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# A Review: The Applications of EDTA in Endodontics (Part I)

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***Abstract :*** *EDTA is a frequently used irrigant in root canal treatment. Its main activity is toward smear layer removal because of its chelating power which makes it effective in removing the inorganic component of dentin. But it cannot remove the smear layer effectively; a proteolytic component, such as NaOCl, should be added to remove the organic components of the smear layer. EDTA contributes to the elimination of bacteria in the root canal.*

***Keywords:*** *Anti-microbial, Chelating, EDTA, MTAD, NaOCl, Smear layer.*

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## I. History Of EDTA

Alfred Werner 1893 developed the theory of coordination compounds, today referred to as chelates. For this turning point in reclassifying inorganic chemical compounds, Werner received the Nobel Prize in 1913. He went on to create accounting for the process by which metals bind to organic molecules, which is the basis for chelation chemistry. In the mid 1930's Germany developed its own chelating material. The synthetic substance they invented was EDTA (Ethylene-diamine-tetra-acetate). Chelating agents were introduced into endodontics as an aid for the preparation of narrow and calcified root canals (1).

## II. Chemical Formula Of EDTA

It is a polyaminocarboxylic acid with the formula [CH2N (CH2CO2H) 2]2. Nowadays, EDTA is mainly synthesized from ethylenediamine (1,2-diaminoethane), formaldehyde (methanal), and sodium cyanide (2).

## III. Mechanism Of Action Of EDTA

EDTA is a complex molecule with a claw-like structure, which binds and seizes divalent and trivalent metal ions such as calcium and aluminum to form a stable ring structure. EDTA removes bacterial surface proteins by combining with metal ions from the cell envelope leading to bacterial death (1). EDTA forms a stable complex with calcium. When all available ions have been bound no further dissolution takes place; therefore, EDTA is self-limiting (1).

## IV. Applications Of EDTA In Endodontics

### 4.1. Smear layer removal

It has been reported that EDTA decalcified dentine to a depth of 20–30 μm in 5 min (3). The paste type chelating agents do not remove the smear layer effectively when compared to liquid EDTA. EDTA is normally used in a concentration of 17% and can remove the smear layers when in direct contact with the root canal wall for less than 1 minute. Addition of surfactants to liquid EDTA did not result in better smear layer removal (4). A quaternary ammonium bromide has been added to EDTA solutions to reduce surface tension and increase penetrability of the solution. When this combination (REDTA) was used during instrumentation, there was no smear layer remaining except in the apical part of the root canal (5). The ideal working time of EDTAC (EDTA and cetavlon) was suggested to be 15 min in the root canal and no further chelating action could be expected after this (6). Takeda et al reported that irrigation with 17% EDTA, 6% phosphoric acid, and 6% citric acid did not remove the entire smear layer from the root canal system (7). Both EDTA and citric acid can effectively remove the smear layer when used together with NaOCl. 17% EDTA, 18% Etidronic acid, and 7% maleic acid removed the smear layer from different tooth levels (coronal, middle, and apical)(8). A study found that 5% and 7% maleic acid can be an alternative to routine use of 17% EDTA (9). MTAD is an efficient solution for the

removal of the smear layer, especially in the apical third of root canals, and does not significantly change the structure of the dentinal tubules so it is better than EDTA (10). When 17% EDTA was used as a final rinse, the smear layer was removed from the middle and coronal thirds of canal preparations, but it was less effective in the apical third of the canals. When compared with EDTA, Desy Clean[(sorbic acid (0.15 ml/L), hydrogen peroxide (128 ml/L), sodium benzoate (0.21 ml/L), acetic acid (26.64 ml/L) and water (845 ml/L)] can be a promising agent as an irrigation solution with optimal smear layer removal capacity and less erosive effects (11). Seventeen Percent EDTA solution and 24% EDTA gel used in association with 1% sodium hypochlorite were more effective in removing the smear layer compared with sodium hypochlorite alone (12). Q-Mix was as effective as 17% EDTA in removing canal wall smear layers after the use of 5.25% NaOCl as the initial rinse (13). 3 min 8% EDTA irrigation was as effective as 1 min 15% EDTA (14).

**4.2. Anti-microbial activity**

EDTA is desirable as a chemical adjunct, which removes the smear layer and possesses antimicrobial activity (15). Chelating agents like EDTA when used during chemicomechanical preparation remove the smear layer and possess the antimicrobial activity (16, 17). EDTA has a germicidal effect at a concentration of 10% as reported by Patterson (17). EDTA 10% and 15% has antimicrobial activity, both on culture plates and in broth (15). The antimicrobial effect of EDTA was stronger than that of citric acid and 0.5% NaOCl but weaker than 2.5% NaOCl and 0.2% CHX (18). EDTA inhibited E. faecalis even when diluted 512 times (0.033% concentration). EDTA has little or no antibacterial effect (19). The antimicrobial effect of Na- EDTA was maintained as long as the chelators have not formed bonds with metal ions (20). Regarding to the antibacterial activity of EDTA combined with ultrasonic activation, it took 7 days to get all cases bacteria- free (21). In another study EDTA was effective against Candida albicans (22).

**V. Biocompatibility of EDTA**

When EDTA was forced to extrude through the apical foramen into the periapical tissues, no periapical tissue damage could be detected after 14 months (23). The placement of EDTA for 28 days after pulpotomy produced no pulpal tissue necrosis (23). In the study of Míriam F. Zaccaro Scelza 10% citric acid proved to be the less aggressive tested solution at 14 days. At 28 days, all solutions were similar, but EDTA-T kept showing the higher number of inflammatory cells (24). EDTA has been shown to inhibit the substrate adherence capacity of macrophages as well as the binding of vasoactive peptide to macrophage membranes in vitro. These results suggest that leakage of EDTA to periapical tissues during root-canal preparation may inhibit macrophage function, and thus alter the inflammatory response in periapical lesions. EDTAC caused much greater tissue irritation than EDTA (17). Extrusion of even a low concentration of EDTA solution through the apical foramen resulted not only in an irreversible decalcification of periapical bone but can also have consequences for neuroimmunological regulatory mechanisms (25).

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