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Özgün Araştırma Makalesi

Radiographic Assessment of Pulp Stone Prevalence in Patients Undergoing Head and Neck Radiotherapy

Baş ve Boyun Radyoterapisi Uygulanan Hastalarda Pulpa Taşı Prevalansının Radyografik Olarak İncelenmesi

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ABSTRACT

Aim: To evaluate the prevalence of pulp stones in patients undergoing head and neck radiotherapy in comparison to healthy subjects.

Material and Methods: Patient records retrieved from the Gaziantep University Dentistry Faculty between the years 2014 and 2022 were selected. Panoramic images of oncologic patients exposed to head and neck radiation, as well as healthy subjects, were included in the study. Radiographies of patients with complicated systemic conditions, edentulous patients, and patients with full-mouth fixed bridges were excluded. The groups were arranged as equivalent to each other in terms of age and gender. The presence of pulp stones in the first and second molar teeth of 124 (Group Radiotherapy (n=62) and Group Control (n=62)) patients was radiographically assessed by two observers. The Chi-square test was employed for statistical analysis of the data.

Results: The ratio of pulp stones was found to be significantly higher in the radiotherapy group (50%) (31) as compared to the control group (19.3%) (12) ($p<0.05$).

Conclusion: Pulp stones are more common in patients exposed to head and neck radiotherapy. Ionized radiation therapy may have induced calcification in the pulp space.

Keywords: Head and neck cancer; Panoramic radiograph; Pulp calcification

ÖZET

Amaç: Baş-boyun radyoterapisi uygulanan hastalarda pulpa taşı prevalansını sağlıklı bireylerle karşılaştırmalı olarak değerlendirmek.

Gereç ve Yöntem: Gaziantep Üniversitesi Diş Hekimliği Fakültesi'nden 2014-2022 yılları arasında alınan hasta kayıtları seçildi. Çalışmaya baş ve boyun radyasyonuna maruz kalan onkolojik hastaların yanı sıra sağlıklı bireylerin panoramik görüntüleri de dahil edildi. Sistemik rahatsızlıkları olan hastaların, dişsiz hastaların ve tam ağız sabit köprülü hastaların radyografileri çalışma dışı bırakıldı. Gruplar yaş ve cinsiyet açısından birbirine denk olacak şekilde düzenlendi. 124 (Grup Radyoterapi (n=62) ve Grup Kontrol (n=62)) hastanın birinci ve ikinci büyük azı dişlerindeki pulpa taşlarının varlığı iki gözlemci tarafından radyografik olarak değerlendirildi. Verilerin istatistiksel analizinde ki-kare testi kullanıldı.

Bulgular: Pulpa taşı oranı radyoterapi grubunda (%50) (31) kontrol grubuna (%19,5) (12) göre anlamlı olarak yüksek bulundu ($p<0.05$).

Sonuç: Pulpa taşları baş boyun radyoterapisine maruz kalan hastalarda daha sık görülmektedir. İyonize radyasyon tedavisi pulpa boşluğunda kalsifikasyona neden olmuş olabilir.

Anahtar Kelimeler: Baş ve boyun radyoterapisi; Panoramik radyografi; Pulpa kalsifikasyonu

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INTRODUCTION

Pulp stones, defined as calcified formations, can occur in both healthy and diseased teeth.[1] It can be observed as free deposits as well as attached to or embedded in the dentin, coronal pulp or root pulp. Pulp stones can occur in many different sizes; however, stones below 200 microns cannot be seen in a radiographic examination.[2]

The exact cause of pulp calcifications still remains unknown.[3] However, few studies have argued that some factors like aging, caries, dental procedures, periodontal diseases, and epithelial residues in the pulp tissue are associated with pulp stone formation.[4,5]

Large-sized pulp stones in the pulp chamber may pose challenges in root canal treatment by causing an inability to enter the canal orifices with the instrument and may also change the pulp anatomy. Specifically, adherent stones may deflect the tips of the canal files in the wrong direction or block passage through the canal.[6]

The meta-analytical study of Jannati *et al*.[7] revealed that pulp stones are seen in more than one-third of the world's population, mostly in women.

Calcium salts are continuously deposited in human tissues, sometimes in an orderly manner and sometimes not. Usually, soft tissues like arteries, brain, kidneys, lungs, and tooth pulp experience irregular accumulation of calcium.[8]

A review of past studies examining the relationship between pulp stone formation and systemic diseases exposes some interesting findings. For example, a relationship has been found between pulp stones and kidney stones.[9] Furthermore, increased pulp stone formation has been observed in patients with carotid artery calcification and in patients diagnosed with diabetes mellitus[10,11] as compared to healthy individuals.

Head and neck cancer ranks high among malignancies worldwide.[12] It has been shown that radiotherapy, which is a dominant cancer treatment, affects pulpal sensitivity.[13] As it is known, pulp tissue manages the repair process against a certain irritation, and long-term pulpal damage can lead to the formation of structures such as pulp stones.[14] After examining the literature, it has been observed that there is not enough information about the frequency of stone formation in the pulp tissue of patients exposed to head and neck radiotherapy. The aim of this study is to determine the prevalence of pulp stones in cancer patients treated with head-and-neck radiotherapy in comparison to healthy individuals. The null hypothesis of the study implies that the incidence of pulp stones would be similar between the two groups.

MATERIAL AND METHODS

Conducting this research was deemed appropriate by the Gaziantep University Clinic Research Ethics Committee dated August 31, 2022 (no. 2022/301). Patient records retrieved from Gaziantep University Dentistry Faculty between 2014 and 2022 for checking and dental treatment reasons were selected in this retrospective study. Initially, 452 cancer patients' images were extracted from hospital records. Images of patients who received radiotherapy for areas other than the head and neck, patients with chronic morbidity such as diabetes and cardiovascular and autoimmune diseases, patients using medications such as antidepressants and aspirin for a long time, patients with all their teeth extracted, and patients with full-mouth fixed bridges were excluded from the study. Squamous cell carcinoma, olfactory neuroblastoma, malignant melanoma, thyroid, larynx, pharynx, and lip malignancies were among the cancer diagnoses in the experimental group. Furthermore, by eliminating patient images of poor quality, panoramic images of a total of 62 patients, including 31 women and 31 men, were determined as the radiotherapy group. Subsequently, a control group was constituted from the radiographs of 62 healthy individuals, with gender and age pair-matched. Radiopaque mass images detected in the coronal pulp chamber of molar teeth (excluding third molars) were described as pulp stones and marked as present or absent (Figure 1). All radiographic examinations were performed by two endodontists, and each finding was recorded after achieving interobserver consensus.

Statistical analysis

For numerical variables, mean and standard deviation are provided, while frequency and percentage analysis are provided for categorical variables in the descriptive statistics of the study data. The Chi-

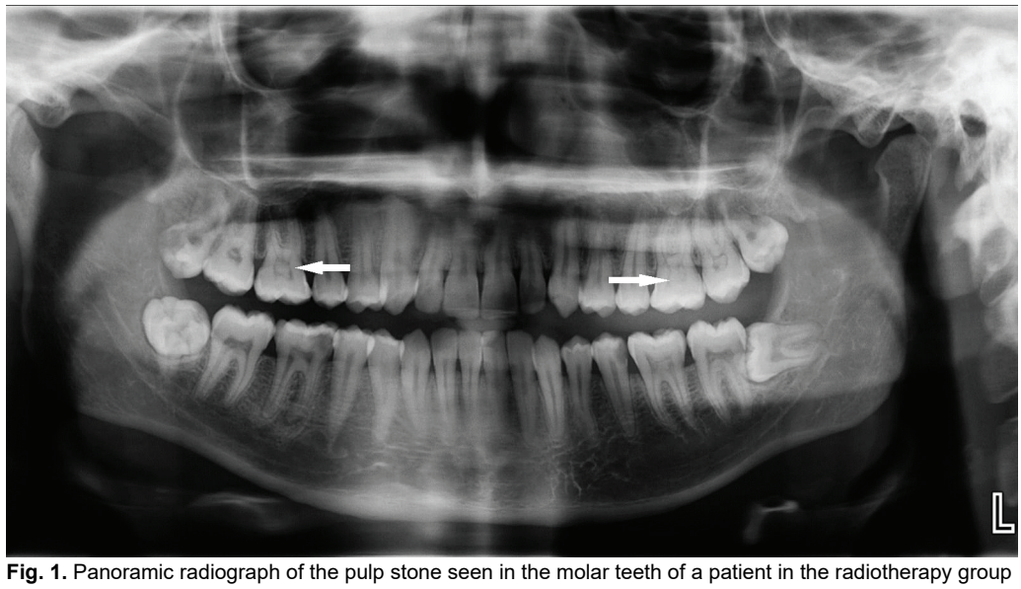

Fig. 1. Panoramic radiograph of the pulp stone seen in the molar teeth of a patient in the radiotherapy group

squared test with Yates' correction was performed to examine significance of the proportions observed in case and control groups. Analyses were performed using the SPSS 22.0 software. A P value < 0.05 was considered indicative of statistical significance.

RESULTS

The average age of the individuals in the experimental and control groups in the current study was 42.53 ± 14.1 (Table 1). The proportion of pulp stones in the radiotherapy group (50%) (31) was found to be significantly higher than the control group (19.5%) (12) (p<0.05) (Table 2).

Table 1. Mean age values and gender distribution in the groups

		Control	Radiotherapy
Age (Mean ± Sd)		42.53 ± 14.1	42.53 ± 14.1
Gender n (%)	**Male**	31 (50)	31 (50)
	Female	31 (50)	31 (50)

DISCUSSION

Pulp stones and pulpal sclerosis are calcifications resembling the dentin structure within the pulp tissue; however, the cause of their development has not yet been clearly revealed. Pulp stones are often seen as an incidental finding on radiographs. Although pulp stones smaller than 200 µm cannot be detected radiologically, radiological methods are often preferred in studies because they are less invasive compared to histological methods.[14] For this reason, our study was carried out on images of patients whose panoramic radiographs were taken for various dental reasons.

Treatment procedures for cancer patients include chemotherapy, radiotherapy, and their combinations. In our study, the prevalence of pulp stones in patients who received radiotherapy in the head and neck region was found to be significantly higher than in healthy individuals who did not receive radiotherapy, and the null hypothesis was rejected. It is

Table 2. Prevalence of pulp stone in study groups and chi-square test

		Control n (%)	Radiotherapy n (%)	χ^2	p
Pulp stone	**Present**	12 (19.35)	31 (50)	11.535	0.001*
	Absent	50 (80.65)	31 (50)		

*p<0,05; Chi-squared test with Yates' correction

known that ionizing radiation causes some changes in orofacial tissues.[15] A few such changes include complications such as mucositis, radiation caries, bone necrosis, and trismus.[16] It has also been stated that radiotherapy may affect the dental pulp. Some researchers, as a result of their studies using electric pulp testing and cold sensitivity tests, stated that the negative pulp response rate was higher in the early days of exposure to radiotherapy.[17,18] Considering some research outcomes regarding the loss of pulp sensitivity after radiotherapy, it is thought that the sensitivity of teeth in the center and near an irradiated area tends to decrease.[19] The reason for this situation may be attributed to vascular changes because Madani and colleagues emphasized that teeth affected by radiation may exhibit significant vascular occlusion.[20] Additionally, in a study conducted on rats, after 60 days of ionizing radiation at different doses, pulp tissue was examined, and tissue inflammation and occlusion in blood vessels were detected in the group exposed to high doses.[21]

The main matrix component of free pulp stones has been identified as Type I collagen. Considering that most stones are fibrodentin, it is thought that non-odontoblastic pulp cells are responsible for collagen. Moreover, robust osteopontin immunostaining in the pulp stone's peripheral zone indicated that collagen originated from less differentiated pulp cells and is essential to calcification. This is because mature osteoblasts often express osteocalcin, and osteopontin expression typically occurs before osteocalcin expression.[22] These osteopontin immunohistochemistry results are parallel to those of urinary stones and atherosclerotic plaques.[23,24] Another significant factor in the formation of calcified foci inside the necrotic area of breast tumors is the osteopontin produced by macrophages.[25] Considering these findings, it becomes imperative to investigate the effect of cancer disease on human metabolism in the formation of calcifications such as pulp stones, independent of radiotherapy.

As a result of Havelek *et al*.'s[26] examination of irradiated cultures of dental pulp stem cells (DPSCs), statistically higher volumes of Ca2+ accumulation were observed as compared to the non-irradiated control group, which can be considered a reason for the higher rate of pulp stone formation in the patients who are exposed to radiotherapy in our study. In the same study, it was shown that in human dental pulp stem cells (DPSCs), radiation-induced immature DPSCs are differentiated into odontoblast and osteoblast categories. DPSCs located near blood vessels respond via differentiation to odontoblast-like cells that synthesize tubular dentin *in vivo* during injury.

Past studies have emphasized that irritation of the pulp tissue as a result of surgical procedures, dental caries, chronic irritants such as long-term wear and erosion, periodontal problems, and traumatic responses to orthodontic treatments may have a harmful effect on the pulp.[4,27] Microorganisms that cause tooth decay can cause irritation, damage to the vascular wall of the pulp tissue, and the accumulation of calcium salts in the tissue. In addition, radiation caries, characterized by demineralization in the cervical parts of the teeth and a brown and black appearance on the incisal edges and tubercle tips, is among the most frequently encountered dental complications in patients receiving head and neck radiotherapy, which occurs in the teeth.[28,29] In our opinion, this effect can be considered a factor that may induce pulp calcification in our study. Ranjitkar *et al*. stated that chronic pulp irritation may cause pulp stone formation.[14] In this sense, ionizing radiation irritates the pulp tissue and promotes the formation of pulp stones, which needs to be investigated further.

Çiftçioğlu *et al*.[30] emphasized the relationship between nanobacteria and pulp stone formation in their research.In future studies, one of the possible reasons for the high rate of stones in our study group may be determined by meticulously examining the frequency of nanobacteria in cancer patients and patients receiving head and neck radiotherapy and their relationship with pulp stones in the same patients.

One of the limitations of our study is that since the X-ray records were evaluated retrospectively, it could not be determined whether these formations existed before radiotherapy in patients with calcification in the pulp chamber. For this reason, the current study should be considered pioneering research, and the X-ray findings must be compared before and after radiotherapy in future research endeavors.

Regarding the second limitation, patients with head and neck cancer may be subjected to chemotherapy

and radiation therapy at the same time. As far as we are aware, there is no scientific data demonstrating the effect of chemotherapy alone on tooth pulp.[13] This makes it challenging to assess the degree to which chemotherapy influenced our results.

CONCLUSION

According to the current study's findings, patients undergoing head and neck radiation have a higher incidence of pulp stones than healthy people. It is suggested that before beginning root canal treatment, patients undergoing head and neck radiation therapy should have their teeth thoroughly inspected for the presence of pulp stones.

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