Metallurgical analysis and fatigue resistance of WaveOne and ProTaper Nickel-Titanium instruments

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Abstrak

The aim of the study was to evaluate cyclic fatigue resistance of two NiTi instruments and to analyse their surface, fractographic and matrix morphology under ESEM/EDS and optical microscopy. WaveOne Primary and ProTaper Universal F2 brand new instruments were subjected to fatigue testing in an artificial canal with 5.0 mm radius and 60° angle of curvature. Seventy-two instruments were divided into three groups (n = 24), according to the selected kinematics: WaveOne using reciprocation (A); ProTaper using reciprocation (B) or rotation (C). Time to fracture was recorded. Data were analysed with ANOVA and Tukey test. ESEM/EDS analysis was conducted on new files to examine surface characteristics and on fractured fragments to identify the fractographic features. Metallographic analysis was performed with optical microscope on new instruments to evaluate alloy properties. Significant differences were found with Group A, which was statistically more resistant to cyclic fatigue ($P < 0.05$) than the other groups. Surface analysis of new instruments showed both in WaveOne and ProTaper files the presence of deep milling marks. ESEM fractographic analysis of WaveOne showed multiple crack origins with an area of fatigue propagation wider than ProTaper instruments, in which a single crack origin could be detected. EDS analysis confirmed the equiatomic NiTi composition. Metallographic analysis under optical microscope revealed in WaveOne instruments the presence of nano-crystalline martensitic grains embedded in austenite matrix, presence which could not be found in ProTaper files. WaveOne NiTi files revealed higher resistance to fatigue stress, suggesting extended working time in clinical applications.