Influence of free radicals signal from dental resins on the radio-induced signal in teeth in nuclear retrospective dosimetry : kinetic analysis using EPR

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Target audience

ESR scientists, MR scientists interested in dosimetry and/or in the characterization of biomaterials

Purpose

Dental enamel is a natural dosimeter frequently used with EPR detection for retrospective dosimetry purpose and dose reconstruction in individuals accidentally exposed to ionizing radiations, because a dose dependent signal is observed in this type of material [1, 2]. Teeth very frequently bear restoration performed by dentists using dimethacrylate based resins. An strong EPR signal is also documented in those resins, possibly causing an interference with the dosimetric signal from the enamel. The aim of this study was to evaluate the influence of dental resins on the measurement of the dosimetric signal in teeth.

Method

Among the commercial resins the most frequently used in dentistry, 19 were included in this study. Experimental compositions of different common commercial monomers (Bis-GMA, TEGDMA, UDMA, Bis-EMA) were also evaluated to search for a possible class effect. Firstly, the occurrence and magnitude of an EPR signal was investigated in each resin. Secondly, the decay kinetics of the EPR signal was measured over a 6 months period (L and X band). The size of each sample (30mg) was compatible with a medium-size restoration of an anterior tooth. The signal intensity was compared to the dosimetric signal recorded in teeth after a 3 Gy irradiation.

Results

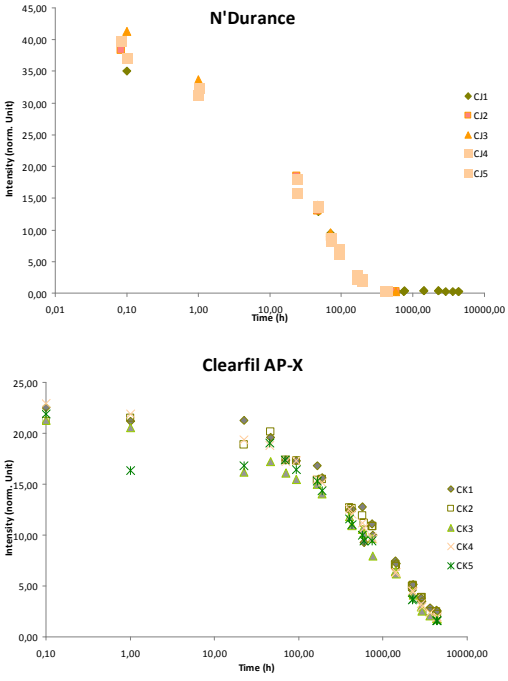

Fig. 1 : Decay kinetics of the epr signal recorded in X band in commercial resins N'Durance and Clearfil AP-X. Time is expressed in a log scale.

An EPR signal was observed in all the samples tested. The initial signal recorded after polymerization ranged from 16 times (i.e. Venus Diamond, Heraeus Kulzer Inc.) to 105 times (N'Durance, Septodont) higher than the dosimetric signal observed in tooth after a 3 Gy irradiation.

The observed decay kinetics followed a bi-exponential model with a first compartment showing a rapid decay and a second compartment showing a much slower decay. In both compartments, different rates of signal decay were observed according to the tested resin. The most rapid decay was seen in N'Durance (Septodont) ($t_{1/2\ 1st}$ = 1.2 h (1.0-1.7) ; $t_{1/2\ 2nd}$ = 51 h (47-57)) and the slowest decay was seen in Clearfil AP-X (Kuraray America, Inc) ($t_{1/2\ 1st}$ = 82.8 h (58.7-140.4) ; $t_{1/2\ 2nd}$ = 1270 h (1101-1499)) (Fig. 1). In most resins, the signal recorded six month after the polymerization was low enough not to interfere significantly with the dosimetric signal.

Conclusion

Tooth enamel associated with EPR detection is a very promising natural dosimeter. When conducting retrospective dosimetry, attention should be paid to recent restorations on teeth (less than 6 month), specially for doses lower than 3Gy. These results should be refined by further studies investigating the influence of size and the geometry of the restoration on the dosimetric signal using "in the field" conditions.

References

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