Influence of Rotary Instrumentation with Continuous Irrigation on Pain and Neuropeptide Release Levels: A Randomized Clinical Trial

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Abstract

Introduction: The first objective was to determine correlation among various experimental and clinical pain measurement procedures. The second objective was to evaluate the influence of rotary instrumentation with continuous irrigation on pain and neuropeptide release levels. **Methods:** Forty patients who had preoperative pain at the levels of 3–8 on the visual analogue scale were included. Gingival crevicular fluid (GCF) samples were collected. Patients were randomly assigned to 2 treatment groups, the standard preparation group and the preparation with continuous irrigation group. Apical fluid samples (AFS) were collected after instrumentation. In the second visit, the patients' pain levels were recorded, and GCF and AFS were obtained. Substance P, calcitonin-gene related peptide (CGRP), interleukin (IL)-1β, and IL-10 levels were analyzed from the GCF and AFS samples. For comparison between groups, the Mann-Whitney test was used ($P < .05$). **Results:** In terms of clinical data, no significant difference was detected in the first and second sessions between groups. The IL-10 level obtained from AFS significantly decreased in the second session in both groups ($P < .001$). Visual analogue scale scores of spontaneous pain correlated with percussion pain positively ($r = 0.718$, $P < .001$). CGRP (GCF) (second session) and IL-10 (GCF) (second session) positively correlated with percussion pain ($r = 0.425$, $P < .01$) ($r = 0.379$, $P < .05$). **Conclusions:** Rotary preparation with continuous irrigation has not been more effective than the standard preparation method for reducing pain. Because of determination of the correlation between CGRP and IL-10 with percussion pain, these neuropeptides can be used in further studies. *(J Endod 2016;42:1613–1619)*

Key Words

Endodontics, instrumentation with continuous irrigation, neuropeptide, pain, rotary instruments

Significance

This study determines the correlation among various experimental and clinical pain measurement procedures and compares conventional rotary preparation and root canal preparation with continuous irrigation. Rotary preparation with continuous irrigation has not been more effective than the standard preparation method for reducing pain. CGRP and IL-10 levels taken from gingival crevicular fluid positively correlated with percussion pain.

People are greatly afraid of endodontic origin pain (1). A patient undergoing endodontic treatment suffers from varying levels of pain as spontaneous pain or pain on percussion at imponderable point of treatment period (2). There have been assays to visualize the clinical effect of endodontic treatment procedures on pain relief in relation to levels of bacterial endotoxins and proinflammatory cytokines (3, 4). A variety of techniques have been used for debridement and decontamination of the root canal system to decrease the pain and inflammation associated with endodontic treatment procedures (2, 5). Dentin chips, pulp tissue, microorganisms, and/or irrigants may be extruded into the periradicular tissues during root canal preparation procedures. Perfect control of the working length may decrease this risk, but nevertheless, any extrusion of debris may potentially induce postoperative complications such as flare-ups (6, 7).

Cytokines have gained significance in endodontic treatments, and many studies are performed in this area. Substance P and calcitonin-gene related peptide (CGRP) play an important role during the inflammatory process. Substance P was the first neuropeptide to be identified in dental tissues. It is released by neurons on various types of harmful stimuli as thermal, mechanical, and chemical (8). CGRP-immunoreactive cells compose 40%–50% of dorsal root ganglia neurons (9). Multiple studies have adduced that trigeminal afferent neurons expressing CGRP innervate dental pulp (10, 11). In a clinical study, it was reported that during inflammation there was significantly more CGRP receptor expression in human pulp (12). Substance P starts to release within 15–30 minutes after injury (13). One of the proinflammatory cytokines, interleukin (IL)-1, has many biological activities and regulates many genes expressed during inflammation (14). Biological effects of IL-1 have been revealed in almost all tissues and organs within a few hours after infection or injury (15). IL-1 agonist has 2 major isoforms with each other, IL-1α and IL-1β. IL-1β synthesis is 10–50 times more than IL-1α synthesis, and IL-1β has more potent proinflammatory properties (16). IL-10 is a cytokine that potently inhibits the synthesis of many cytokines, including IL-1 and tumor necrosis factor-alpha (17). The biological effects of IL-10 can be listed as follows:

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suppression of the proliferation and cytokine secretion of T cells, suppression of macrophage function and IL-12 production, suppression of proinflammatory cytokine production such as IL-1, IL-6, and IL-8, suppression of nitric oxide and prostaglandin synthesis and interferon-γ production, increase of differentiation and proliferation of B cells, increase of IL-1ra production, and reducing the proliferation of preosteoclasts to inhibit bone loss (18, 19).

Periapical tissue exudates taken from root canals contain local produced inflammatory mediators, and it should reflect the immune responses occurring in the periapical lesions. Periapical exudate samples could be obtained from root canals during regular nonsurgical treatment of teeth affected with apical periodontitis (20). Peripheral body fluids such as gingival crevicular fluid (GCF) are often used as identity markers of acute and chronic inflammation; the composition of these fluids might change as a result of their proximity to an inflammatory focus. GCF is a serum transudate that can be collected from the gingival crevice. Collection of GCF is simple and presents minimal risk to the patient (21).

Visual Analogue Scale (VAS) used for pain research is subjective and differs from one subject to another. For this reason, analysis of neuropeptides could be useful. Determination of neuropeptide level from periapical exudates could be negatively affected in case the samples taken from periapical exudates are lower than required levels, and thus use of GCF samples could be useful to confirm neuropeptide levels. One of the objectives of the study was to determine the correlation between various experimental and clinical pain measurement procedures.

Root canal instrumentation with nickel-titanium rotary instruments has the potential to induce stress in the root dentin (22). Dentinal stress that formed during root canal instrumentation could cause postoperative pain. During instrumentation, dentinal chips covered on the flutes of the instruments could increase friction between root canals and instruments. Furthermore, it may have a potential to increase dentinal debris extrusion because of clogged dentinal chip space of the instruments. Thus, as a general rule during rotary instrumentation, frequent cleaning of the dentinal chips on rotary instruments is recommended. To overcome a number of problems encountered in rotary nickel-titanium files, Self-Adjusting File (SAF) (Re-Dent-Nova, Ra'nana, İsrael) was developed. The hollow design of the system allows continuous irrigation during instrumentation. However, continuous irrigation using NaOCl is not possible with conventional rotary instruments because of risk of erroneous activation by the dentist without noticing, causing an unwanted spillage of NaOCl. The solution could be simultaneous use of other nontoxic irrigation solutions such as saline or distilled water to increase removal of dentinal chips from the flutes of the rotary instruments. The second objective of this study was to evaluate the influence of rotary instrumentation with continuous irrigation procedure on pain and neuropeptide release levels.

Materials and Methods

Subject Selection

After approval of Ethics Committee of İzmir Katip Çelebi University, 40 patients participated in the present study. Patients had been informed and were asked to sign an approval form for the clinical procedures. Patients referred to the Department of Endodontics of İzmir Katip Çelebi University School of Dentistry for treatment of mandibular premolar teeth with symptomatic pulpitis and symptomatic apical periodontitis were evaluated as possible candidates for this study. Subjects with no systemic diseases, without any medications within past 2 weeks, and older than age of 18 years were included in the study groups. A subject was excluded if the tooth had been non-vital and had periodontal probing depth of more than 3 mm and root fracture or crack. All the teeth included in the present study were vital; pulpal diagnosis was symptomatic irreversible pulpitis, and periapical diagnosis was symptomatic apical periodontitis with no visible periapical radiolucent area. In addition, subjects who had 3–8 preoperative pain level according to VAS were included to ensure standardization.

The power analysis was conducted on the basis of data from a previous similar study (2). A sample size of 20 patients in each group was calculated to be sufficient to detect significant clinical and biochemical data differences (alpha at level 0.05, 81% power, and effect size of 0.92). Subjects were randomly assigned to treatment groups as follows: standard preparation (SPG) and preparation with continuous irrigation (PCIG) (Fig. 1).

Experimental Procedures and Sample Collection

Each subject's pain level (spontaneous pain and pain on percussion test) was recorded by using the VAS score before the beginning of treatment procedure. The participant verbally expressed the level of discomfort by choosing a number in comparison with level 10 pain and quantified the pain by using the following values: level 0–3, mild pain; level 4–6, moderate pain; and level 7–10, severe pain.

GCF was collected from the experimental tooth at the beginning and 3 days after treatment. One investigator (S.G.) collected all samples. Before sample collection, the tooth was isolated with cotton rolls and dried gently with air. A saliva ejector was also used to prevent saliva contamination. Paper strips (Periopaper; Oraflow, Plainview, NY) were inserted to the gingival sulcus until mild resistance was felt. The strips were removed from the gingival sulcus after 30 seconds. Two samples were collected for each tooth from gingival sulcus on mesial and distal vestibular surfaces. The samples contaminated with bloody saliva were discarded. The amount of collected GCF was determined by Periotron 8000 (Harco, NY). Then, all the strips were immediately placed in Eppendorf tubes and stored in the refrigerator at −40°C for further analysis.

Before treatment, mandibular anesthesia was achieved with 1.8 mL articaine 4% and 1:100,000 epinephrine (Ultracain DS; Aventis Co, İstanbul, Turkey). Numbness of the tooth was checked with a cold test. The tooth was isolated with a rubber dam, and access cavity was refined. Previous restoration and caries were removed. All application was done by one operator (H.B.), and all files were used for single usage.

SPG. After the access cavity preparation, pulp extirpation was done with a barbed broach. The working length was determined with a size #10 K-file and apex locator (ProPex II; Dentsply Maillefer, Ballaigues, Switzerland), and apex locator was confirmed with radiography. In all cases apex locator showed working length shorter than radiographic apex, with a range of 0.5–1.5 mm. Thus records of apex locator were used in all cases. Apical widths of the teeth were controlled with #20 instrument, and if #20 instrument was extruded from the apex without any force, tooth was excluded from the study. Initially, root canals were irrigated with 2 mL saline. OneShape (MicroMega, Besancon, France) file with a taper of 0.06 and size of 25 was used with in-and-out movements without pressure at a rotational speed of 350 rpm and 300 g/cm torque. When apical resistance was encountered, the instrument was removed and cleaned, and the root canal was irrigated with saline. After saline irrigation, the solution was aspirated in the root canal by an injector. The canal's patency was checked with a #10 instrument. Then, OneShape paper point (#25) (MicroMega) was inserted into the root canal and left in place for 30 seconds to collect the root canal exudate. To ensure