pain experienced by patients during initial alignment, were evaluated. The authors concluded that there is some evidence to suggest that there is no difference between the speed of tooth alignment or pain experienced by patients when using one initial aligning arch wire over another. However, as they report, root resorption had not been investigated by any randomized clinical trial, even though it is one of the most serious side effects of orthodontic treatment. They suggest that further evaluation of the aligning arch wires should consider this potentially serious side effect of orthodontic treatment.

As derived from the literature, there seems to be lack of knowledge concerning the effect of the leveling arch wires used in everyday clinical practice on orthodontic root resorption. Therefore, the primary objective of this study was to compare the amount of root resorption following the leveling phase of orthodontic treatment performed with super-elastic arch wires and conventional multi-stranded stainless steel arch wires. Leveling duration was compared between the groups. Additionally, a comparison of the severity of apical root resorption between central and lateral incisors during that phase of treatment was attempted. Finally, the effect of several patient- and treatment-related variables on apical root resorption was evaluated.

Methods

The study was approved by both the Ethical Committee in Norway and the Norwegian Social Science Data Services (NSD) (REK Vest 229.08 2008/12408-ØYSV). All study participants and/or their parents read and signed an informed consent form before treatment initiation. A power analysis was performed for calculation of the sample size. In order to identify a difference of 0.5 mm at the 0.05 level of significance with 80% power, using a standard deviation (SD) of 0.8, 41 patients were required in each group.

One hundred fifty-six orthodontic patients, who were about to start treatment at the private clinic of one of the authors (EF), were assessed for eligibility to participate in the study. Patients who showed signs of apical root resorption, were earlier orthodontically treated, or had endodontic treatment of their front teeth were excluded from the sample. Finally, 82 patients were included in this prospective study.

All patients received orthodontic treatment with straight-wire edgewise technique. The appliances used were 0.022-in. Diamond Twin brackets (Ormco Corp., Clendora, CA, USA). The study was parallel in design, with an allocation ratio of 1:1. Clinical assistants arbitrarily allocated patients into two experimental groups with 41 patients each, using prepared random number list (Table 1). Treatment was performed by one of the authors (EF), who was informed about the treatment group during bonding. During the leveling phase, patients in the first group were treated with super-elastic arch wires (SE group), whereas patients in the second group were treated with stainless steel arch wires (SS group). The typical arch wire sequence for the SE group was 0.014 in. Sentalloy, 0.016 in. Sentalloy, and 0.018×0.025 in. Bioforce (Dentsply/GAC, Bohemia, NY, USA). The arch wire sequence for the SS group was 0.0175 in. Penta-one multi-stranded (Masel Orthodontics, Carlsbad, CA, USA), 0.016 in. Australian regular (A J Wilcock PTY, LTD, Whittlesea, Australia), and 0.016×0.022 in. resilient (3M Unitek, Monrovia, CA, USA).

A number of variables were recorded for each patient (gender, age, ANB angle, overjet, overbite, impacted maxillary canines, invagination of each incisor, crossbite separately for teeth 12 and 22). During the course of treatment, any complaint from the patients would be noted in their clinical journal. All patients were radiographically examined at two predetermined points of treatment: before treatment start and at the end of the leveling phase, approximately 6 to 10 months after initiation of treatment. Leveling duration was also recorded. During the examinations, periapical radiographs of maxillary and mandibular incisor teeth were taken with a standardized long-cone paralleling technique. The tube was placed at a fixed distance of 7 cm from the film, using a customized Eggen holder. Four radiographs were taken each time: one with the central ray beam between the two maxillary central incisors, one with the X-ray beam centered at the maxillary lateral incisor on each side, and one radiograph with the central beam between the mandibular central incisors. Both apex and the incisal edge of the incisor teeth should be clearly visible. Unsatisfactory X-rays were excluded from the study. Totally, 311 teeth were examined radiographically in 79 patients: 2 teeth in 6 patients, 3 in 18 patients, 4 in 46 patients, 5 in 1 patient, 6 teeth in 1 patient, 7 teeth in 6 patients, and finally 8 teeth in 1 patient. All periapical radiographs were converted to digital images by using an EPSON perfectionV700 scanner at a resolution of 300 dpi (Epson Inc., Long Beach, CA, USA). The

Table 1 Gender and age distribution of the patients in the two groups

	Males	Females	All	Mean age (years)	Range (years)	SD
SE group	22	19	41	13.3	11 to 16	1.5
SS group	18	23	41	13.7	11 to 22	2.4
All	40	42	82	13.5	11 to 22	2.0