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The antibacterial effect of silver anode in root canals

Oral Microbiol Immunol

Abstract

The present study reports on the application of silver anode in root canals for disinfection of infected teeth.

Twenty-seven teeth of twenty-three patients were exposed to the positive polarized silver electrode(s). The initial flora of the infected canal(s) was identified before the pure silver electrode(s) was inserted. A low level of DC was obtained using a silver watch battery which was placed into an acrylic removable appliance. The positive pole was applied to the silver electrode(s) throughout four successive days and adequate sterilization was provided with the exception of two cases.

Key words Silver anode disinfection, Silver anode in chronic alveolar abscess.

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Introduction

The pure silver moiety is called the silver anode (SA) when it is polarized positively. SA has been found to be antiviral, antibacterial, antifungal and antitumoral (5,8,9,10,11,15). These effects can be produced between current levels of 5-20 μ A without any irreversible damage to mammalian cells (2,14). The effectiveness is not enhanced by increasing either the current level or duration (9,11).

The antibacterial mechanism of SA is based on free silver ions are emitted from the metal surface. Free silver ions and most silver compounds that are able to dissociate can easily penetrate any tissue, even when the tissue is avascular (2). However, the antibacterial effect of SA does not completely depend on the emission of free silver ions. Its mechanism is not clear yet. The MIC of Ag-sulfadiazine is 25 μ g/ml for *S. aureus* of dental origin, but the MIC of anodic silver is 0.25 μ g/ml for the same strain (2). Further, the antibacterial effect of SA continues even when the electric current is stopped (10,11). In contrast to anode, the cathode is not microbicidal, but it does stimulate osteoblastic activity (1,2,4,6,9,14,16). In the literature, there are studies reporting the healing of periodontal bone defects (6), the facilitation of orthodontic tooth movements (7) and the fixation of dental implants (12) by the use of external electricity. Also, SA has often been used in the treatment of orthopaedic infections (1,4,14,16). The poles were reversed during therapy in order to ossify the infected non-union after sterilization was established by several days of SA application.

The main concern of this study was to determine the antibacterial effect of silver anode on the bacterial flora of infected root canals.

Material and methods

SA was used on twenty-three patients (9 males and 14 female) to provide root canal sterilization. Their average age was 33 years (range, 16-60 years; median, 31). The duration of dental infection ranged from 1.5 to 7 years (median, 4 years), 22 of 27 teeth had chronic apical abscesses. 4 teeth had a Miller's Mobility Index of 2, but 5 patients had a history of some trauma. 4 cases had persistent fistulas and all of the patients complained of occasional pain. 14 of 27 teeth had at least one previous traditional mechanical preparation and chemical treatment prior to this treatment. The patients accepted the anodic silver treatment and collaborated with us. The patients did not use any local or systemic antimicrobial agents for four days before treatment.

The following protocol was applied to each of the patients:

Step.1: The root canal(s) was debrided mechanically under sterile conditions without using any antiseptic in the canal(s). The tissue residues near the apex were inoculated into blood agar and CDC anaerobe blood agar. The difficult cultivable bacteria and fungi were recorded in their genus level (if any), after the fresh material was directly inspected on a slide.

The first medium was aerobically incubated for 2 days. The second was anaerobically incubated for 7 days with the use of BBL Gas Pack System Jar (BBL, Cockeysville, MD). The API20A test kit (API System, Vercieu, France) was used for tests of anaerobes. The standard biochemical and physiological tests were performed on the other organisms. All bacterial identifications were obtained with a computer assistance. The 3 most dominant strains from each sampling of flora were assessed.

A wire of 99.9% pure silver, 0.5 mm in diameter, to be used as the anode was inserted into the root canal. The control radiographs were taken. Access cavity was closed temporarily. An individual stone model was obtained with the use of a hydrocolloid material.

Step.2: On the model, a strip of pure silver foil (19x12x0.5 mm) as cathode was adapted to palatal surface of the infected tooth as close as possible to the suspected position of the root. The negative pole of the battery (Sony, Silver Watch Battery, 1.55V 317-SR516SW, Sony energytec Inc Jap) was soldered to the silver cathode. A cavity was prepared in the relevant tooth of the stone model and the positive pole of the battery was placed into the cavity through a serial resistor (R1, 47 K Ω) by an insulated thin wire (Fig 1). Two resistors were used if two teeth were treated in the same mouth. The attachments were placed on the intact teeth, the holding appliance was prepared using self-cure acrylic (Unitek ON. 703-307, Nonrovia, California 91016).

Step.3: Access cavity was reopened, washed with sterile saline, but not dried in order to obtain the electrical contact between the surface of the root dentin and the SA. The appliance was inserted in the mouth after the attachments were activated. The individual current level was measured and noted before the thin wire was pushed into the cavity. A moistened cotton pellet with conductive cream and a temporary filling were placed into the cavity to ensure good contact of the wire. The patient kept the appliance in the mouth for four days.

Electrical Parameters The surface of the cathode was 2.28 cm², the surface of anode ranged from 0.2985 to 0.9664 cm² (median, 0.346 cm²). The actual current level ranged from 17.184 to 19.375 μA (median, 17.775 μA). The average of the total charge density was 1.548 Coulomb per day (range, 1.4846976 - 1.674; median, 1.539). This value were below the safety limit (2 C/day) for living mammalian cell (2). Already, there was a tendency for the current level to decline during the application because of the ion saturation of the tissue.

Step.4: The cavity was reopened, the SA(s) was removed. The microbial detection was repeated as described in Step.1. The SA(s) was replaced, the cavity was temporarily closed for one more week.

Step.5: If the culture result was the negative, the root(s) was filled with Endomèthasone (Septodont,Saint-Maur,France) with the SA remaining in the root canal. If the culture was positive, Step.4 was repeated, the appliance was not reapplied.

Results

The appliances were well tolerated by the all patients. No adverse effects were seen on the oral tissues except for the discoloration of 2 teeth which was caused by the silver iontophoresis. It is noteworthy that, in all floras, the anaerobes were either dominant (72 %) or disappeared first (Table 1). Also, the fungi were not rare (12.7 %). Satisfactory disinfection was obtained and infection has not reappeared within the control period with the exception of two cases. The mobilities of 4 teeth remained, however this was expected because of the osteolytic nature of SA. 2 of 4 fistulas closed in the third week after SA treatment.

In such a study, the absence of satisfactory prospective controls, each patient was considered their own control as each represented the failure of previous standard treatments for their dental infections.

Discussion

Obtaining a negative culture from an infected root canal is correlated with the success of the root canal treatment. However, the presence of a negative culture or a decrease in the number and/or type of bacteria present may not always reflect the clinical healing and must be assessed together with the clinical situation.

During the polarization of the SA, the silver ions migrated in direction of root dentin, dentin canals, cementum, periodontium, lamina dura, alveolar bone, connective tissue, mucosa and saliva

respectively by iontophoresis. Obviously, the lingual surfaces of the roots were much more affected. The depth of penetration into dento-alveolar tissues of silver ions was not known. However, in our preliminary study, the maximum silver emission zone at the same charge density was found to be 14 mm in agar gel containing bacterial nutrients (Ann Med Sci, in press). Hence, the penetration into hard tissues of silver was assumed to be similar.

The silver ions which invaded into the tissue and the silver complexes kept their antibacterial activity even after active therapy ended. The antibacterial effect of SA was not momentary. For this reason, the bacterial growth disappeared spontaneously in 2nd or 3th control cultures despite the fact that the 1st control culture was positive. Nevertheless, the two cases failed, it is possible that, some individual factors were exist, e.g. alcoholism, but both microbial flora were found to be highly sensitive to SA in vitro.

In conclusion, the silver anode was found to be highly effective in treating infected root canal flora in this pilot study. The SA application can be an alternative for treatment of persistent dental infections. Further studies are necessary to determine the calcification capability of the negative pole in the apical lesion after SA application.

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Legends

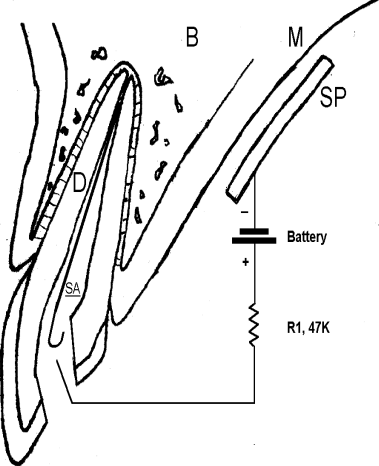
Table 1. Microbiologic and clinical aspects of the silver anode (SA) treated teeth. Most dominant three strains for each of the flora were reported. *CAA*, Chronic Apical Abscess; *CMP*, Chronic Marginal Periodontitis; *CAP*, Chronic Apical Periodontitis; *MMI*, Miller Mobility Index; **1,2,3,4**, in the same mouth; * Colony counts were reduced to ten or less; **F1a**, See Figure 1a; **F1b**, See Figure 1b.

Fig 1. Two examples for the appliance on the individual model, X-ray and experimental setup of silver anode (SA) treatment.

a. A woman, 31 years old. There was a chronic apical periodontitis since last 4.5 years in the left upper canine. Two conventional root treatments were performed 2 and 1.5 years before this time. The tooth was highly sensitive to percussion and pulp was already open when she came for treatment. Facultatives were dominant in the flora. Satisfactory sterilization was provided by the 4th day after SA application. The sensitivity disappeared. The tooth was filled. (See Table.1, *F1a*)

b. A girl, 20 years old. She received a severe trauma 4 years previously with the top of a bottle. There was a chronic apical abscess for 4 years in the right lower first premolar with active drainage present. A root canal treatment one year previously and antibiotherapy 3 and 2 years previously had been used. The drainage stopped in third week after SA treatment. The tooth was filled. (See Table.1, *F1b*)

a.



b.

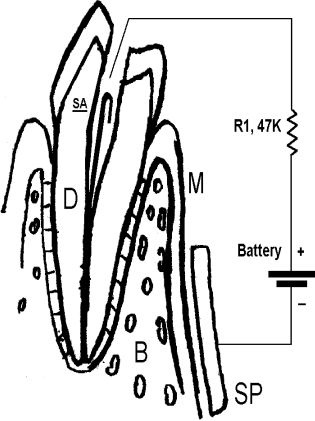


Fig 1