HYDROXYL RADICAL ACTIVITY IN BLEACHED ROOT-FILLED TEETH

by

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DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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For Karen, Clare and Nicholas

SUMMARY

Bleaching procedures have been carried out on both vital and root-filled teeth for many years. These bleaching procedures have generally been considered to be both effective and safe. The most commonly used bleaching agent in the treatment of discoloured root-filled teeth has been 30% hydrogen peroxide. This is sometimes used in combination with sodium perborate. Harrington and Natkin (1979) were the first to report an association between bleaching procedures in root-filled teeth and the condition of invasive cervical root resorption. Reports then followed from other authors supporting this observation. Harrington and Natkin suggested that the cause of bleaching-related root resorption could be the leakage of bleaching agents from the pulp chamber through patent dentinal tubules into cervical periodontal tissue during the bleaching procedure. This could damage periodontal tissue and initiate root resorption. This process may well be facilitated by traumatically or developmentally produced defects in the cementum layer in the cervical region of the tooth. A recent study (Rotstein et al., 1991) has indeed demonstrated the passage of hydrogen peroxide from the pulp chambers of root-filled teeth to the external root surface. In this study, greater concentrations of hydrogen peroxide were detected when there were defects in the cementum layer.

Experimental and clinical reports have served to demonstrate the toxic nature of hydrogen peroxide (Seale et al., 1981 ; Weitzman, 1986). Hydrogen peroxide is considered to be a reactive oxygen species (Halliwell, 1989b) and has been demonstrated *in vitro* and *in vivo* to cause the generation of hydroxyl radicals in the presence of transition metals

such as iron. Ferrous salts combined with hydrogen peroxide will generate hydroxyl radicals (Halliwell, 1978). Although most iron in the body is bound to either haemoglobin, myoglobin, transferrin or ferritin, in some disease states, iron is free to participate in such a reaction. Furthermore, iron may be made available for this reaction when haemoglobin is exposed to hydrogen peroxide.

The hydroxyl radical is one of a number of oxygen-derived free radicals and is considered extremely reactive. Its role in the destruction of connective tissue components, collagen and hyaluronic acid, is well documented (Greenwald, 1981). Hydroxyl radicals are also capable of altering deoxyribosenucleic acid (DNA) through strand breakage as well as destroying cell membranes through lipid peroxidation.

In traumatised teeth, the development of deep discolouration has been attributed to the extravasation of blood components from the pulp chamber into surrounding dentinal tubules with possible subsequent decomposition of these components (Grossman, 1988). Freccia and Peters (1982a) further suggested that, with the breakdown of extravasated erythrocytes, iron is released. Combination of this iron with hydrogen sulphide produced by bacteria may also result in the formation of brown - black iron sulphide, thus adding to the degree of discolouration of the tooth.

The aim of the present study was to determine whether hydroxyl radicals are generated when hydrogen peroxide is used to bleach root-filled teeth which have been discoloured by blood components.

Forty extracted human premolar teeth were root-filled with gutta percha and AH26^{R} sealer cement. Twenty of the teeth were experimentally discoloured by blood components. All teeth were then

thermocatalytically bleached using 30% hydrogen peroxide while the tooth roots were suspended in a test solution of sodium salicylate. Hydroxyl radical generation was determined by the detection of products of the reaction of this radical with salicylate using high performance liquid chromatography with electrochemical detection.

The presence of reaction products was detected in twenty five of the teeth. A significant association was found between the presence of tooth discolouration caused by blood components and the production of hydroxyl radicals. There was no association between the presence of cementum defects and the production of hydroxyl radicals. If anything, there was an apparent inhibition of hydroxyl radical production by cementum defects. Greater yields of hydroxyl radicals were detected in teeth which were discoloured by blood but which did not have detectable defects in the cementum at the cemento-enamel junction (CEJ). Overall there was no significant statistical association between the use of ethylenediamine tetra-acetic acid (EDTA) to flush the pulp chamber before the bleaching procedure and the production of hydroxyl radicals. However, the greatest individual yields of hydroxyl radicals found in this study occurred in teeth in which EDTA had been used to flush the pulp chamber prior to the bleaching procedure.

Supplementary experiments in the present study demonstrated that intense U.V light increased the production of hydroxyl radicals from sodium salicylate solution alone and in sodium salicylate solution which contained hydrogen peroxide.

There appeared to be a minor reaction between hydrogen peroxide and sodium salicylate solution itself. This phenomenon is discussed as it may have had some influence on the results of the present study and it

may hold implications for other studies which have employed this technique for the detection of hydroxyl radicals.

It was concluded that hydroxyl radicals are generated during bleaching of root-filled teeth. There is a significant association between the presence of tooth discolouration due to blood components and the production of hydroxyl radicals. The presence of EDTA may result in a greater yield of hydroxyl radicals in discoloured, root-filled teeth undergoing bleaching. The generation of hydroxyl radicals could be one mechanism underlying periodontal tissue destruction and invasive cervical root resorption that may occur after intracoronal bleaching of discoloured root-filled teeth.

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