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Dental Treatment Approach in Two Patients with Osteogenesis Imperfecta: Case Report

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ABSTRACT
Osteogenesis imperfecta (OI) is a very common, inherited autosomal dominant disease. It is characterized by deformity and fragility in bone structure, blue sclera, hearing loss, scoliosis, and dentinogenesis imperfecta. Molecular studies have shown that the cause of OI is a mutation of genes named COLIA1 and COLIA2 in both chains of collagen. Biochemical tests that examine the collagen structure or molecular tests that examine the DNA structure are used for making a definite diagnosis of the disease. It is reported that the prevalence of OI is between 1: 5000 and 1: 20000 in newborns, regardless of ethnic and racial discrimination. In addition to hard tissue involvement, tissues commonly contain collagen such as tendons, ligaments, skin, sclera, dental tissue, the middle and inner ear may be affected. Common dental anomalies in patients are dentinogenesis imperfecta (DI) and malocclusion. This case report evaluated two male patients, 18 and 19 years old, with abnormalities in the mouth, teeth, and body tissues. The dental treatment of the patients was completed by applying resin-based composite restorations to affected hard dental tissues with a minimally invasive treatment approach.
Keywords: Osteogenesis Imperfecta, Brittle Bone Disease, Minimally Invasive Dentistry, Direct Resin Composite Restorations.

Osteogenesis İmperfektalı İki Hastada Dental Tedavi Yaklaşımı: Olgu Sunumu

OZ
Osteogenezis imperfekta (Oİ) popülasyonda yaygın rastlanan, otozomal dominant kalıtsal bir hastalıktır. Kemik yapısında deformite ve kırılganlık, mavi sklera, işitme kaybı, skolyoz ve dentinogenez imperfekta ile karakterizedir. Moleküler çalışmalar neticesinde osteogenesis imperfektanın, kollajen zincirlerindeki COLIA1 ve COLIA2 adlı genlerin mutasyonu sonucu meydana geldiğini göstermektedir. Hastalığın kesin teşhisi için kollajen yapısının analiz edildiği biyokimyasal testler veya DNA yapısını inceleyen moleküler testler kullanılmaktadır. Etnik ve ırk ayrımı gözetmeksizin Oİ prevalansının, yenidoğanlarda 1: 5000 ile 1: 20000 arasında olduğu bilinmektedir. Sert doku tutulumuna ek olarak, tendon, bağ doku, deri, sklera, diş dokusu gibi kollajen içeren dokular ile orta ve iç kulak yaygın olarak etkilenmektedir. Hastalarda sık görülen dental anomaliler dentinogenezis imperfekta (Dİ) ve maloklüzyondur. Bu olgu sunumunda osteogenesis imperfekta hastalığına sahip olan ve ağız, diş ve vücut dokularında normalden farklılıklar gözlemlenen, 18 ve 19 yaşlarındaki iki erkek hastanın dental ve sistemik durumu incelenmiştir. Etkilenen diş sert dokularının tedavileri, minimal invaziv tedavi yaklaşımı ile reçine esaslı kompozit restorasyonlar uygulanarak tamamlanmıştır.
Anahtar Kelimeler: Osteogenesis Imperfekta, Kırılgan Kemik Hastalığı, Minimal Invaziv Dişhekimliği, Direkt Reçine Kompozit Restorasyonlar.

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INTRODUCTION

Osteogenesis imperfecta (OI) is known as brittle bone disease that is an autosomal dominant hereditary disease characterized by bone fractures and cracks (Primorac et al., 2001; Ward et al., 2002). It is caused by mutations in genes encoding Type I procollagen (COL1A1 and COL1A2) (Pollitt et al., 2006). The prevalence of OI is estimated to be one in 20000-50000 infants (Osteogenesis Imperfecta Association, 2001). Type 1 collagen is found in the skin, ear, tendons, vessels, heart valves, teeth, sclera, and bone. The most important clinical feature of OI is bone fractures and deformities due to increased bone fragility. In some cases, the curvature may develop in the bones without fractures. Non-skeletal findings are related to organs with type I collagen and blue sclera is a well-known extra-skeletal finding of OI. The presence of blue sclera supports the diagnosis, but it is not pathognomonic for OI. At the same time, the dysmorphic, triangular face is another common finding of OI. Dentinogenesis imperfecta can also be seen, characterized by OI, and primary teeth are more affected than permanent teeth. Teeth are brownish or bluish in appearance, soft, transparent, and fragile. Although dental tissues appear normal in clinical examination, changes due to OI and affected hard tissues can be shown in more detail in the radiological and histological examination. In these patients, hearing loss may develop due to the deformation of the ear bones. Subcutaneous hemorrhages may develop on the skin, heart valve disorders such as mitral valve prolapse, and aortic regurgitation can be seen (Burnei et al., 2008; Hekimsoy, 2009).

There are seven types of OI according to classifications made by researchers (Burnei et al., 2008; Hekimsoy, 2009; Glorieux et al., 2000; Glorieux et al., 2002; Ward et al., 2002). The common clinical feature of all OI types is increased bone fragility and the severity of the disease can be expressed as~~:~~ type I <type IV, V, VI, VII <type III <type II. The type of inheritance can be seen as autosomal dominant (OD) between OI types I-V, and autosomal recessive (OR) in types VI and VII. Sometimes the symptoms of the disease can be variable, and the patient may not be included in any group (Hekimsoy, 2009; Fotiadou et al., 2016).

There are difficulties in the differential diagnosis of patients with osteogenesis imperfecta in dentistry. However, obtaining detailed anamnesis, family history, and consanguineous marriage can give great clues. Intraoral radiographs should be examined in detail from the quality of the jaw bones to the structure of the tooth roots. Malocclusion may also be present in patients. In the presence of malocclusion, cephalometric radiography can be also used to determine whether it is skeletal or dental.

CASE REPORT

Case report I

In December 2019, the 18-year-old male patient applied to our clinic with the esthetic complaint of anterior teeth. The patient was 1.57 cm in height and 56 kilograms in weight, had polydiastema between the anterior teeth. Hypermineralized areas, discolorations, deep caries, dental calculus, and malocclusion problems were observed. As a result of the radiographic examination, it was observed that there was a slight narrowing of the pulp tissue of the teeth in the cervical areas and a low density in the bone structure (Figure 1). In the extraoral examination, it was observed that the patient had a blue sclera (Figure 2), mild growth retardation of the long extremities, and minimal curvature of the spine. He had mild stenosis in the chest and occasionally had difficulty in breathing. After taking the medical history, it was learned that patient had previously broken his arm and leg 3 times when he was 12, 14, 18 months old, due to skeletal deficiency. The clinical diagnosis of OI was first made when he was 18 months old, in the Department of Pediatric Endocrinology at Istanbul University Medical Faculty. When radiological and histological examinations were investigated; long lamellae were found to be as poor quality and irregular appearance. The patient said that he used the drug called Aredia by injection, which was prescribed as a bisphosphonate for 3-4 months~~,~~ and then stopped using the drug on the recommendation of his doctor. In the family history, it was found that OI disease was also present in his older brother.

The patient, who was informed about the advantages and disadvantages of different treatment options and signed an informed consent form. The direct composite veneer was planned for teeth 11-12-13-21-22-23-33-43 and Class IV direct composite restoration was planned for teeth 31 and 41. One week before the restorations, the initial periodontal treatment was completed. The shade selection of the composites was made in daylight using the color scale of the manufacturer. Isolation was provided with cotton rolls and suction. The teeth were restored using universal adhesive with the total-etch method, and a nano-hybrid resin composite. Enamel and dentin surfaces were roughened with 37% phosphoric acid (Scotchbond; 3M ESPE) for 15 seconds and rinsed for 15 seconds. Universal adhesive agent (Scotchbond Universal Adhesive, 3M ESPE, St. Paul, MN, USA) was applied to the enamel and dentin surfaces and rubbed for 20 seconds. After drying gently with air spray for 5 seconds, it was polymerized with an LED light device for 10 seconds. Brownish defects in dentin were masked with Masking Liner (Essentia, GC, EUROPE, Leuven, Belgium) and polymerized with a LED light device for 20 seconds. A2 Body shade of Clearfil Majesty ES-2 (Kuraray, NY, USA) was used with incremental technique. Mylar strips were used ~~for~~ to create the restoration contours of proximal surfaces. Each composite layer was polymerized with the LED

light device for 20 seconds. After the restorations were completed, occlusion was checked, and premature contacts were eliminated with finishing burs. The finishing and polishing steps were applied using discs, spiral wheels and, strips of Sof-Lex System (3M ESPE, St. Paul, MN, USA). Post-operative images of the restorations at 1-week and 6-month controls are shown in Figure 4 and 5 respectively.

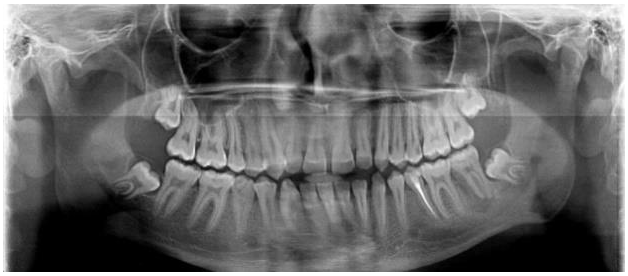

Figure 1. Radiographic image of patient I.

Figure 2. Patient with blue sclera.

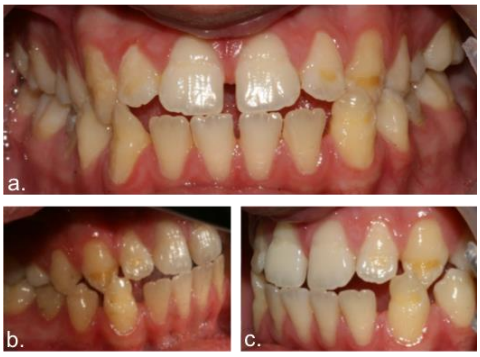

Figure 3. Intraoral images of patient I before treatments.

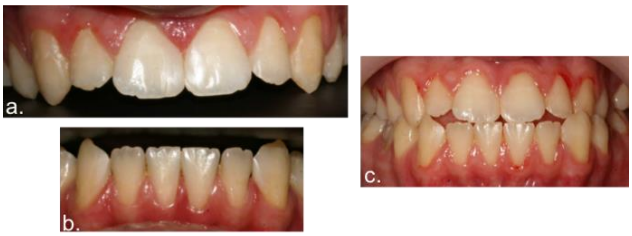

Figure 4. Intraoral images of restorations at one week.

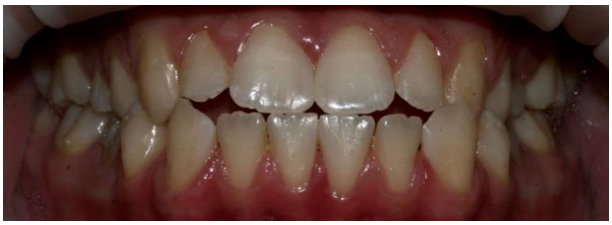

Figure 5. Intraoral images of restorations at six months.

Case report II

A 19-year-old male patient applied to clinic with cold and sweet sensitivity of teeth number 15 and 25. As a result of clinical and radiographic examination, deep dentin caries in number #15 and #25, a poor canal treatment and radiolucency around the distal root of number #36, congenital upper lateral deficiency, the presence of polydiastema in the anterior region of both the lower and upper jaws, decrease in density of bone structure was detected (Figure 6). According to the general evaluation, severe growth retardation, and bowings in the long extremities, moderate curvature of the spine, stenosis in the chest, and breathing difficulties were observed (Figure 7,8). He was 1.45 cm in height and 43 kilograms in weight. According to detailed anamnesis, previously he had a proximal humerus fracture (Figure 8). He had-the fish scale-like appearance of the bone lamellae, moderate deformities in long bones, and osteogenesis imperfecta was type IV. He was using bisphosphonate group drugs by injection and was being followed up at Istanbul University Faculty of Medicine.

Treatment of the teeth numbered #15, #25 and #36 was planned and the patient was informed that both aesthetic restorations could be made to the anterior teeth. However, the patient stated that he did not have an aesthetic concern about the appearance of his teeth, he was only uncomfortable with the sensitivity of his premolar teeth and had percussion pain in his molar tooth. The informed consent form was signed by patient. The restorative treatments of teeth numbered #15, #25 and #36 was completed with A3 shade of Filtek Z250 Universal Restorative (3M ESPE, St. Paul, MN, USA) composite. It was decided to renew the root canal treatment of the tooth numbered #36. K-files (Dentsply, Maillefer, Ballaigues, Switzerland) were preferred due to their penetration ability and hedström files (Dentsply, Maillefer, Ballaigues, Switzerland) for their superiority in material removal. During the biomechanical root canal preparation, the

canal was irrigated with 5 ml of 2.5% NaOCl solution at each file change. Digital radiographic images (Visualix Gendex Dental Systems, Monza, Italy) were taken from different angles to verify complete removal of the old root canal filling. The treatment was completed by filling the root canals with lateral condensation technic, using Gutta Percha (Meta Biomed, Chungcheongbuk-do, Republic of Korea) and AH 26 (De Trey, Zurich, Switzerland) canal sealer. After the root canal treatment, the teeth were restored using universal adhesive with the total-etch method, and a microhybrid resin composite Enamel and dentin surfaces were roughened with 37% phosphoric acid (Scotchbond; 3M ESPE) for 15 seconds and rinsed for 15 seconds. Universal adhesive agent (Scotchbond Universal Adhesive, 3M ESPE, St. Paul, MN, USA) was applied to the enamel and dentin surfaces and rubbed for 20 seconds. After drying gently with air spray for 5 seconds, it was polymerized with an LED light device for 10 seconds. The restoration was completed with Filtek Z250 Universal restorative (3M ESPE, St. Paul, MN, USA). Each composite layer was polymerized with the LED light device for 20 seconds. After the restorations were completed occlusion was checked and premature contacts were eliminated with finishing burs. The finishing and polishing steps were applied by using discs, spiral wheels, and strips of Sof-Lex System (3M ESPE, St. Paul, MN, USA). The patient was called for control at the end of the first, 3rd, 6th, 12th, and 24th months.

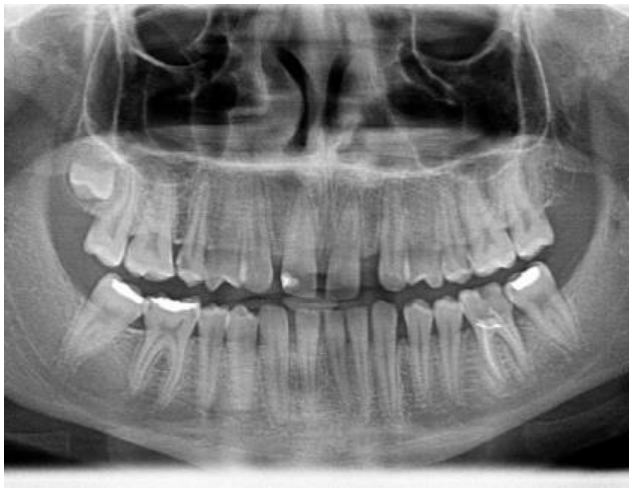

Figure 6. Radiographic image of patient II.

Figure 7. Patient with blue sclera, curvature of the spine and bowed legs.

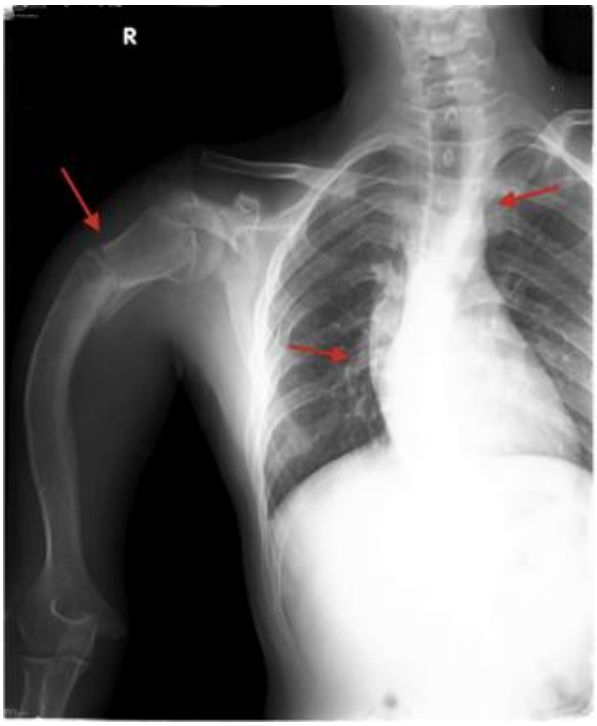

Figure 8. Radiological image of proximal humerus fracture and scoliosis curves.

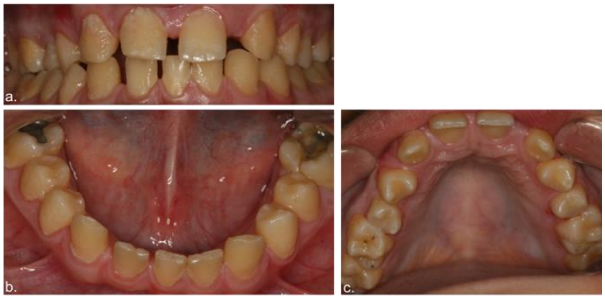

Figure 9. a, b: The intraoral view before treatment. c: The intraoral view of teeth numbered 15 and 25 after treatment.

DISCUSSION

Osteogenesis imperfecta (OI) is a dominant inherited disease characterized by increased bone fragility, and mutation of type I collagen. While making the diagnosis, it should be evaluated as multidisciplinary in suspicious cases.

In this case report, patient-I. had Class III malocclusion with the bilateral cross-bite. Schwarts and Tsipouras (1984) found Class III malocclusion in 67% of the patients in their study on 28 children with osteogenesis imperfecta and stated that 88% of the patients with class III had unilateral or bilateral cross-bite. The cause of malocclusion has been associated with anterior, posterior and vertical hypoplasia and excessive development and protrusion of the lower jaw due to inhibition of upper jaw growth (O'connell & Marini, 1999).

In both cases the patients were diagnosed with osteogenesis imperfecta a few months after birth. It was reported that the bisphosphonate group drugs used in the past are effective in reducing chronic bone pain and fracture frequency. However, invasive treatments in patients under the prescription ofbisphosphonates produce a risk factor for osteonecrosis (Burnei et al., 2008; Gupte et al. 2006).

In patients with OI, primary teeth are more affected than permanent teeth and DI is observed more frequently. Early diagnosis in children with DI involvement is very important to prevent loss of vertical dimension. Severely worn and damaged primary teeth are treated with prosthetic crowns to protect the remaining teeth and restore vertical dimension (Sanches et al., 2006). Damage of permanent teeth should also be treated with as possible as the minimally invasive method, considering the risk of bisphosphonate-induced osteonecrosis and bone fragility.

In Osteogenesis Imperfecta, approximately 50 % of cases are associated with Dentinogenesis Imperfecta type I, that caused by type I collagen mutations (Massé et al. 2021). Primorac et al. (2001) stated that DI was observed with a more severe form of the OI, with greater fracture rates and growth retardation. It has been determined that the enamel structure is affected in OI patients when Dentinogenesis Imperfecta is present (Massé et al. 2021).

It was stated that low-grade mineralization or enamel hypoplasia can be observed, and enamel fractures and abrasions are caused by the irregular structure of DEJ in these cases (Lindau et al.1999). Dentin tissue is frequently exposed and has an opaque, yellow-brown, or gray-blue appearance (Zhang et al. 2001). In our study, patient-I has hypoplastic enamel defects on his anterior and premolar teeth. The exposed dentin tissue in the upper lateral and lower-upper canine teeth had a yellowish-brown color. Patient- II did not have enamel defects, but there was a yellowish-brown appearance in the dentin reflected under the enamel in the entire tooth sequence.

In OI cases, problems in adhesion with dental hard tissues could occur. It is stated that a typical hybrid layer cannot be formed as in healthy dentin tissue due to conditions such as the dentinal tubules being engorged and smaller than normal, and the thick and irregular distribution of collagen fibers (Masse et al.2021). The changes in the enamel structure also cause insufficient porosity and roughening pattern different from the normal after the etching process with phosphoric acid (Kramer et al. 2018). Some researchers stated that the enamel should be abraded mechanically before the adhesive procedure or 5.25% NaOCl should be kept for 1 minute after acid application to increase adhesion to the enamel (Chay et al., 2014; Masse et al.2021). However, the effectiveness of these procedures needs to be proven by more clinical studies.

CONCLUSION

In patients with dental involvement such as osteogenesis imperfecta, early diagnosis is very important to prevent the progression of tissue damage. On the other hand, provide good oral hygiene and dental hygiene training, the patient should be motivated to the importance of oral care. The treatment approach should primarily be towards the protection of healthy teeth, in case when tooth decay exists, the treatment should be completed by applying preventive treatment procedures with minimally invasive methods as possible. In addition, the multidisciplinary approach will help both the patient and dentists in the correct indication and treatment options. The control of the patient every 6 months is very important, and the patient should be motivated in this regard.

Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of
this article.

Author Contributions

Plan, design: OB, OY, MB; **Material and methods:** OB, OY; **Data analysis and interpretation: OB**, EK **Writing and corrections:** OB, MB

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