Orthodontic treatment for an adolescent with a history of Acute Lymphoblastic Leukemia

Mark E. Runge, DDS, MS Daniel L. Edwards, DDS

Dr. Runge is associate professor, Department of Surgery, Orthodontics, and Dr. Edwards is assistant professor, Department of Surgery, Dental Medicine at the Loyola University Chicago, Stritch School of Medicine. Correspond with Dr. Runge at mrunge@luc.edu

Abstract

This case report describes the treatment of a Class I malocclusion that involved ectopic position of the maxillary permanent left canine and the mandibular permanent right second molar. The patient was an adolescent who presented with a medical history that was remarkable for diagnosis and treatment of acute lymphoblastic leukemia (ALL).Dental history was remarkable for significant, generalized shortened roots that were more severe in the mandibular arch. The treatment included fixed appliance therapy in the maxillary arch only and surgical luxation of the mandibular second molar. Successful integration of the maxillary permanent left canine was accomplished without excessive flaring of the maxillary permanent incisors or disruption of the buccal segment occlusion. The risk of external root resorption on teeth with abnormal root morphology, as a result of fixed appliance therapy, should be weighed against the relative benefits that are expected from treatment. (Pediatr Dent 22:494-498, 2000)

Acute Lymphoblastic Leukemia (ALL) is the most common form of leukemia affecting young children. Leukemia is a malignant disease of the bone marrow and blood, characterized by the uncontrolled growth of blood cells. Advances in treatment regimens, including multiagent chemotherapy and radiation therapy, have greatly increased the chances for survival. Today, it is likely that greater than 60% of the population of these leukemia survivors may reach adolescence. Some of them may develop a dentoskeletal problem requiring orthodontic treatment. Therefore, ALL should not be considered as a contraindication for orthodontic treatment. However, the risk versus benefit of each individual case should be carefully evaluated when making a treatment decision that involves orthodontics in patients with a history of ALL. This is especially true given the finding that a possible negative treatment effect from chemotherapy and radiation therapy is arrested root development, resulting in abnormal root morphology. This case report describes fixed orthodontic treatment on an 11 year old male who presented with an impacted permanent maxillary left canine and an impacted permanent mandibular right second molar. His medical history included diagnosis of ALL at age 2 years, 11 months and subsequent chemotherapy and radiation therapy. Radiographic analysis revealed abnormal root morphology prior to fixed orthodontic treatment.

Literature review

Treatment protocols and standard of care from 1986 to 1999

The most common cancer in young children is Acute Lymphoblastic Leukemia. It is usually diagnosed by examination of blood and bone marrow samples, with reported signs and symptoms of paleness, tiredness, and weakness, enlarged lymph nodes, recurrent minor infections or poor healing of minor cuts, and excessive bruising or bleeding. ALL occurs in approximately 2/100,000 (0.005%) children under 14 years of age and is most common in early childhood, peaking between 2 and 3 years of age.[1]

Chemotherapy was introduced in 1948 as a treatment for ALL, resulting in short clinical remissions[2]. Current chemotherapeutic regimens have improved survival times from 8 to 12 years in about 80 percent of children diagnosed with ALL. Maguire and Welbury[3] report that over 70% of the children diagnosed with ALL between 1985 and 1990 were still alive up to 9 years after diagnosis and 60% of them were expected to show long lasting, complete remission. These children are considered long term survivors. As the second "baby boom" (1977 –1994, with peak births of 4.2 million in 1990)[4] ages, it is likely that a percentage of these long term survivors may develop a dentoskeletal problem, such as impaction or malocclusion, for which orthodontic treatment could be considered a solution.

Multiagent chemotherapy

Multiagent chemotherapy may include antimetabolites (methotrexate, fluorouacil, cytarabine), antitumor antibiotics (doxorubicin, dactinomycin, mitomycin, and bleomycin), plant alkyloids (vincristine, vinblastine and etoposide) and high-dose alkylating agents. Long term survivors who were treated with multiagents show some post-treatment effects, including deficits in growth, organ function, intellectual capacity, social competence, increased risk of second malignant neoplasms, and dental malformations.[2] Treatment with multiagent chemotherapy at the peak age of occurrence for ALL, between 2 and 3 years of age, places the patient at risk for odontogenic developmental abnormalities. Schour and Massler[5] report the initiation of odontogenesis in humans begins at 7 weeks in utero for a permanent central incisor and completion of root formation may not occur until 25 years for a permanent third molar. Rosenberg et al.[6] conducted the first study to identify

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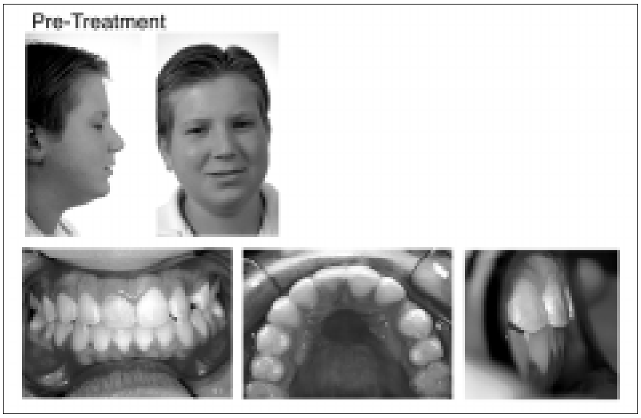

Fig 1. Pretreatment extraoral and intraoral photographs.

altered dental root development associated with chemotherapy alone. The study consisted of 17 long term survivors of childhood ALL treated with chemotherapy before the age of 10 years. They found that patients had an altered dental root development evident on periapical radiographs most likely related to the chemotherapy treatment. Another report suggests that colchicine, vinblastine, and cyclophosphamide alter odontogenesis by the inhibition of dentin formation in rat incisors.[7] It is important that the orthodontist is aware of the effects of multiagent chemotherapy treatment and its impact on the treatment plan for the patient.

Radiation therapy

Head and neck radiation therapy is often given in combination with multiagent chemotherapy in the treatment of ALL. Maguire and Welbury report that the effects of direct irradiation of bone, soft tissues, and blood vessels are dose-related and have their most profound effects in rapidly growing patients.[3] The reported results of radiation therapy include bony hypoplasia of the jaws, orbits, and facial skeleton that may contribute to malocclusion. Radiotherapy has also been shown to arrest tooth development, which produces microdontia, enhances atrophy of the overlying soft tissue, causes enamel hypoplasia or incomplete calcification, and causes arrested root development. Irradiation to the central nervous system may reduce hypothalamic-pituitary function, resulting in diminished production of Growth Hormone and Thyroid-Stimulation Hormone. This may, in turn, adversely affect craniofacial development and odontogenesis. It is difficult to assess whether these defects are components of the therapy (multiagent chemotherapy or radiation therapy) or a result of the disease itself. The degree and severity of these effects appear to depend upon the child's age at diagnosis and the type and dose of cranial irradiation. Jaffe et al[8] stated that other factors which may cause these defects cannot be excluded, such as antibiotic medications, systemic disturbances, fever, and poor nutritional habits. Local factors and/or normal variations must also be considered.

Root morphology

Rosenberg [6] reported signs of altered root development in a group of patients treated for childhood ALL with chemotherapy that included root tapering or narrowing, blunting of the root apex, and actual loss of root length. Sonis[9] described developmental disturbances of the permanent dentition, including arrested root development, resulting from therapy for childhood ALL. He suggests that immature teeth in children treated before age 5 were at greater risk for developmental disturbances than mature teeth. Orthodontic treatment is associated with a risk of apical root resorption[10]. There is a general agreement that the presence of abnormal root morphology increases the risk factor of further resorption.[11] The effects of combined chemotherapy and radiation on root development is an important consideration when a treatment plan including orthodontics is being considered for a patient with a history of ALL. Alternate plans may have to be chosen in cases with arrested root development from multiagent chemotherapy and radiation therapy. The risk of further root resorption as a result of orthodontic therapy must be weighed against the benefits of treatment.

Risk versus benefit

The issue of risk in this case focuses on two concerns. The first is the chance of further external root resorption from treatment with fixed orthodontic appliances. The second is the possible development of complications arising from leaving the maxillary permanent left canine and the mandibular permanent right second molar impacted. Those complications include resorption of adjacent bone and root structure at the maxillary permanent left lateral incisor and the mandibular right second molar from an enlarging follicular cyst.[12] The benefits of orthodontic treatment in this case include the addition of these teeth as functional units in the occlu-

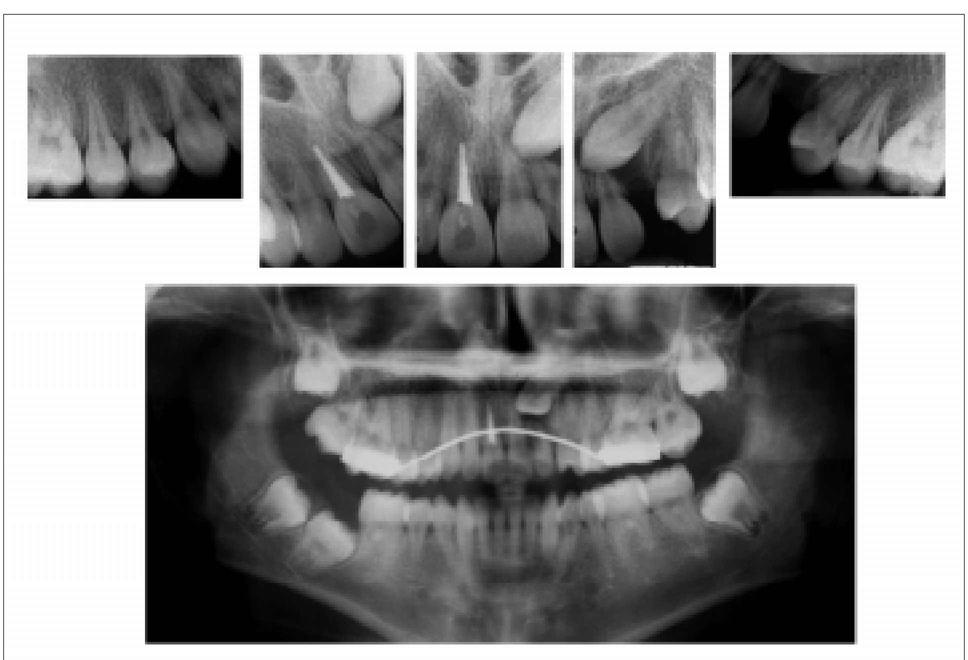

Fig 2. Pretreatment periapical and panoramic radiographs.

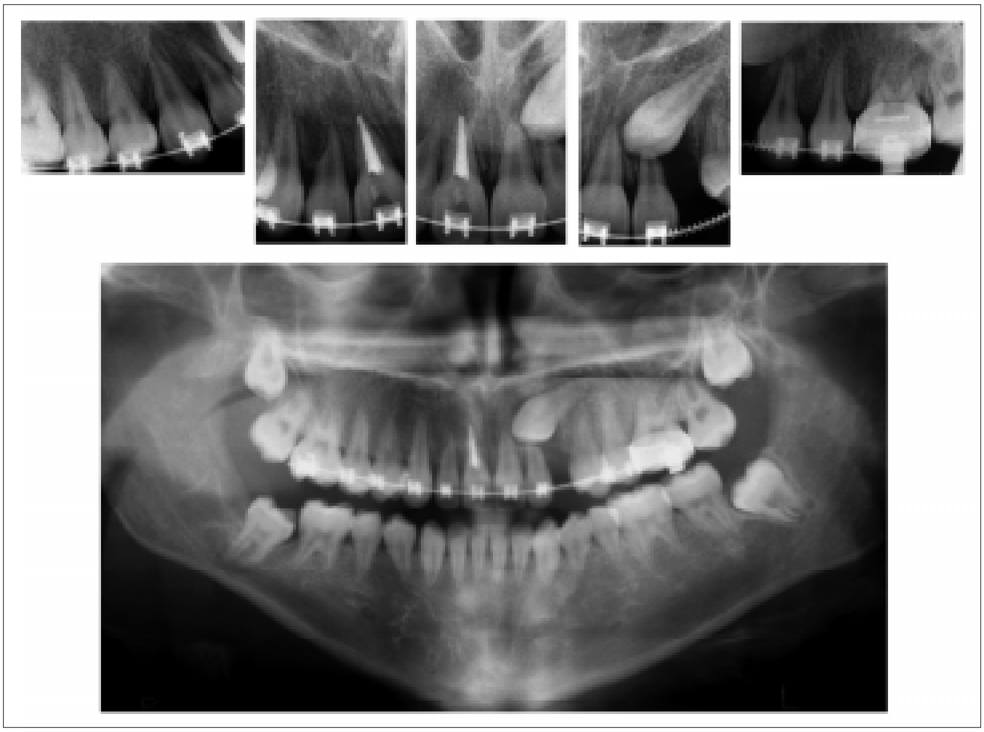

Fig 3. Progress periapical and panoramic radiographs.

sion, the preservation of the maxillary left lateral incisor and reduction of the risk for complications.

Case report

History

The patient presented at age 14 to evaluate the chief complaint of "permanent tooth is not descending properly into place." Medical history, as explained previously, was remarkable for diagnosis of ALL at age 2 years, 11 months. The patient underwent chemotherapy and radiation therapy from age 2 years, 11 months to 3 years, 1 month. Dental history was remarkable for previous endodontic treatment by the referring general dentist on the maxillary left permanent central incisor secondary to trauma, a Nance holding arch placed by the referring general dentist for space maintenance in the mixed dentition, and generalized abnormal root morphology which was more severe in the mandibular arch.

Clinical examination

Extraoral examination revealed a convex, mesognathic soft tissue profile (Fig 1). Upper lip measured 19mm and 3mm of the maxillary incisor showed at rest. Intraoral examination revealed an edge to edge molar relationship bilaterally and an edge to edge permanent canine relationship on the right in the permanent dentition. Maxillary and mandibular arch forms were ovoid and no crossbites were noted. Overbite measured 2 mm and overjet measured 2 mm. The maxillary dental midline deviated 2 mm left from the facial midline and the mandibular dental midline nondeviated from the facial midline. Tooth size arch length deficiency at the position of maxillary left canine was 3 mm.

Radiograph and photograph examination

Lateral cephalometric analysis revealed a Class I skeletal pattern with the maxillary and mandibular incisors at a normal angulation in their respective denture bases. Panoramic radiograph revealed the permanent third molars beginning root stage of formation and the ectopic position of the maxillary left canine and the mandibular right second molar (Fig 2). A maxillary arch series of periapical films was taken for assessment of pretreatment, progress and post-treatment root length. Normal values for crown to root ratio were determined with the use of a dental anatomy text.[13] They are as follows: maxillary premolar (.37); maxillary canine (.37) and maxillary central incisor (.44). In this case, the pretreatment crown to root ratios, as measured on periapical radiographs, were: maxillary premolar (.72); maxillary canine (.83); and maxillary central incisor (.90). Photographic analysis revealed vertical and transverse symmetry. Lip position was normal in relation to the Esthetic plane.

Problem list

Patient presented with a Class I malocclusion, ectopic position of the maxillary left canine and mandibular permanent right second molar, prior endodontic treatment of the maxillary left permanent central incisor, and arrested root development which was more severe in the mandibular arch.

Recommended treatment plan

The goal of treatment was 18 months of maxillary arch treatment with fixed appliances. The objectives were to regain space (3 mm) for the maxillary left canine, uncover and align the maxillary left canine, extract the mandibular right third molar, luxate the mandibular right second molar, and observe eruption of the second molar.

The prognosis was guarded for achieving 100% of goals and objectives due to patient history of abnormal root morphology. Possible complications included

Fig 4. Immediate post-treatment periapical radiographs.

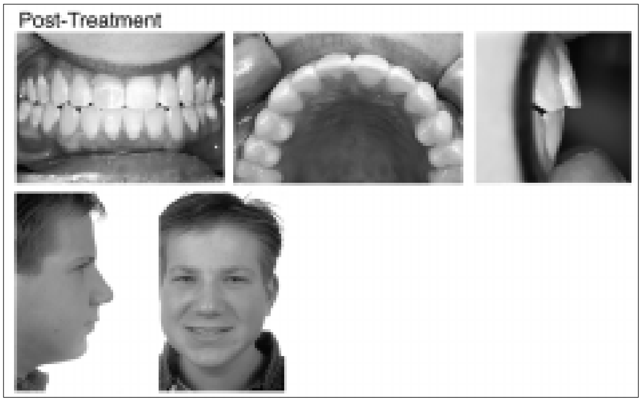

Fig 5. Post-treatment extraoral and intraoral photographs.

further root resorption in the maxillary arch. The patient and his parents were informed that at the 6 month progress update appointment, periapical films of the maxillary arch would be retaken. If an additional 20% of external root structure had resorbed, treatment would be terminated and appliances removed. This figure of 20% was chosen by the authors based on the pretreatment root morphology in this case. The crown-to- root ratios were already approaching 1:1 in the incisor region. Further loss beyond an additional 20% posed too great a risk for increased destabilization, mobility, and possible tooth loss. Other possible complications include external root resorption of the maxillary left lateral incisor, ankylosis of the maxillary left canine, and failure of the mandibular right second molar to erupt.

Alternate treatment plan I

The goal was to extract maxillary left permanent canine. The prognosis was guarded for removal of canine without trauma to the maxillary left permanent lateral incisor. Possible complications included devitalization of adjacent teeth.

Alternate treatment plan II

No treatment. The prognosis was poor for spontaneous resolution of problem list. Possible complications included ankylosis of the maxillary left canine, root resorption and loss of the maxillary left lateral incisor, and ankylosis of the mandibular right second molar.

Treatment and outcomes

Treatment lasted 18 months; 7 months to regain the 3 mm. in arch length that were needed to accommodate the permanent canine and an additional 10 months to erupt and guide the tooth into position in the arch. The maxillary arch was bonded from first molar to first molar. The mandibular arch was not bonded. Three months into the case, the mandibular right third molar was extracted and the right second molar was uncovered and luxated. At 6 months into treatment, a progress panoramic radiograph and a progress maxillary arch series of periapical radiographs were taken (Fig 3). Crown to root ratios at this progress report were : maxillary premolar (.72); maxillary canine (.83) and maxillary central incisor (.90). These ratios were essentially unchanged from the pretreatment values and the decision was made to proceed with treatment. An updated panoramic radiograph showed the mandibular right second molar had changed position toward a favorable angulation and vertical position in the alveolus. At 7 months into the case, the maxillary left canine was surgically uncovered and a traction hook with ligation chain (TP Orthodontics, LaPorte, IN 46350 USA) was bonded to the crown. Nine days after the uncovering procedure, the eruption and alignment of the canine into the maxillary arch was begun. As the canine was erupted, preexisting external root shortening of the left lateral incisor was revealed at the site where the canine crown had been positioned.

At 18 months, the case was debanded and a removable retainer was placed. A post-treatment maxillary arch series of periapical radiographs were taken (Fig 4). The crown to root ratios at this time were: maxillary premolar (.76); maxillary canine (.83); and maxillary central incisor (1.0). These ratios were slightly increased in comparison to the pretreatment ratios. However, they did not indicate a greater than 20% loss of external root structure. Maxillary arch form and maxillary dental midline alignment with both the facial and mandibular dental midlines were acceptable. Overjet was increased an additional 2mm (Fig 5). The left lateral incisor exhibited increased clinical mobility and its alveolar bone support appeared diminished on a periapical radiograph. Despite the guarded prognosis, it may have become devitalized by the continued presence of the canine, had that tooth been left in its ectopic position. The mandibular right second molar erupted and became a functional unit in the occlusion.

One year after the appliance removal, clinical examination revealed that the mobility of the left lateral incisor had not increased and that no significant changes had occurred in the position of the left canine. The

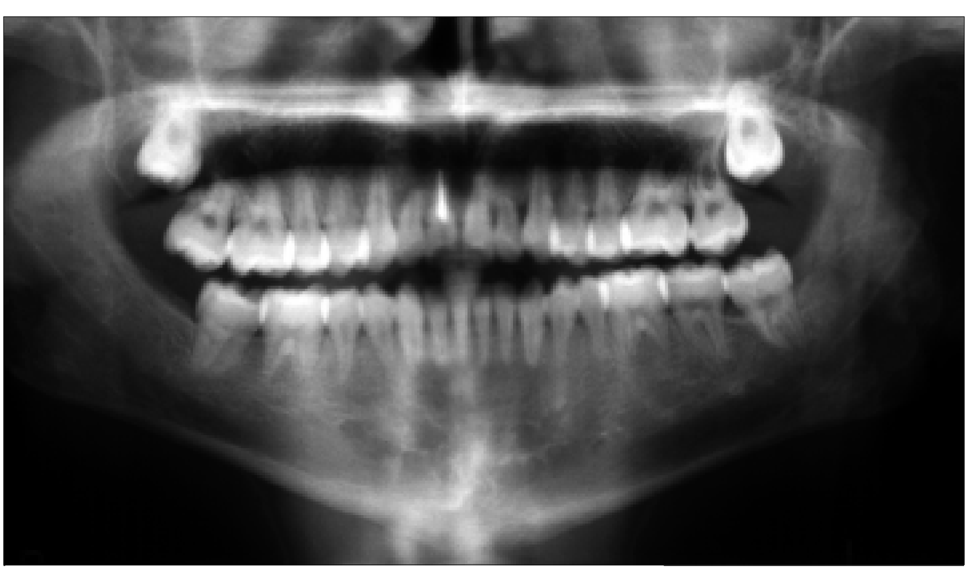

Fig 6. One year post-treatment panoramic radiograph.

position of the mandibular right second molar had also remained stable, as shown by the post-treatment panoramic radiograph (Fig 6). Both teeth continue to be functional units in the patient's occlusion.

Discussion

The main concern in this case was the risk of further root resorption versus the benefit of alignment of the impacted maxillary canine and mandibular molar. The pretreatment arrested root development was probably a result of the chemotherapy and radiation therapy delivered in early childhood. Rosenberg[6] reported the time of exposure to the chemotherapy and radiation is directly related to the effects of tooth development. It is also possible that altered hormone function adversely affected this patient's craniofacial development. Sonis[9] reported other studies of growth failure or growth hormone deficiency in children who received cranial RT for ALL.

The response of the already short roots to orthodontic forces was monitored with pretreatment, progress (6 months) and post-treatment periapical films of the maxillary arch. Crown to root ratios were measured and it was decided that if a greater than 20% loss of root length occurred during treatment, the appliances would be removed and treatment suspended. This did not occur. Foreshortening and enlargement of radiographs may have affected the interpretation of the radiographs. Clinically, no increase in mobility was noted as a result of the fixed appliance therapy except at the maxillary left lateral incisor. Active movement of the canine away from the ectopic position not only improved the integrity of the maxillary arch and overall occlusion, but it also preserved the root of the left lateral incisor from further resorption and possible loss.

The plan of treatment for followup regarding the compromised lateral incisor is as follows:

- Patient, parents, and general dentist were informed of the problem;
- Suggested followup radiographs at 3 year intervals to monitor further changes;
- Restorative options discussed if tooth is lost:
- Single tooth implant;
- Resin bonded bridge.

Future investigations could gather information about whether there is an increased incidence of ectopic tooth position in the population of long term survivors of ALL. Another could look at the timing of growth hormone deficiency in ALL patients and the effect that it has on the eruption of the permanent dentition.

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