained from both human and animal sources. MSCs are often regarded as appropriate cells for the field of regenerative medicine. Under proper in vitro circumstances, they have the ability to differentiate into osteogenic, adipogenic, chondrogenic, and myogenic cells. In 1976, Friedenstein et al. successfully extracted MSCs from the bone marrow of mice (16). The cells were found to have a spindle-shaped morphology and the ability to attach to plastic surfaces. Recent advancements in technology and research on tissue

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engineering suggest that MSCs, which are present in various tissues such as fat, bone marrow, dental pulp, and PDL, have the capacity to differentiate into multiple cell types such as osteoblasts, chondrocytes, hepatocytes, and neurons. This differentiation is triggered by various stimulating factors (17-19).

The International Society for Stem Cell Research (ISSCR) categorizes cell populations as MSCs if, under laboratory conditions, they:

1. Exhibit fibroblast-like shape in cell culture conditions and adhere to plastic.

2. Express endothelium antigen (CD31), HLA-DR, and CD105 (SH2), but not hematopoietic-specific markers (CD45, CD34, CD11b, CD14, or CD79a).

3. Undergo in vitro differentiation into mesodermal cells, namely osteoblasts, adipocytes, and chondrocytes (20).

Furthermore, MSCs possess immunomodulatory characteristics. MSCs possess chemokine receptors on their surface, enabling them to travel to sites of inflammation or tissue injury in the body (21). Once there, they can restrict the activities of T lymphocytes, B lymphocytes, and natural killer cells, as well as prevent the development of dendritic cells (22). In addition, they possess immunomodulatory and anti-inflammatory characteristics through the production of cytokines. These cells can be utilized for the treatment of both acute and chronic disorders without causing suppression of the immune system, since they are immunologically autonomous (23).

Human-derived MSCs have the ability to develop into several cell types, including neurons (ectodermal), hepatocytes (endodermal), osteoblasts, adipocytes, and chondrocytes (mesodermal). Currently, MSCs may be derived from several tissues, such as:

• Bone Marrow Derived Mesenchymal Stem Cells (BM-MSCs)

• Adipose Tissue Derived Mesenchymal Stem Cells (AT-MSC)

• Dental Tissue Derived Mesenchymal Stem Cells (DT-MSCs):

• Apical Papilla Stem Cells (SCAPs)

• Stem Cells Derived from Human Exfoliated Deciduous Teeth (SHEDs)

• Dental Follicle Progenitor Cells (DFPCs)

• Dental Pulp Stem Cells (DPSCs)

• Periodontal Ligament Stem Cells (PDLSCs)

• Gingival Tissue Derived Mesenchymal Stem Cells (G-MSCs)

Recent research has demonstrated that MSCs play a significant role in regenerative cell renewal, tissue repair, and wound healing. Furthermore, they have been proven to be a safe and valuable resource for medical treatment and research (24-26).

**2. Stem Cell Research on Regenerative Periodontology**

A potential approach for regenerating periodontal tissue in the context of periodontal therapy involves incorporating progenitor cells into a pre-made three-dimensional structure, which is then inserted into the damaged area. This technology overcomes some limitations of conventional regeneration therapies by

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enabling the prompt administration of growth factors and progenitor cells directly into the damaged area. As a result, the typical delay in recruiting progenitor cells to the wound site is eliminated. For successful periodontal tissue engineering, the following crucial components are necessary:

1. A sufficient quantity of suitable precursor cells with the ability to develop into the necessary fully developed tissue types, such as osteoblasts, cementoblasts, and fibroblasts.

2. Appropriate signals to control tissue neogenesis and cellular differentiation.

3. A conductive three-dimensional extracellular matrix scaffold designed to promote and enhance cellular differentiation and the formation of new tissue.

This review examines several research that have tested different types of stem cells described above, as well as different types of scaffolds (15).

**2.1. Embryonic Stem Cells**

Kang et al. (27) demonstrated the successful differentiation of mouse embryonic stem cells (ESCs) into osteogenic lineages in a laboratory setting. They also showed that when mouse ESCs were combined with hydroxyapatite/tricalcium phosphate (HA/TCP) or ESC-derived embryoid bodies (EBs), they were able to form an osteoid structure within a tooth socket.

Inanc et al. (28) examined the impact of dental root surfaces on the adherence of cells and the initial growth of human embryonic stem cells (hESCs) when combined with the coculture of periodontal ligament fibroblast cells. The connection between periodontal progenitor-like cells produced from hESC and tooth root surfaces (RSs) is crucial for the potential utilization of these cells in investigating periodontal development and regeneration mechanisms, as well as in applications involving the engineering of periodontal tissues using cells.

Ohazama et al. (29) discovered that when combined with embryonic day 10 oral epithelium, ESCs exhibited the activation of certain odontogenic mesenchymal cell genes, such as Lhx7, Msx1, and Pax9. This indicates that ESCs have the potential to react to signals from the embryonic dental epithelium.

**2.2. Induced Pluripotent Stem Cells**

Tang et al. (30) utilized MSCs derived from induced pluripotent cells, which were obtained from bone marrow cells expressing the CD34-positive surface marker, to investigate osteogenic differentiation. In a separate animal study, the same method was employed to examine periodontal tissue regeneration, yielding positive outcomes (31). In a preliminary mouse study, induced pluripotent MSCs were administered intravenously through systemic and topical routes to experimental animals specifically designed to simulate periodontal disease. The study revealed a decrease in inflammation and the prevention of damage to the alveoli (32).

**2.3. Bone Marrow Derived Mesenchymal Stem Cells**

Houshmand et al. (33) examined the impact of enamel matrix derivative (EMD) and recombinant human transforming

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growth factor-beta (rhTGF-beta) on the differentiation of osteoblasts derived from human bone marrow mesenchymal stem cells (BMSCs) and human periodontal ligament stem cells (PDLSCs). The goal was to gain a deeper understanding of how biomaterials and growth factors can be used to improve stem cell-based methods for bone regeneration. No bone-related messenger RNAs were detected in any of the experimental groups after 5, 10, or 15 days of EMD treatment. On the 21st day, the alizarin red staining showed a negative result in the bone marrow-derived mesenchymal stem cells and periodontal ligament-derived stem cells treated with EMD. Osteonectin mRNA expression was detected in the BMSC culture supplemented with rhTGF-β on day 15, and this level of expression was found to be statistically similar to that of the positive control group. However, mineralization of the extracellular matrix was inhibited in both groups of stem cells.

Liu et al. (24) examined the impact of exosomes produced from bone marrow mesenchymal stem cells on the process of periodontal regeneration. The treatment with BMSC-sEV resulted in a substantial increase in the migration and proliferation of PDLCs ($p < 0.05$). Following 7 days of stimulation, the application of BMSC-sEV resulted in enhanced mineralization capacity of PDLCs, as indicated by alizarin red staining. Additionally, the mRNA levels of osteopontin, osteocalcin, collagen type I and fibronectin were considerably elevated in the BMSC-sEV group.

### 2.4. Adipose Tissue Derived Mesenchymal Stem Cells

The effectiveness of AT-MSCs inserted onto tissue scaffolds was assessed in a study conducted at the intersection of periodontal regenerative therapy and stem cell and tissue engineering. The study was conducted where a scaffold comprising β-TCP and AT-MSCs was inserted into the rectus abdominis muscle of a patient who had previously undergone hemimaxillectomy. The histological analysis of the sample, conducted 6 months post-procedure, revealed the existence of osteocytes and mineralized trabecular structures that exhibited appropriate bone shape. Following the placement of the harvested bone graft in the deficient region of the patient's maxilla, implant therapy was administered to the corresponding area. The researchers documented that the implant was successfully fixed with primary stability (34).

Tobita et al. (35) conducted an animal investigation in 2013 where they artificially produced class III furcation deficits in dogs. During the trial, one of the experimental groups was administered platelet-rich plasma (PRP), while the other group got both PRP and AT-MSCs. The participants in these groups were monitored for a duration of 2 months. Based on their findings, the researchers determined that the group treated with both AT-MSCs and PRP showed the formation of PDL fibers, as well as a significant presence of alveolar bone and cement-like structures after two months. In contrast, the group treated with PRP alone did not exhibit the formation of PDL fibers.

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To assess the periodontal regenerative capability of AT-MSCs, surgically induced fenestration defects were utilized in a rodent model. The experimental groups were designed as polyglycolide-polylactide scaffolds combined with AT-MSCs and cell-free. After a duration of five weeks, a greater amount of PDL, cementum, and bone formation was observed in the group that received a combination of AT-MSC compared to the group that did not get any cells (36).

**2.5. Dental Tissue Derived Mesenchymal Stem Cells**

As previously stated, mesenchymal stem cells can also be found in mammalian teeth. These dental MSCs share several in vitro traits with MSCs derived from bone marrow, including clonogenicity, expression of specific markers, and the ability to differentiate into cells resembling osteoblasts, chondrocytes, and adipocytes. This differentiation process aids in tooth growth and repair. The versatility and availability of MSCs have prompted a novel approach in dental regeneration research, as they may give rise to several types of cells (37).

Rats were subjected to a cranial defect in a study by Asutay et al. (38) that compared the osteogenic differentiation capabilities of DP-MSCs and scaffolds comprising HA and TCP. The study was designed to span a duration of 8 weeks, with the experimental groups being as follows:

- DP-MSC, HA, TCP
- HA combined with TCP
- Defect only

The study findings indicated that the experimental group, which included DP-MSC, exhibited notably elevated bone mineral density and calcification rate in comparison to the other groups.

A histological evaluation of the effectiveness of PDL-MSCs in periodontal regeneration was conducted by Mrozik et al. (39) To accomplish this, the researchers developed periodontal defect models derived from sheep models. The study involved the application of scaffolds containing alginate and gelatin to the control groups, and scaffolds containing PDL-MSCs, alginate, and gelatin to the experimental groups. Histological examinations conducted in the respective sites four weeks post-application revealed that the experimental group exhibited a larger surface area of freshly generated alveolar bone compared to the control group, along with a higher amount of cement formation.

A research was conducted to assess the effectiveness of PDL-MSCs and scaffolds containing calcium phosphate in regenerating periodontal tissue. Periodontal defect models were produced in dogs, and the results were examined at 4, 8, and 12 weeks using computed tomography, immunofluorescence analysis, and light microscopy. The results showed that vimentin and STRO-1 proteins were positive in PDL-MSCs, cytokeratin proteins were negative, and scaffolds containing calcium phosphate promoted osteogenic differentiation (40).

In a study by Yoo et. al (25) researchers assessed the impact of PDL-MSCs and scaffolds containing collagen on the healing of periodontal tissues. Dehiscence defects

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were surgically induced in the maxillary premolars and first molars of dogs. After 8 weeks, the healing of periodontal tissues was examined using histological analysis. The researchers documented that PDL-MSCs exhibited a positive effect on periodontal regeneration, namely in the development of cementum and new bone.

According to research by Duan et al. (41) where researchers utilized enamel matrix proteins and their derivatives, the study showed PDL-MSCs may differentiate into alveolar bone, periodontal ligament, and cementum.

In a different study examining how PDL-MSCs can differentiate, researchers found that these cells can become osteogenic, which means they can help the cement-periosteum complex grow again (42).

Li et al. (43) induced gingival defects in rats and examined the effectiveness of G-MSCs. After two weeks of applying G-MSCs to the defect region in the study group, the local gingival tissue and morphology exhibited similarity to that of normal healthy gingival tissue. In contrast, the defect areas in the control group had a greyish tint.

In a clinical trial examining the impact of DP-MSCs on osteogenic differentiation, collagen scaffolds incorporating DP-MSCs were implanted into molar extraction cavities with the purpose of generating compact bone. Following a three-year period of observation, examination of biopsy samples from the corresponding locations demonstrated the presence of osteocytes, newly formed bone structure, and Haversian canal structure enclosed by concentric layers of lamellae (44).

To determine the effect of DP-MSCs on osteogenic differentiation, DP-MSCs were implanted into the extraction sites of an experimental group using a collagen-containing scaffold in a 2017 clinical trial. The control group utilized a collagen scaffold that was devoid of cells. After a period of sixty days following the treatment, a histological examination of the relevant locations revealed that the experimental group, which received DP-MSCs, displayed differentiated bone structures containing the Haversian system. In contrast, the control group showed only minimal levels of these tissues (45).

Multiple clinical trials have assessed the effectiveness of DP-MSCs in promoting the regrowth of periodontal tissues. Periodontitis patients with intraosseous defects underwent surgical intervention to fill the defects with micro-sized collagenous scaffolds that contained DP-MSCs. The patients were then monitored for a duration of one year. The researchers observed a notable decrease in the depth of periodontal pockets and an increase in the amount of clinical attachment gain (46).

A clinical experiment was conducted to examine the use of PDL-MSCs in guided periodontal tissue regeneration (GDR). PDL-MSCs were employed in conjunction with the xenogeneic graft material Bio-Oss®. In the study, PDL-MSCs/Bio-Oss®/GDR and Bio-Oss®/GDR were utilized as the comparative groups (47). While both experimental groups exhibited a statistically significant elevation in alveolar bone height when compared to the initial measurements, the researchers determined that there were no statistically significant distinctions between the two groups.

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Altıkat et al. (48) examined the impact of 2D and 3D culture environments on the osteogenic differentiation of AT-MSCs, DP-MSCs, and PDL-MSCs. They found that the cells in the 3D study group, which were created using scaffolds containing HA, exhibited notable osteogenic differentiation compared to the other groups.

## CONCLUSION

Mesenchymal stem cells possess the capacity to offer an alternative treatment paradigm in investigations of tissue engineering for periodontal regeneration therapy. While the complete understanding of the possible advantages and disadvantages of cell-based therapy studies is lacking, research conducted on animals and case series studies indicate that these therapies have promise in the field of periodontal regeneration therapy.

**Conflict of Interest:** The authors declare no conflicts of interest.

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**Derleme/Review**

# Evaluation of the Place of Artificial Intelligence Applications in Medical Sciences and Dentistry

## Yapay Zekâ Uygulamalarının Tıp Bilimleri ve Diş Hekimliğinde Yerinin Değerlendirilmesi

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**ABSTRACT:** Intelligence, which is also considered as human mental processes such as learning, problem solving, needs to be developed. The use of devices for its development introduced the idea of machine intelligence and that has paved the way for the concept of artificial intelligence (AI). AI has the capacity not only to imitate human intelligence, but also to stimulate thoughts and reactions, and it has the ability to learn on its own. AI, which has an impact on the fields of philosophy, mathematics, gaming, music psychology, also has an impact on health sciences. Nowadays, in health sciences and dentistry, manual labor, skills and experience are sometimes cannot be sufficient in the treatments that restore the functions that patients previously lost, and patient requirements cannot be fully met. In addition, assessments such as occlusion, tubercle contacts, angulation of the prosthesis, force distributions that require millimetric calculation and their adjustments can sometimes be oversight. For this reason, computers, programs and undoubtedly AI have also taken their place in current treatment procedures.

**Keywords:** Artificial intelligence, dentistry, endodontics, medical informatics

**ÖZET:** Öğrenme, problem çözme gibi insana ait zihinsel işlemler olarak da değerlendirilen zekânın geliştirilmeye ihtiyacı vardır. Geliştirilmesi için cihazların kullanılması makine zekâsı düşüncesini getirmekle birlikte yapay zekâ (YZ) kavramının önü açılmıştır. YZ, insan zekâsını taklit etmekle kalmayıp düşünce ve tepkileri stimule etme kapasitesine sahiptir ve kendi kendine öğrenme yeteneği vardır. Felsefe, matematik, oyun, müzik, psikoloji alanlarında etki gösteren YZ, aynı zamanda sağlık bilimlerinde de etki göstermektedir. Günümüzde tıp bilimleri ve diş hekimliğinde, hastaların daha önce kaybettikleri fonksiyonları geri kazandıran tedavilerde el işçiliği, beceri ve tecrübe bazen yeterli olmamakta, hasta gereksinimleri tamamen karşılanamamaktadır. Buna ek olarak milimetrik hesap gerektiren oklüzyon, tüberkül temasları, protezin açılanması, kuvvet dağılımları gibi değerlendirmeler ve bunların ayarlamaları bazen gözden kaçabilmektedir. Bu sebeple güncel tedavi prosedürlerinde bilgisayarlar, programlar ve şüphesiz YZ da yerini almıştır.

**Anahtar Kelimler:** Diş Hekimliği, endodonti, tıbbi bilişim, yapay zekâ

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## INTRODUCTION

Artificial Intelligence (AI) and its derivatives, which have made a great breakthrough in recent years, are appearing in the literature with different purposes and different results day by day. Artificial intelligence provides benefits in many areas such as content production, agricultural land assessment, advertising, language, literature research as well as in well-known areas such as mathematics, law, trade, communication. AI studies fed by cumulative data are focused on thinking like a human and realizing the predicted goals that a human cannot do. For AI, it can be mentioned as part of the opportunity created to achieve the goals in the world (1). AI is a general term that refers to the use of a computer to model intelligent behavior with minimal human intervention (2) and has an algorithm that can learn on its own. The tasks that he often performs have a connection with human intelligence (3). It affects the opinions that people offer in their daily lives, and even their behavior more and more every day (4). AI, traces of which are seen in every field, has also taken its place in medical sciences. AI has been a bridge between informatics and medicine in many areas such as treatment planning, X-ray deciphering, prosthetic restoration, construction. Artificial intelligence used in the healthcare sector provides improvements in specialized areas as well as operational initiatives implemented in hospitals (5). In addition, the field dentistry also can be counted as personal hospitals in other words. Every clinic has its own patients and programmes as well. Moreover, in some emergency cases the dentist should be much more intelligent, sufficent and fast. That points the truth which dentistry is being much more attached to AI and it would have been a promising fortune (6). Because AI has recently been used in dentistry, which has led to successful results. AI provides advanced benefits such as data analysis, risk assessment, elective processing. Even in dental education, an increase in skill level has been observed. In addition, AI can be used for patient management, diagnosis, prognosis and the other branches as well (7). It has a wide range that enlights the view of treatments. AI can detect tooth numbers, measure muscles, can detect the links between tooth and anatomical structures, can detect periodontal diseases, can detect landmarks, evaluate caries prognosis, and identify radiolucencies (8). This review has been prepared in order to show examples, to be a guide and to make evaluations about the use of programs and AI within the framework of the information provided by current literature sources.

### 1.1 The place of artificial intelligence in medical sciences and artificial intelligence in the health sector

AI has many benefits in many areas from music to games, from creating picture choreography to programming and directing, and even in educational sciences. AI is in a period of deceptively rapid growth, and health sciences have taken their place among the areas in which this period of growth is showing its influence (9). Medicine is very different from other fields where AI is applied. AI enables new discoveries and improved processes in the entire healthcare process (10). Medicine is an area where the potential for possible

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application seems high. The idea of interpreting X-rays has been in existence for many years. However, it is technically difficult to use it as a definitive diagnostic tool in the clinic in terms of this goal (11). There are two main branches of the application of AI in medicine. These fields are called physical field and virtual field. The physical part includes medical devices and devices involved in care outcomes that are becoming increasingly complex, robots and their uses. The virtual component, on the other hand, is known as 'Machine Learning (ML)', represented by mathematical algorithms that improve learning through experience (2). Most of the concepts used in medicine can be treated as fuzzy data. Due to the inherent nature of medical concepts and the imprecise nature of the relationships between these concepts, the method suitable for medical applications is fuzzy logic, which is equivalent to fuzzy logic. Imprecise medical conditions can be identified in fuzzy sets (12). A common reason fuzzy logic framework comprises of 3 diverse stages. These stages are known as blurring, inference and rinsing. Blurring changes over numerical inputs into fuzzy values utilizing the participation capacities of the inputs. After being changed over to values, inference at that point produces fuzzy yields from fuzzy inputs utilizing rules that reflect human encounters related to the issue of intrigued. The final portion changes over fuzzy yields to numerical yield by means of the output's participation capacities (13). Fuzzy logic is useful in various fields such as cancer diagnosis in medicine, benign-malignant lesion separation, quantitative drug use, ischemic stroke, radiation therapy, appropriate lithium dosage regulation (14). Especially what is separate from what exists in human nature, the existence of an error-free diagnosis, if possible, is questioned. Its main purpose can also be called to support the clinician in the decision-making process (15).

A subset of ML called 'Deep Learning (DL)', that has a large number of computational layers, which form a network of neurons that identify patterns and thus perception can be improved. In this way, evaluations such as alveolar bone loss, periapical radiolucency, radix entomolaris can be performed easily. Automated technology can speed up clinical processes and increase the efficiency of the dentist (7). Deep learning technologies can provide diagnostic assistance to dentists as analysing and recognizing of dental images (16). Not only diagnostic assistance but also more benefits provide by DL which are also detecting caries, tooth number and place detection, disease of periodontal tissue, lesions, determination of age and maybe more due to improving technology (17). Since AI has a wide range of applications starting from diagnosis and extending to treatment, such as pathology or radiography evaluations, drug development, dose calculations, robotic surgery applications, dentistry applications, prosthesis production, AI applications have the potential to be used in almost every field of medicine (18). Indeed, the AI item GPT-4 has the potential to assist bolster restorative development, from making a difference with quiet release notes, summarizing later clinical trials, giving data around moral rules, and much more (19). It provides significant aesthetic and functional improvements in the surgical procedure (20). Multiple clinical problems in the fields

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of medicine and dentistry can cause difficulties for physicians. AI facilitates the work of clinicians by defining solutions to these problems. In this way, it will be able to have a great impact on medical medicine and dentistry (21). One of the benefits of AI is that the treatments and medical interventions applied to patients can be performed in a high-quality manner, as well as achieving predictable results, making complex protocols simple, and these applications are developing day by day (22). Today, artificial intelligence is recognized as a branch of engineering that applies new concepts and new solutions to solve complex problems (2). The application of AI in jobs where doctors are not looking hot is an advantage for the health informatics sector, where the workload is intense. For many physicians, technologies that were once very popular, such as electronic health records, have become too much responsibility over time. This situation has increased overload and burnout rather than alleviating it. Using artificial intelligence to facilitate the workload will increase the time that physicians will devote to the patient (23). When AI is used to alleviate the working conditions of medical personnel, especially physicians, it will also be a factor in increasing productivity, since the relevant personnel can use the time lost with paperwork and regulations to useful endeavors to improve both themselves and their institution. This, in turn, can shed light on the rise in the healthcare sector by contributing to both personal and social progress. When the usability, reliability and practicality of AI applications are proven as a result of sufficient research, it will also take its place in routine daily clinical treatments. Ethical, management and regulatory considerations are of critical importance in the design, implementation and integration of every component of AI applications and systems (10).

**1.2 The effects of artificial intelligence on dentistry**

AI applications operating in many fields are gaining a place in the field of dentistry as well as in many fields of medicine. Dentists are using AI more and more in their branches as time goes on (24). Computer-based diagnostics is gaining momentum thanks to its ability to detect and diagnose lesions that the human eye cannot notice, thus paving the way for a holistic application (25). Micro-endodontic robots can also be used in endodontic treatments associated with painful patients, narrow field of vision, blocked root canals. The devices can evaluate the history information and intraoral images entered with their own coding (26). However, there is also the use of AI in areas such as tumor-related lesions, alveolar bone loss, evaluation of maxillofacial cysts, diagnosis of salivary gland diseases, maxillary sinusitis (27). In addition, it has been found that it has enough sensitivity, specificity and accuracy to become a model for detecting vertical root fracture in digital radiography (28). The configuration of the root canal can be created in three dimensions, and the findings found in the root canal, such as the depth of caries or calcifications, can be detected. Treatment applications minimize the possibility of experiencing undesirable conditions such as ledge, perforation, tool seperation, healthy tissue destruction, which are unsuccessful due to the fact that they are performed according to measurements in a planned manner (29).

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Prosthetically, it also contributes to the production of aesthetic prostheses by making many calculations, including face measurement (30). Physicians should not forget that computers can also give erroneous results when using the possibilities of technology. Regardless of the extent to which digitization advances, physicians must incorporate their own knowledge and experience into their practice (31) Artifacts, intraoral image of the patient and clinical symptoms should of course be compared with the data output presented in radiography and AI application, and the supported data should be focused on.

**1.3 Limitations and issues that need to be improved**

AI should be improved in some aspects or steps should be taken for ease of use by physicians. The way humans interpret data and the way machines express data are not the same. For this reason, there is doubt in medical diagnoses, compliance is sought. The correlation in the anamnesis findings is an accepted basis as an intermediate Deceleration. However, medical interventions, when examined technically, are based on the basis of causality for a definitive diagnosis in order to solve the mechanisms underlying the patient's medical history (32). Due to the complexity of medical clinical practice by patient statements, traditional quantitative analysis approaches are not suitable (12). The lack of information and uncertainty caused by the limitlessness of medical science may cause machine fatigue to be contradictory. However, the confusion of the system, the expensive device installation, the need for technicians to receive adequate training, the bias due to the use of data for both testing and learning, the fact that the results cannot be easily applied, the presence of erroneous or incomplete diagnoses should also be considered (5). The necessity of artificial intelligence to support medical decisions and the extent to which it can support them if necessary is a necessary consideration (32). There is no hesitation in accepting the biochemical results and evaluations obtained from an automatic analyzer or images produced by magnetic resonance imaging. However, researchers operating in this field have an obligation to produce evidence that these techniques work at a practical level. Therefore, the need to conduct more randomized controlled trials to prove the effectiveness of artificial intelligence systems in medicine is of vital importance (18). In most cases, it is necessary to understand how a machine decision is made and evaluate the quality of its explanation. The accuracy of disease diagnosis will be higher in the future thanks to programs that can integrate AI diagnosis and human diagnosis to increase appropriate diagnostic possibilities (33). As an example of other limitations in diagnostics, the fact that the performance of each radiography device is different will also affect AI performance. For the information required for diagnosis, AI is processed within data pools, and if the pool does not have a wide knowledge base, the success of the results obtained on rare diseases, drugs and uses will not be high (34). Although artificial intelligence can help in many ways, the final decision should be made by the dentist, since dental treatments require a multidisciplinary approach (25). The most basic reason for this is that the one who will be left alone with any legal responsibility is not the

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device, but the physician himself. The patient may put forward the grounds that he/ she has been harmed while complaining from the physician and may file a lawsuit. What is at the root of the disadvantages that occur in the distinction between malpractice and complications is sloppy work and careless work. The physician should improve himself according to current medical sciences (35). Besides all these data, it should be remembered that AI is a science that can learn and act on what it learns. The fact that different answers can be obtained when the same question is asked in different ways in chat programs, which are AI products, is one of the issues that best exemplifies this situation. This leads us to the conclusion that the fact that the data 'taught' to the relevant program is not correct leads to the fact that the result obtained is also not correct.

## CONCLUSION

AI operates in many areas of human life on a wide range from the past to the future. In the health sector, it is also used in a wide range from document arrangements to patient records, from operational data to prosthesis construction, from diagnosis to treatment. The presence of manual dexterity in treatments causes differences in the medical interventions applied by some physicians and there are difficulties in providing medical standards. Providing a certain standard in transactions can be achieved with AI applications. The cumulative increase in technology and knowledge, combined with each literature publication and practical applications, enables artificial intelligence to move towards taking its place in daily clinical treatments in a routine way. Although artificial intelligence is a science based on data, it should be remembered that it may have errors, it should be evaluated that an incomplete response may be obtained in cases with rare or limited information, and the doctor should definitely create a synthesis appropriate to his own knowledge, experience and the patient's symptoms on the couch and make an ethical decision on his own with the outputs from artificial intelligence.

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**Olgu Sunumu/Case Report**

# Palatinal Oluk Tedavisi ve 1 Yıllık Takibi: Vaka Raporu

## Palatinal Groove Treatment and 1-Year Follow-Up: Case Report

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**ÖZET:** Palatal oluk daha çok maksiller lateral kesicileri etkileyen bir kök deformitesidir. Kök kanalının gelişim esnasında tam kapanmaması ve farklı derecelerde periodonsiyum ile bağlantılı olması şeklinde tanımlanabilir. Endo-perio lezyonlar başta olmak üzere birçok probleme yok açabilir. Kemik kaybının da sık görüldüğü durumlarda periodontal cerrahiler tedavi planına dahil edilir. Tedavideki esas nokta kök kanalı ve periodonsiyum arasındaki ilişkiyi ortadan kaldırmaktır. Fakültemize başvuran 32 yaşındaki kadın hastada, kök kanal tedavisi ve kök yüzeyi düzleştirmesi tedavilerinden sonra iyileşmeyen fistül yolu varlığı gözlenmiştir. Detaylı muayene sonucu 12 nolu dişinde palatal oluk tespit edilmiştir. Hastaya cerrahi olarak müdahale edilmiş alan granülasyonlardan temizlenmiş ve izole edilmiştir. Palatal oluk biodentin ile kapatılmıştır. Süturları 2 hafta sonra alınmıştır. 1 yıllık takibi yapılmıştır. Palatal oluk gibi gelişimsel deformitelerin tedavisinde multidisipliner çalışmak ve Biodentin gibi ortama uygun mekanik ve kimyasal özellikleri olan materyaller kullanmak başarılı bir tedavi için önemli olduğu düşünülmektedir.

**Anahtar Kelimler:** Biodentin, palatal oluk, periodontal cerrahi

**ABSTRACT:** Palatal groove is a root deformity that mostly affects the maxillary lateral incisors. It can be defined as the root canal not closing completely during development and being connected to the periodontium to varying degrees. It can cause many problems, especially endo-periodontal lesions. In cases where bone loss is common, periodontal surgeries are included in the treatment plan. The main point in treatment is to eliminate the relationship between the root canal and periodontium. A 32-year-old female patient who applied to our faculty was observed to have a fistula that did not heal after root canal treatment and root planing treatments. As a result of detailed examination, the palatal groove was detected. The area where the patient was surgically operated was cleaned of granulations and isolated. The palatal groove is closed with biodentine. The sutures were removed 2 weeks later. A 1-year follow-up was performed. It is thought that working in a multidisciplinary manner and using materials with mechanical and chemical properties suitable for the environment, such as Biodentine, are important for a successful treatment in the treatment of developmental deformities such as palatal groove.

**Keywords:** Biodentin, palatal groove, periodontal surgery

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## GİRİŞ

Palatal oluk, sıklıkla maksiller lateral kesicileri etkileyen kök oluşum deformitesidir (1). Singulumun hemen apikalinden başlayarak kök ucuna kadar ilerleyebilen çeşitli derinlik ve uzunluktaki açıklık olarak tanımlanabilir (2,3). İlk olarak Lee ve ark. (4) tarafından tanımlanmıştır. Kesin etiyoloji tam olarak anlaşılamamıştır, ancak bazı yazarlar bunun, odontogenez sırasında mine organının ve Hertwig epitel kılıfının minimum düzeyde içe katlanmasını veya patogenetik mekanizmaların ortak görüldüğü için dens invaginatus'un en hafif formunu içerdiğini öne sürmüşlerdir (5,6).

Palatal oluklar hem hastanın hem de klinisyenin erişemeyeceği derinliklerde mikrobiyal plak birikimi için uygun alan oluşturabilir (7). Palatal oluklara sahip dişler sıklıkla cep oluşumu ve alveolar kemik kaybı dahil ciddi lokalize periodontal ataşman kaybıyla ortaya çıkar (8).

Kök kanalının periodonsiyum ile bağlantılı olması sebebiyle endo-periodontal lezyonlar görülmektedir. Palatal oluk fark edilemediğinde iyileşme sağlanamamakta ve çekim düşünülmekteydi; ancak günümüzde geleneksel kök kanal tedavisi ve kök yüzeyi düzleştirme işlemlerine ek olarak yönlendirilmiş doku rejenerasyonu, endodontik cerrahi ve kasıtlı replantasyon tedavileri uygulanmaktadır (9–11). Temel anlamda oluğun kapatılması, kök kanalı ile periodonsiyum ilişkisinin kesilmesine dayanan tedavide cam iyonomer siman, mineral trioxide aggregate (MTA) ve Biodentin gibi restoratif terapötik ajanlar kullanılmaktadır (12).

## VAKA SUNUMU

Sistemik olarak sağlıklı 32 yaşındaki kadın hasta sağ maksiller vestibüler bölgedeki fistül yolu sebebiyle Van YYÜ Diş hekimliği Fakültesi Endodonti kliniğine başvurmuştur (Şekil 1). Endodontistler tarafından kanal tedavisi tamamlanan hasta (Şekil 2), kontrole çağrıldığında fistül yolunun kapanmadığı görülmüştür. Dişin mesiopalatinalinde 10 mm'yi aşan patolojik periodontal cep ve orta derece gingival enflamasyon tespit edildiğinden, hasta Periodontoloji kliniğine konsülte edilmiştir. Detertraj ve kök yüzeyi düzleştirme işlemlerinin tamamlanıp kontrolde 10 mm'yi aşan patolojik cep varlığının devam etmesi ve iyileşme olmamasından dolayı başka sebepler araştırılmıştır (Şekil 3). İntraoral muayenede etyolojik faktörü belirlemek için klinik muayene yapılmıştır; çürük, restorasyon olmaması ve dişin palatinal tarafında derin ve dar bir periodontal cep varlığı palatal oluk olduğunu düşündürmüştür. Hastaya cerrahi operasyon ve komplikasyonlar anlatılmış, hastadan aydınlatılmış onam alınmıştır. Kök kanal tedavisinin yenilenmesinin, cerrahi operasyondan sonra yapılmasına karar verilmiştir.

Operasyon esnasında Endodonti ve Periodontoloji multidisipliner tedavi yaklaşımı sağlanmıştır. Periodontal cerrahi prosedürü lokal anestezi altında uygulanmıştır. Greater palatin sinirinin anestezisi sağlanmış ve palatinal flep eleve edilmiştir. Palatal mukoza sütur ile karşıt ark dişlere bağlanarak stabilizasyonu sağlanmıştır. Kanama kontrolü sağlandığında palatinaldeki sert doku defekti açığa çıkmıştır.

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**Şekil 1.** Hastanın ilk radyografik görüntüsü

**Şekil 2.** Kanal tedavisi sonrası periapikal radyografi görüntüsü

**Şekil 3.** Cerrahi öncesi intraoral görüntüsü

Granülasyon dokuları temizlenmiş, kök yüzeyi kürete edilmiş ve serum fizyolojik ile irrige edilmiştir. Kurutularak izole edilen defekt sahasına, Biodentin materyali uygulanarak defektin onarımı sağlanmıştır (Şekil 4 A). Palatal mukoza stabilizasyon süturu alınarak flep primer kapatılmıştır. Süturlar, anterior dişlerin kontak noktalarının insizallerine uygulanan kompozitlere asılarak flep koronale pozisyonlandırılmıştır (Şekil 4 B).

Süturların alınması için 2 hafta sonra tekrar çağırılan hastada operasyon sahasında enfeksiyon bulgusu gözlenmemiştir. Ayrıca fistül yolunun da daha iyi olduğu izlenmiştir (Şekil 5).

Hasta kök kanal tedavisinin yenilenmesi için çağırıldığında yurtdışına çıkmak zorunda olduğunu belirtmiş ve randevularına gelememiştir. Yaklaşık bir yıl sonra tekrar muayeneye geldiğinde cep derinliğinin 2 mm olduğu ölçülmüş, periodontal cebin tamamen iyileştiği görülmüştür (Şekil 6). Kök kanal tedavisi yenilenemediği için fistül yolunun kapanmadığı izlenmiştir (Şekil 7).

## TARTIŞMA

Sistemik olarak sağlıklı genç bir hastada, cep oluşumu ve alveolar kemik kaybı da dahil olmak üzere şiddetli lokalize periodontal ataşman kaybıyla komplike olan, palatal oluklu bir lateral kesici diş mevcuttu. Mevcut vaka raporunun amacı; oluğun ortadan kaldırılmasını, periodontal ataşmanın ve kemik kaybının yenilenmesini sunmaktır.

Dişlerde boyut, şekil, sayı, yapı ve dişlerin sürme paterni değişiklikleri gibi gelişimsel anomalilerin oluşumundan çeşitli genetik ve çevresel faktörler sorumludur. Dişte görülen deformite türleri, bu faktörlerin etki ettiği diş morfogenezinin evresine bağlıdır (13).

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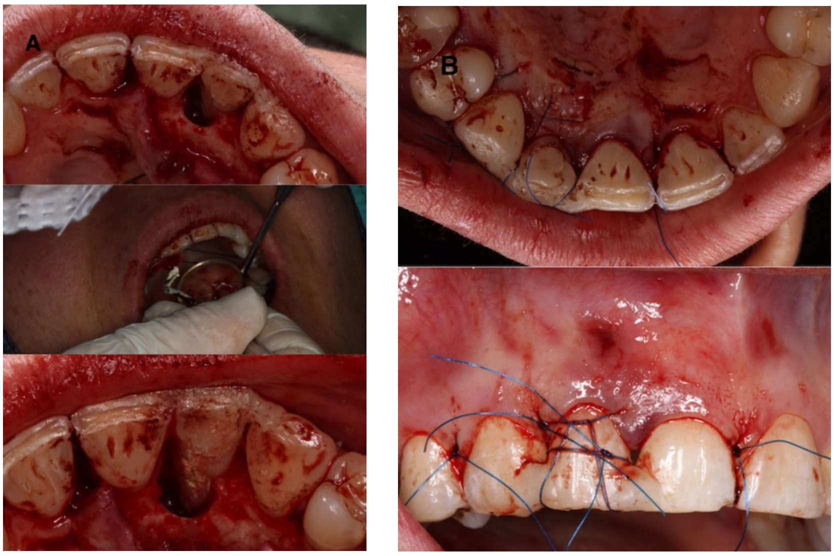


**Şekil 4A ve Şekil 4B.** Cerrahi operasyon görüntüleri

Palatal oluk, prevalansı %2,8-8,5 olan nadir görülen bir gelişimsel anomalidir (14). Bu tür dişlerde tedavinin esası, olukların ortadan kaldırılması ve enfeksiyonun tam olarak kontrol altına alınmasıdır (15).

İyileşmeyen endodontik veya periodontal apselerde altta yatan sebeplerden biri olan palatal oluk teşhisi çeşitli yöntemlerle yapılabilir. Detaylı klinik muayenenin önemi büyüktür. İntraoral açılı periapikal radyografiler, cone-beam bilgisayarlı tomografiler net bilgiler verir (16,17).

Kök kanalı ve periodonsiyum ilişkisini kesmek için Biodentin kullanılmıştır. BiodentineTM literatürde sıklıkla umut verici bir malzeme olarak kabul edilmiştir ve trikalsiyum silikat bazlı simanların önemli bir temsilcisi olarak hizmet vermektedir (18). MTA olarak adlandırılan orijinal trikalsiyum silikat bazlı ürünler, optimal olmayan manipülasyon, uzun sertleşme süreleri, kanal duvarı dentinine düşük adezyon, sertleşmeden önce nispeten yüksek çözünürlük ve zaman içinde diş yapısında renk değişmesi gibi limitasyonlara sahiptir (19–21). Biodentin, üstün fiziksel özellikleri, kolay manuplasyonu, artan biyouyumluluğu ve çok çeşitli klinik uygulamaları nedeniyle literatürde olumlu eleştiriler kazanmıştır (22). Bazı durumlarda palatal oluk onarımı için MTA gözlemlenmiştir ve bunun zayıf çalışabilirliği ve dişlerde renk değişikliği riski önemli endişelerdir (10, 23, 24). Ayrıca Biodentin, bazı vakalarda kombine periodontal lezyonlu etkilenen dişlerin uzun süreli korunmasını sağlamak amacıyla palatal oluğu kapatmak için kullanılmıştır (25–28). Biodentinin 10 günlük maruz kalma sürelerine kadar MTA'ya benzer çözünürlük gösterdiği doğrulanmıştır (29).

Biodentin, iyi bir biyouyumluluğa sahiptir ve mezenkimal kök hücrelerin odontojenik/osteojenik farklılaşmasını indükleyebilir (30).

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**Şekil 5.** Cerrahi operasyon sonrası 2. hafta görüntüsü

**Şekil 6.** Cerrahi operasyondan 1 yıl sonraki görüntüsü

Mezenkimal kök hücreler, kalsiyum fosfat biyoseramikleriyle birleştirildiğinde kemik rejenerasyonunda ve doku mühendisliğinde kullanılabilir (31). Kemik defekti, Biodentinin bioaktif özelliği sayesinde greftleme ihtiyacı duyulmadan kapatılmıştır.

**Şekil 7.** Cerrahi operasyondan 1 yıl sonraki periapikal radyografi görüntüsü

Yumuşak doku cerrahisi yaklaşımıyla ilişkilendirilecek rejeneratif biyolojik prensibin veya materyalin seçimi, kemik içi defektin morfolojisine (genişlik, derinlik ve kalan kemik duvarlarının sayısı), miktarına ve onu kaplayacak mevcut yumuşak dokuya bağlıdır (8). Vakadaki 3 duvarlı defekt ve mevcut yumuşak dokular da dikkate alındığında, primer kapatmış ve askı süturla yükseltilen flep ile primer iyileşme sağlamıştır. Ancak endodontik tedavinin tamamlanamaması sebebiyle fistül yolu varlığını sürdürmektedir. Palatal oluk tedavilerinde endodontik ve periodontal multidisipliner yaklaşımın önem görülmektedir.

## SONUÇ

Bu vaka raporunda maksiller lateral dişleri etkileyen palatal oluk teşhisi ve tedavisi anlatılmıştır. Palatal oluk ekspoze derecesine bağlı olarak, anomalilerin tedavi planı değişir. Başarılı bir palatal oluk tedavi sonucu için endodontik ve periodontal tedavilerin eş zamanlı uygulanması

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gerekebilir. Vakada periodontal cerrahi tedavi ile patolojik cep tedavi edilmiş olsa da endodontik tedavi yapılamadığından fistül yolu iyileşememiştir.

**Teşekkür:** Operasyon esnasında biomateryal uygulamaları için Doç. Dr. Esin ÖZLEK'e teşekkür ederiz.

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**Aydınlatılmış Onam:** Hastaya tedavi gereksinimi, tedavi süreci, tedavi sonrası dönem ve olası komplikasyonlar anlatılmış ve aydınlatılmış onam alınmıştır.

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