Prevalence of short-root anomaly in healthy young adults

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Short-root anomaly (SRA), occurring mostly in maxillary incisors, is defined as developmentally very short, blunt dental roots. The condition has a genetic background and is related to hypodontia. Earlier population studies have been based on schoolchildren with developing dentitions and have indicated prevalence figures between 1% and 10%. We studied a random sample of existing panoramic radiographs of 2000 university students for SRA. Roots as long as or shorter than the crowns in the incisors and visually evaluated as very short, blunt roots bilaterally in the posterior teeth were classified as SRA. The prevalence was 1.3%. According to anamnestic information, half the SRA patients had undergone orthodontic therapy, but pre-treatment radiographs were unavailable. In 70% of the SRA patients the short-rooted tooth pairs were upper incisors, but also involved were maxillary premolars, lateral incisors, and lower second premolars. Women were significantly more often affected. We discuss other factors known to cause short-rooted teeth and conclude that the population prevalence for genetic SRA in fully developed dentitions is close to our 1.3%. □ *Tooth abnormalities; tooth apex; tooth root*

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Short-root anomaly (SRA) has been described as developmentally very short, blunt roots of the maxillary incisor teeth (1). In genetic SRA this diagnosis is verified when similar short-rooted teeth appear in some family members, and when other known causes for root shortening can be excluded. Another common reason for short-rooted teeth is any orthodontic treatment known to cause root resorption in most patients (2). Moreover, SRA itself predisposes to root resorption during orthodontic treatment (3–5).

Some types of environmental insults during tooth development may result in short-rooted teeth. After chemotherapy for childhood malignancies various developmental defects of the teeth may appear, most commonly affecting the roots (6–8). Radiation therapy in the craniofacial area (6, 8) or neck (9), even though not focused directly on the jaws, or total-body irradiation (10–12) increases adverse effects on the root development in survivors of childhood cancer. All children treated for acute lymphoblastic leukemia while less than 5 years old presented with disturbances in the roots of their permanent teeth (8). In another study harmful effects on the roots appeared in 94% of children treated with chemotherapy and total-body irradiation before the age of 12 (12). Tooth agenesis is also a common finding, especially in children conditioned with total-body irradiation before bone marrow transplantation; Näsman et al. (11) found that 11 of 19 such children younger than 12 years old later showed agenesis.

Shortness of the roots of the teeth has also been observed in disorders such as scleroderma (13), Stevens–Johnson syndrome (14, 15), Down syndrome (16), and Laurence–Moon–Bardet–Biedl syndrome (17). Some short-stature syndromes—for instance, Aarskog syndrome (18) and dwarfism of Seckel (19)—have been associated with short roots. In addition, case reports describe patients with short stature and short roots with no recognized syndrome (20, 21). All these conditions are rare.

There seems to be variability in the prevalence of developmentally short-rooted maxillary central incisors in various populations. Japanese schoolchildren have shown a prevalence of 10% (22), whereas in Europe prevalences of 2.4% and 2.7% have been reported (23, 24); in these studies children were no older than 14. We could find no reports on the prevalence of SRA in any normal population with fully developed dentitions.

The objective of this study was therefore to establish the prevalence of SRA in a general population by studying a random sample of existing radiographs of healthy university students 18–30 years old. We also wished to describe the affected tooth groups and confirm the prevalence of developmentally missing teeth in patients with SRA.

Materials and methods

Approximately 6000 panoramic radiographs are taken every year of university students at the Finnish Student Health Service (FSHS) in Helsinki, Finland. As a rule, all first-year students are invited to a dental examination, and panoramic radiographs are taken of most of them (80%), problems related to the wisdom teeth being the main indication for the radiography.

A total of 2000 dental records were randomly selected from FSHS active files. Of these, 41 were rejected because

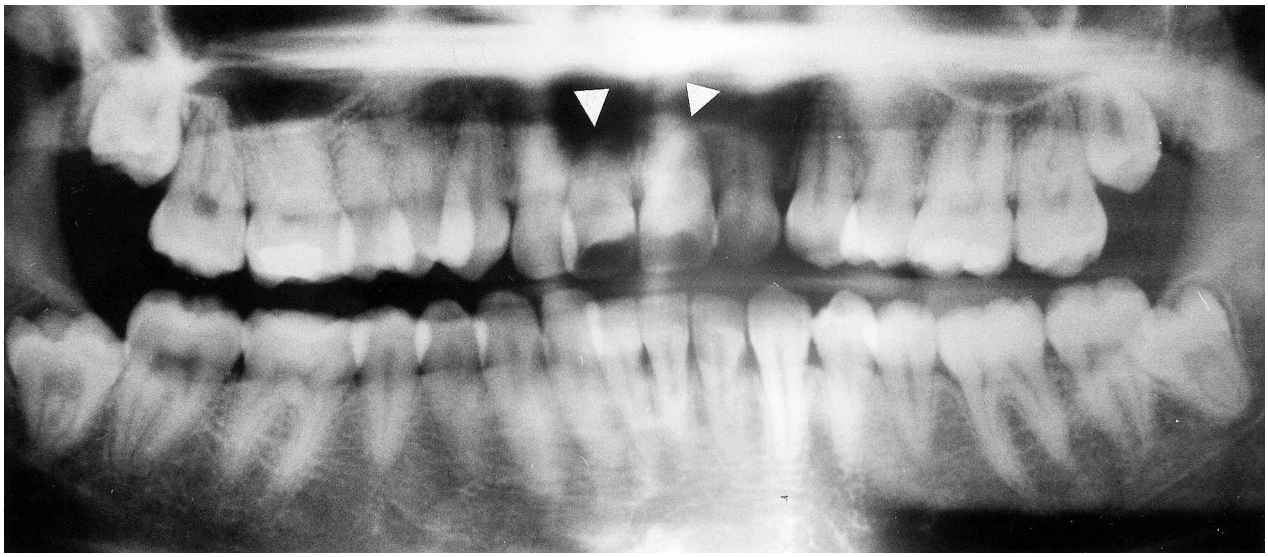

Fig. 1. Panoramic radiograph of a 24-year-old female student with short-root anomaly. Maxillary central incisors are strongly affected with round apices (arrowheads). Short roots are seen throughout the dentition. No orthodontic treatment has been done.

of missing or technically poor radiographs. Consequently, the final sample consisted of 1959 panoramic radiographs taken during the period 1972 to 1998. Of these, 1289 were of female and 670 of male students, aged 19–30 years, the mean age being 20.6.

All panoramic radiographs were examined by one author (S. Apajalahti). Diagnosis of SRA was first based on the crown to root ratio: if the roots were of the same length or shorter than the crowns in at least one pair of permanent teeth bilaterally, the dentition was considered to show SRA (Fig. 1). Single teeth with short roots were ignored. Clearly distinguishable root resorption with sharp-cut edges and open apices was excluded. For the patients thus identified, medical histories were checked on forms the students had filled in at the first appointment.

Congenitally missing teeth were recorded on panoramic radiographs. Teeth were considered to be developmentally missing only if the corresponding deciduous tooth persisted. Third molars were not included.

For statistical analyses, the standard chi-square test was used. A probability value less than 0.05 was regarded as significant.

Table 1. Number and sex distribution of students with short-root anomaly (SRA)

	No. of students (%)	No. of students with SRA (%)
Female	1289 (66)	22 (1.7)*
Male	670 (34)	3 (0.4)
Total	1959 (100)	25 (1.3)

* $P < 0.05$.

Table 2. Number and distribution of tooth pairs with short roots in students with short-root anomaly with or without orthodontic treatment

Tooth group	Without orthodontic treatment	With orthodontic treatment	Total
Maxillary central incisors	9	9	18
Maxillary second premolars	9	4	13
Maxillary first premolars	6	5	11
Maxillary lateral incisors	2	6	8
Mandibular second premolars	4	2	6
Maxillary canines	2	1	3
Total	32	27	59

Results

The prevalence of SRA in the study group was 1.3% (25 of 1959) (Table 1). Of the 25 affected subjects, 13 had earlier undergone orthodontic treatment. The condition was significantly more common in women (chi-square test, $P < 0.05$). The medical histories of the SRA patients included no diseases or medical treatments known to affect tooth development. None of the patients presenting with SRA used long-term medication.

The number and distribution of tooth pairs with short roots are shown in Table 2. The roots of maxillary central incisors were of the same length as or shorter than the crowns in 18 of 25 SRA patients. In addition, maxillary second premolars, maxillary first premolars, maxillary lateral incisors, and mandibular second premolars, in order of frequency, were involved. On average, three tooth pairs were affected. Overall, in 15 subjects (15 of 25) all maxillary central incisors and maxillary premolars were affected. Furthermore, short roots were seen in molars in six of those affected, in three of whom the molars were strongly taurodontic in shape.

Table 3. Number of university students with hypodontia and with or without short-root anomaly (SRA)

	Students with hypodontia and SRA	Students with hypodontia and without SRA	Total
Female	3	72	75
Male	0	33	33
Total	3	105	108

The prevalence of hypodontia in the whole sample was 5.5% (108 of 1959) (Table 3). The prevalences were 5.8% in women and 4.9% in men. In the 25 dentitions with SRA, 3 (12%) also had hypodontia. In two subjects upper and/or lower premolars, and in one subject also upper lateral incisors, were developmentally missing. Additionally, two subjects had peg-shaped lateral incisors.

Discussion

In studying panoramic radiographs of healthy young adults to establish the prevalence of short-root anomaly in the general population, we arrived at a prevalence of 1.3%. The condition was statistically significantly more common in women (Table 1).

Of some 37,000 students at the University of Helsinki 63% are women. In our sample of 1959 students 66% were women, thus representing fairly well the present male to female ratio (37:63) at our university.

The prevalence of SRA in the present study is somewhat lower than those reported for schoolchildren aged 11 years and more (23, 24), whereas our findings are of the same order as those reported for Swedish children by Bergström (25).

The differences in the population groups studied and in the diagnostic criteria may partly explain the discrepancies between our prevalences and those in previous studies. In the present study panoramic radiographs were taken of university students who, as such, form a selected group of young adults. A condition like SRA might be higher in a totally unselected group probably including those with systemic diseases with dental involvement or with syndromes or earlier chemotherapy or radiation therapy, known to affect tooth development. Racial differences may explain the much higher prevalence of 10% found in Japan (22). On visual evaluation, the rounded, short roots typical of SRA are conspicuous. In the present study the diagnosis of SRA was based on bilateral very short and characteristically blunt roots in panoramic radiographs. Systemic diseases or therapies that are known to affect root development were excluded by study of each patient's medical history. With these criteria we could confirm the presence of true genetic SRA, which has seldom been done in prevalence studies. The higher prevalence figures obtained by other researches may thus also include patients with short-rooted teeth resulting from etiological causes other than genetic SRA.

In our study group half the subjects presenting with SRA had received orthodontic treatment, and this may influence root length. In orthodontic patients dental anomalies such as agenesis and ectopia and morphological characteristics such as invagination, original root length, and taurodontism are also suggested as risk factors for apical root resorption (26, 27). Apical root morphology of the upper front teeth have been shown to be of significance for the extent of apical root resorption, pipette-shaped roots having a higher tendency to resorb than roots with a normal apical structure (28). In the present study exclusion of orthodontically treated patients would have biased the study.

Because of provisions concerning protection of patient data, there was no access to the pre-treatment records of the study group patients, so we were able to verify neither pre-treatment root length and morphology nor type and duration of orthodontic treatment performed. Studies of apical root resorption after orthodontic treatment indicate very high occurrence of apical changes. As extreme resorption leading to loss of one-third of the root length is seen only in 0.4% (2), it is not likely that orthodontic treatment was a true confounding factor in the present study. Moreover, it is easy to distinguish between the radiographic images of a resorbed tooth and a tooth with short-root anomaly, and we assume that 1.3% is close to the true prevalence of SRA.

Few observations exist on the distribution of short-rooted teeth within the dentition (1, 4, 20). In agreement with these, we found that maxillary central incisors are the most frequently and characteristically affected. They were symmetrically involved in 70% of the SRA subjects (18 of 25). Maxillary premolars, maxillary lateral incisors, and mandibular second premolars were the other tooth groups affected. Interestingly, with the exception of maxillary central incisors and first premolars, these are the teeth in which other developmental dental anomalies such as hypodontia, peg-shaped teeth, invaginations, and ectopia frequently occur (29–31). Furthermore, in three subjects with SRA, the molars were strongly taurodontic, another developmental anomaly suggested to be associated with hypodontia (32).

We found a prevalence of 5.5% for developmentally missing teeth; Haavikko (33) has reported a prevalence of 7.9% for Finnish schoolchildren. In the present study, owing to the absence of detailed dental histories, the diagnosis of such teeth had to be based on the presence of the corresponding deciduous teeth in panoramic radiographs. No doubt thus exists that several true hypodontia cases were overlooked. Developmentally missing teeth were evident in 12% (3 of 25) of the SRA subjects. Although their prevalence of hypodontia was more than twice that of the whole sample, it did not reach the level of statistical significance. However, our earlier study showed genetic SRA to be related to familiar hypodontia (5). Whereas the prevalence of the genetic form of SRA will probably remain the same, the total number of patients with root length shorter than normal will increase, due to

the growing number of orthodontic treatments performed. Moreover, the increasing survival rates of patients with childhood malignancies will create an expanding group of adolescents and adults with defects in the roots of their teeth. In the future, SRA patients should be divided into diagnostic groups on the basis of etiology.

We conclude that genetic SRA is a condition with a prevalence close to 1.3% in healthy Finnish young adults, affecting females significantly more often than males, and with a predisposition for the maxillary incisors and premolars and mandibular second premolars to be affected. In everyday clinical work root lengths should be carefully checked before the initiation of orthodontic, prosthetic, periodontal, or endodontic therapy, because one person in a hundred may have shorter than normal roots in their upper incisor teeth or premolars. In families with SRA early diagnosis in childhood is possible and may influence orthodontic treatment strategy.

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