CLINICAL USES OF NEODYMIUM LASER IN DENTISTRY

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1. ABSTRACT

Recent advance in laser technology and researches have set the stage for a revolution in dental practice. This article provides a view of a variety of clinical applications of lasers in Dentistry.

2. INTRODUCTION

First demonstrated in 1961 at AT&T Bell Laboratories by Johnson and Nassau, the neodymium laser is the most common solid-state laser. Today the hosts commonly used are $Y_3Al_5O_{12}$. (yttrium aluminum garnet, YAG) and $YLiF_4$ (yttrium lithium fluoride, YLF).

Neodymium lasers have earned many applications in research, industry and medicine. In treatments in which their short pulses and short wavelength offer advantages over the CO_2 lasers preferred for many types of laser surgery. Pulsed neodymium lasers have become the standard tool for treating a common complication of cataract surgery, in which a membrane inside the eye becomes cloudy after the natural lens is replaced by implant. A tightly focused short pulse from a neodymium laser can cut the membrane restoring normal vision. The 1,06 μm wavelength of neodymium laser also can be carried through standard optical fibers, unlike the longer wavelength of erbium and CO_2 lasers, allowing their use with endoscopes for gallbladder surgery and for treating gastrointestinal bleeding(1).

Neodymium laser systems also have been develop for dental applications. Its wavelength is not well absorbed by water but is partially absorbed by hemoglobin and melanin. A 3 to 5 watts pulsed Nd:YAG laser has a coagulation depth of about 150 μm in oral soft tissue. Current uses of Nd:YAG dental lasers include soft tissue removal, hemostasis and coagulation. Studies are been done in surface modification of hard tissue, laser analgesia and desensitization, incipient caries removal and pulp extirpation(2).

3. MATERIALS AND METHODS

A pulsed Nd:YAG laser, wavelength of 1.064 μm, with a quartz contact fiber of 320 μm diameter was used (American Dental Laser- Sunrise Technologies). In order to obtain a coadjutant effect in some of the cases it was applied a continuous low power laser of Ga-As-Al (gallium aluminum arsenide), wavelength of 830 nm (30mW power), with a contact delivery system (Compact Laser-J.Morita-Japan). Laser parameters used are specified in table 01. A He-Ne laser was used as a guide laser, in both Nd:YAG and Ga-Al-As, as they are on the invisible range of the electromagnetic spectrum.

Nd:YAG laser light has an affinity with pigmented tissues, and for this reason, the tooth surface is coated with a black die, prior to the irradiation. In all of the Nd:YAG irradiations was used an air cooling system to prevent an overheating.

In the present work are described laser applications in hard and soft tissues, such as in endodontic procedures, final caries removal, aphtous ulcers, gingival curettage and gingivoplasty.

Case I

Retreatment of a premolar canal with a perforation on the apex of the root and a lesion in this area (Figure 1A). During the sessions the canal was irradiated by Nd:YAG laser under the conditions of mean power of 1.5 W (15 Hz, 100 mJ/pulse), during 20 seconds. Calcium hydroxide P.A. was used as an intracanal medication. In the same session the low power laser (Ga-As-Al) was applied for 6 minutes. The same conduct was done three times and in the fourth session the canal was filled and irradiated by the low power laser. The clinic and radiographic results show, after two months and six months, a gradual reduction of the lesion, which became more evident after twelve months (Figure 1B). No symptomatology was presented by the patient. The procedures can be visualized in the Figure 1C.

Case II

The carious tissue was 80-90 percent removed by traditional methods. The cavity was coated with an initiator, India ink (Figure 2A) and irradiated by the high power laser (Nd:YAG) with

1.5 W (15 Hz, 100 mJ/pulse), during 120 seconds. The dentin tissue without caries and superficial sealing of the dentin tubules, promoting a better post-operative answer can be seen in Figure 2B.

Case III

The patient had an aphtous in the inferior lip (Figure 3A). The pain used to disappear, with no intervention, only after one week, and the reparative cycle was 24 days. The Nd:YAG laser was used with 2.0 W (20 Hz, 100 mJ/pulse), during 180 seconds, removing all the superficial tissue and acting on the edges of the aphtous. The pain disappeared almost immediately.

During the second session and in the following 4 days a low power laser was used for 4 minutes in each session. Figure 3B shows the case 10 days after the first laser irradiation. The reparative cycle was reduced for 10 days.

Case IV

The patient had an iatrogenic ceramic metal prosthesis causing malefaction for periodontal tissue. The prosthesis was removed, temporary pressed crowns were done and a periodontal treatment was also performed. The periodontal inflammation persisted as it can be seen in the Figure 4A.

Nd:YAG laser was irradiated twice within 10 days, with 1.5 W (15 Hz, 100 mJ/pulse), during 90 seconds, in order to obtain subgingival curettage. The Figure 4B shows the area after 25 days from the first irradiation. A normal gingival tissue, without bleeding, can be seen. The granulation tissue removal promoted a gingival retraction with cavity preparation and bifurcation area exposure.

Case V

In this case a gingivoplasty was necessary to expose subgingival carious tissue (Figure 5A). The Nd:YAG laser was used under the condition of 1.5 W (20 Hz, 87mJ/pulse), during 180 seconds. It was possible to remove the gingival tissue with an adequate profile, without bleeding and to carry out the caries removal. The curative or the final restoration can be done in the same section. The control after 1 month can be seen in Figure 5B.

4. DISCUSSION AND CONCLUSIONS

The flare-ups that occur during the endodontic treatments are characterized by an inadequate cleaning and shaping of the root canal, the same way as a deficient filling or the presence of a perforation, which can induce the development of an apical lesion. In most cases there is a microbial involvement. Retreatment of the root canal is a conduct of choice in order to get a better cleaning and sterilization. Some cases require a more aggressive intervention as an apical curettage or apicoectomy.

Studies in the literature show that lasers are excellent coadjutants in many interventions.

In accordance with Matsumoto et all.(3) (1993), on the last two or three years, the lasers have been developed for clinical endodontic use. The capability of intracanal microbial reduction achieved by Nd:YAG laser should be emphasized.

Goodis et all.(4,5) (1992), confirm the removal of the smear layer and organic tissue remaining in the root canal. There was a reduction of microorganisms, comparing with root canals treated conventionally, without laser.

As stated by Gutknecht(6) (1991), the laser promotes the melting of organic substances present in the dentin surface. A slow rotationally movement from the apex to the crown must be done during the application trying to achieve a greater number of dentinary tubules in the canal.

The ideal method for caries removal would selectively remove deseased tissue, eliminate the objectionable sound, vibration, and would not cause pain or damage underlying healthy tissue.

The study realized by White et al.(7,8), found that applying the pulsed Nd:YAG laser system to enamel and dentin for caries removal; do not have detrimental thermal pulpal effects. The same authors concluded that pulsed infrared lasers are capable of inducing physical and chemical changes in tooth structure increasing the mineral and decreasing the organic composition(9,10). These structural modifications result in an increase of dentin microhardness(11).

In soft tissues the lasers have been used for vaporize excess tissues, as in gingivoplasty, gingivectomy and maxillary or lingual frenectomy; reduce hyperplastic tissue ; remõve or biopsy tumors and lesions such as fibromas, papillomas and epulides; remove and control hemorrhaging of vascular lesions such as hemangiomes[11].

Concerning about the Nd:YAG laser, the remotion of the superficial tissue of the aphtous ulcers can be done, reducing the pain and also giving a better tissue healing. Clinical applications of the Nd:YAG laser in dental treatment demonstrate that severe gingivitis was improved and tissue inflammation decreased after laser treatment. Therapeutic benefits of laser dental surgeries include antiinflamatory and sterilization effects. The Nd:YAG laser is also useful for tissue coagulation and for controlling bleeding in oral surgery[12].

Having the necessity of a gingivoplasty as it can be seen in case V, the laser can give double benefits: periodontal, with the tissue ablation, and restorative, having access to remove all the necessary carious tissue.

The low power laser provides cold low energy (non thermal effect) at wavelengths believed to stimulate circulation and cellular activity[13]. These lasers have been used to promote healing and reduce inflammation edema and pain[11].

The association of high and low power laser seems to be a complement of the conventional therapies as demonstrated by Bradley[14] (1994), and confirmed in some clinical cases in the present work.

The process from initial hypothesis to clinical applications must follow the scientific method. This process includes in vitro, animal and human clinical studies, in that order. These investigations must fulfill regulatory governmental agencies requirements before a specific application. The knowledge of laser/tissue interactions, including the specific laser wavelength and laser power; optical and thermal properties of each tissue is also very important.

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6. ACKNOWLEDGES

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LEGENDS

Figure 1-(A) Initial radiography. Perforation on the apical third of the second inferior premolar tooth. Lesion with internal root reabsortion; (B) Controll after 12 months from the canal filling.

Figure 1-(C) Procedures realized during the treatment: filling removal; instrumentation and irrigation with sodium hypoclorite 1%: intracanal laser irradiation.

Figure 2-(A) Teeth coated with an initiator; (B) Nankin and carious tissue removal with Nd:YAG laser.

Figure 3-(A) Apthous ulcers in the inferior lip.

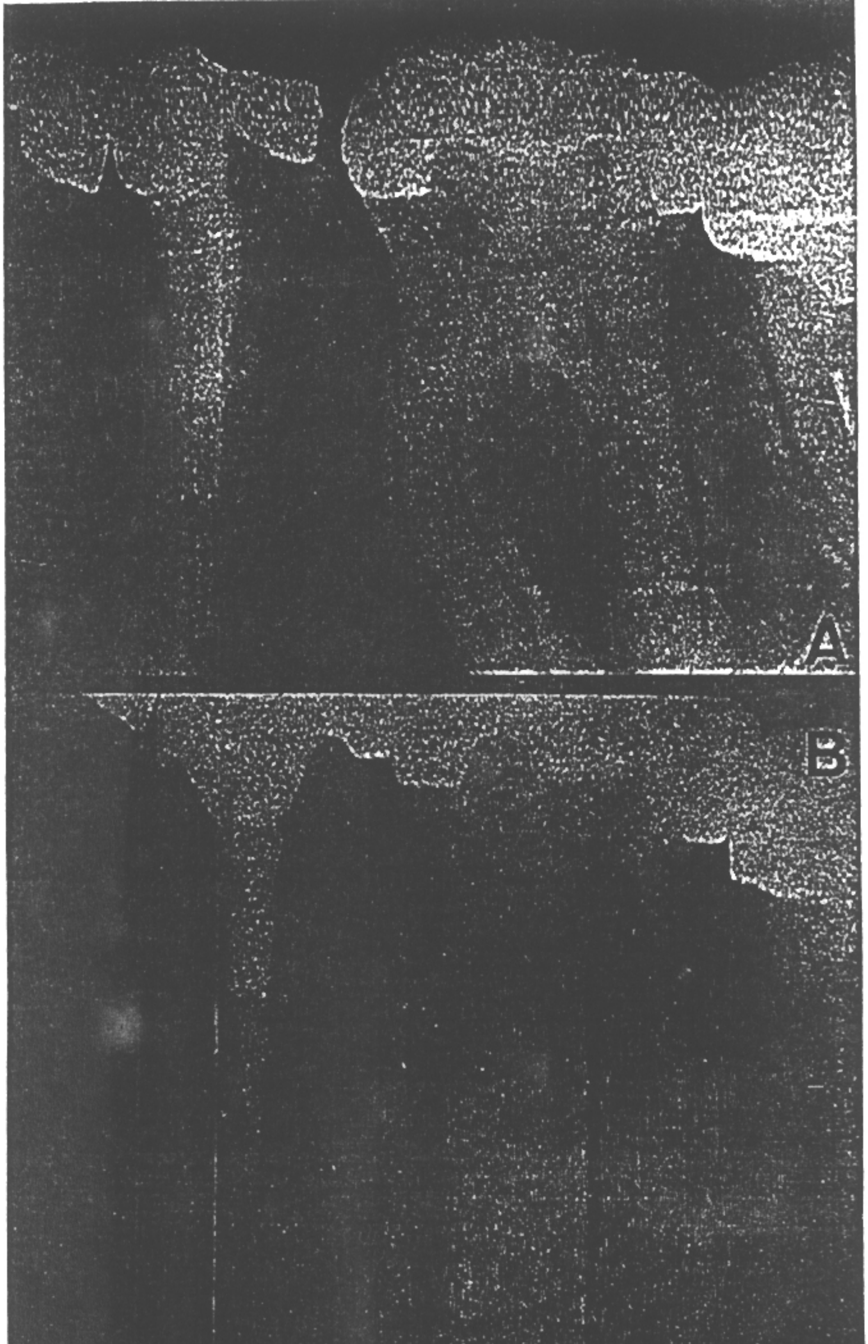
Figure 3-(B) Controll after ten days.

Figure 4-(A) Notice the presence of an inflamed gingival tissue.(B) Controll after 25 dyas after the irradiation. Normal gingival tissue, without bleeding.

Figure 5-(A) Subgingival carious tissue. Necessity of a gingivoplasty to expose the area; (B) Control 1 month after the Nd:YAG laser irradiation.

TABLE 01- Laser parameters used during treatments.

	Nd:YAG						Ga:Al:As
	Mean Power (W)	Energy/pulse (mJ)	Frequency (Hz)	Pulse width (μs)	Exposure (s)	Energy Density (J/cm^2)	coadjutant? (30 mW)
Case I	1,5	100	15	150	20	124,3	YES
Case II	1,5	100	15	150	120	124,3	
Case III	2	100	20	150	180	124,3	YES
Case IV	1,5	100	15	150	90	124,3	
Case V	1,5	87	20	150	180	108,2	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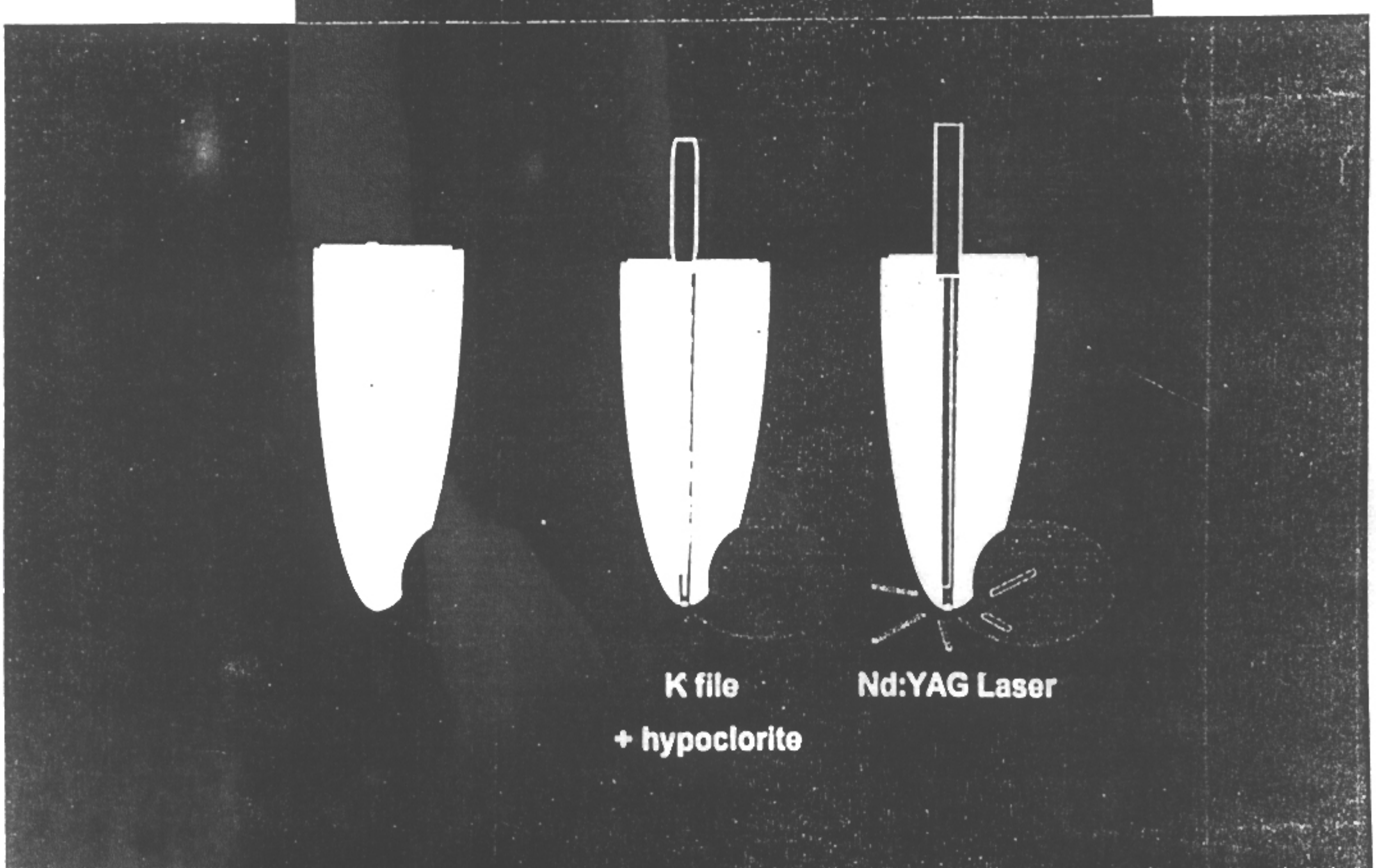
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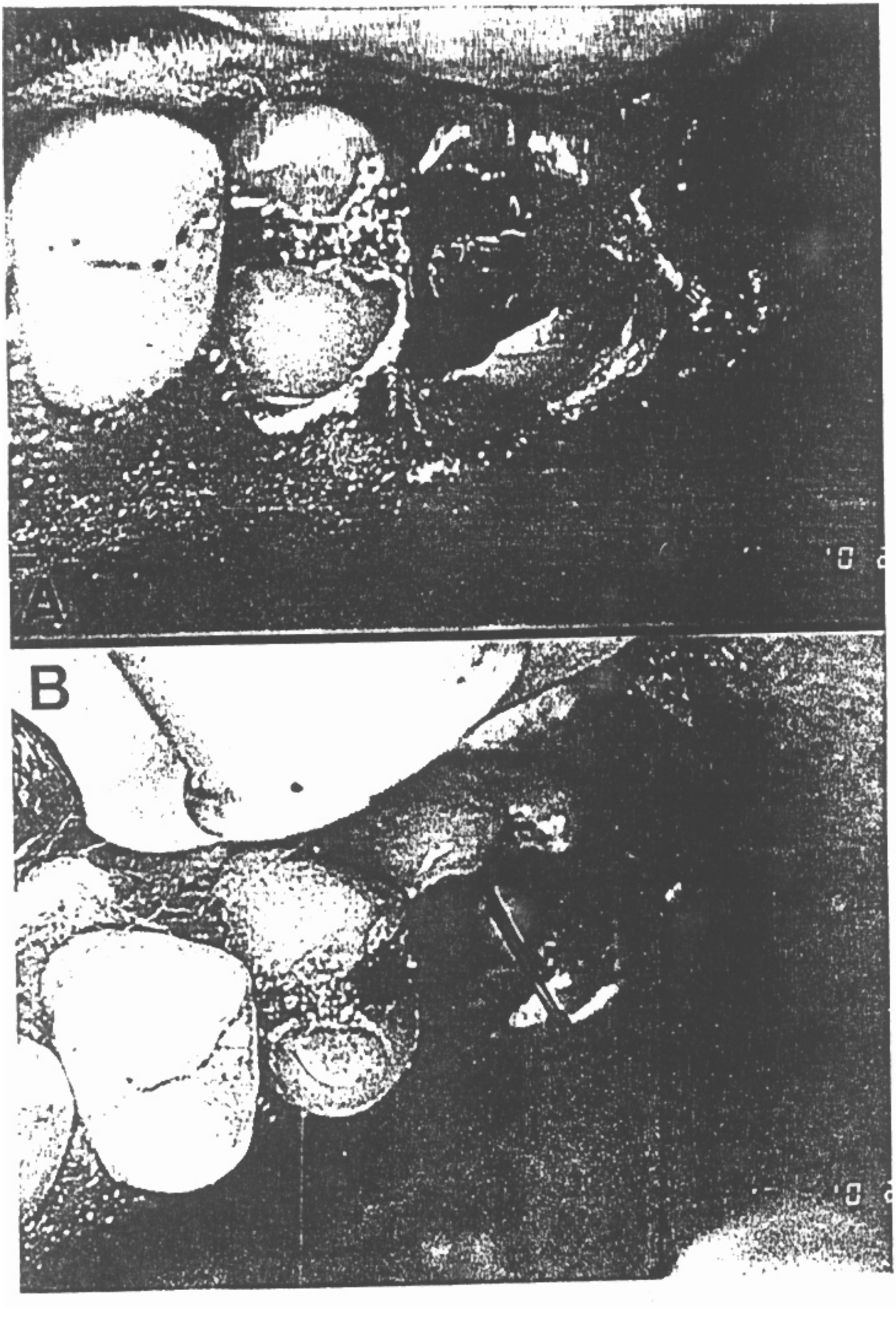
Nd:YAG Laser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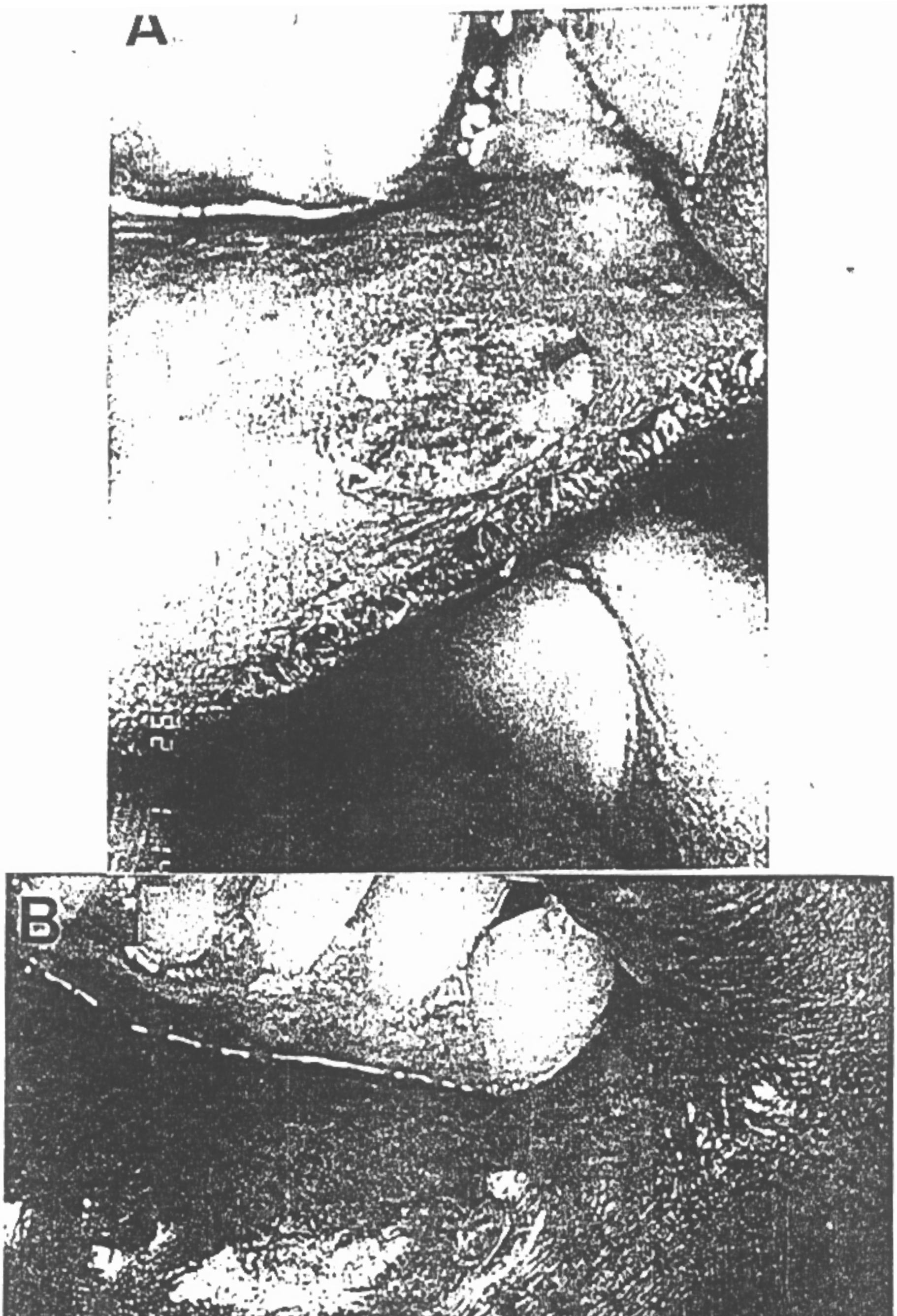
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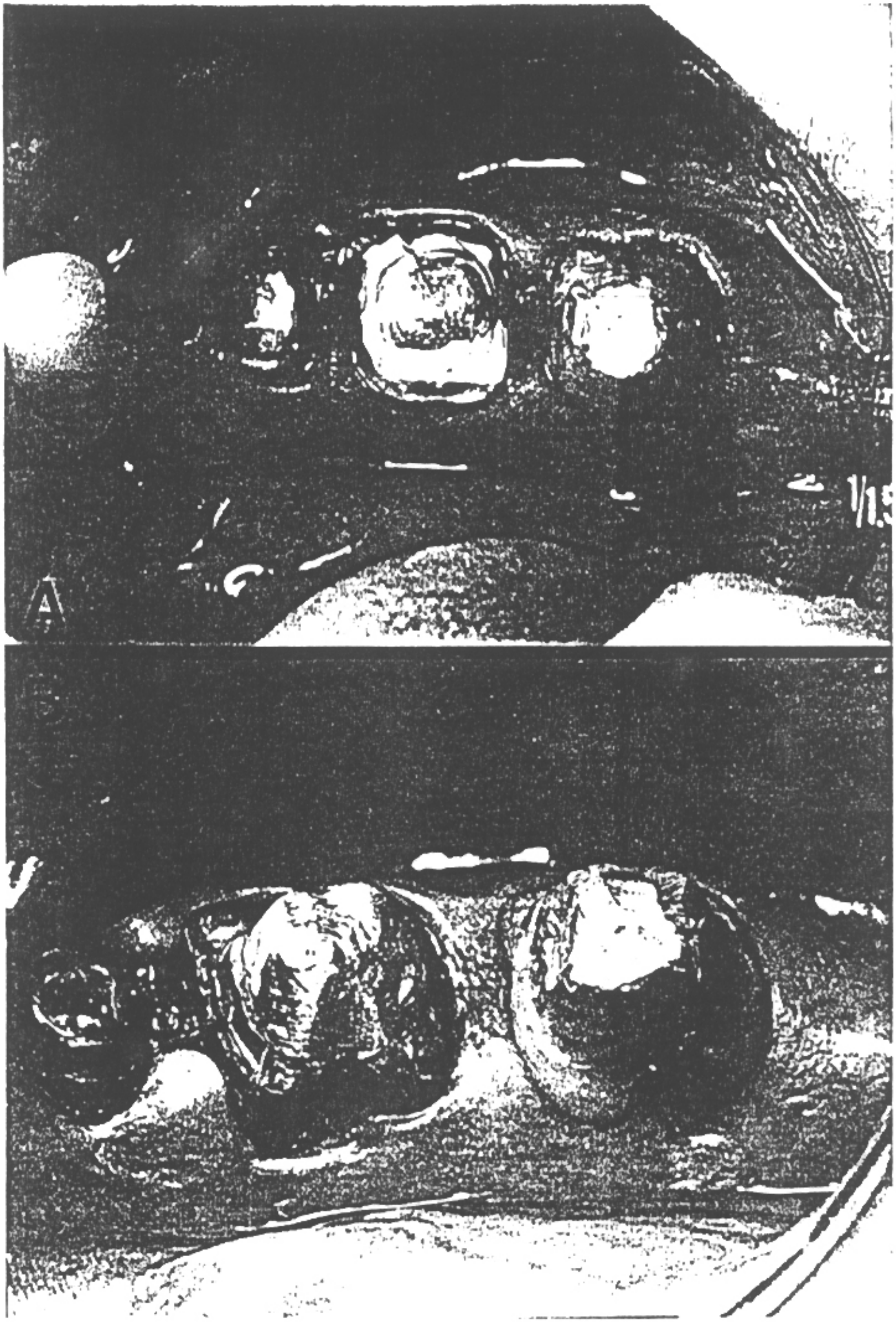
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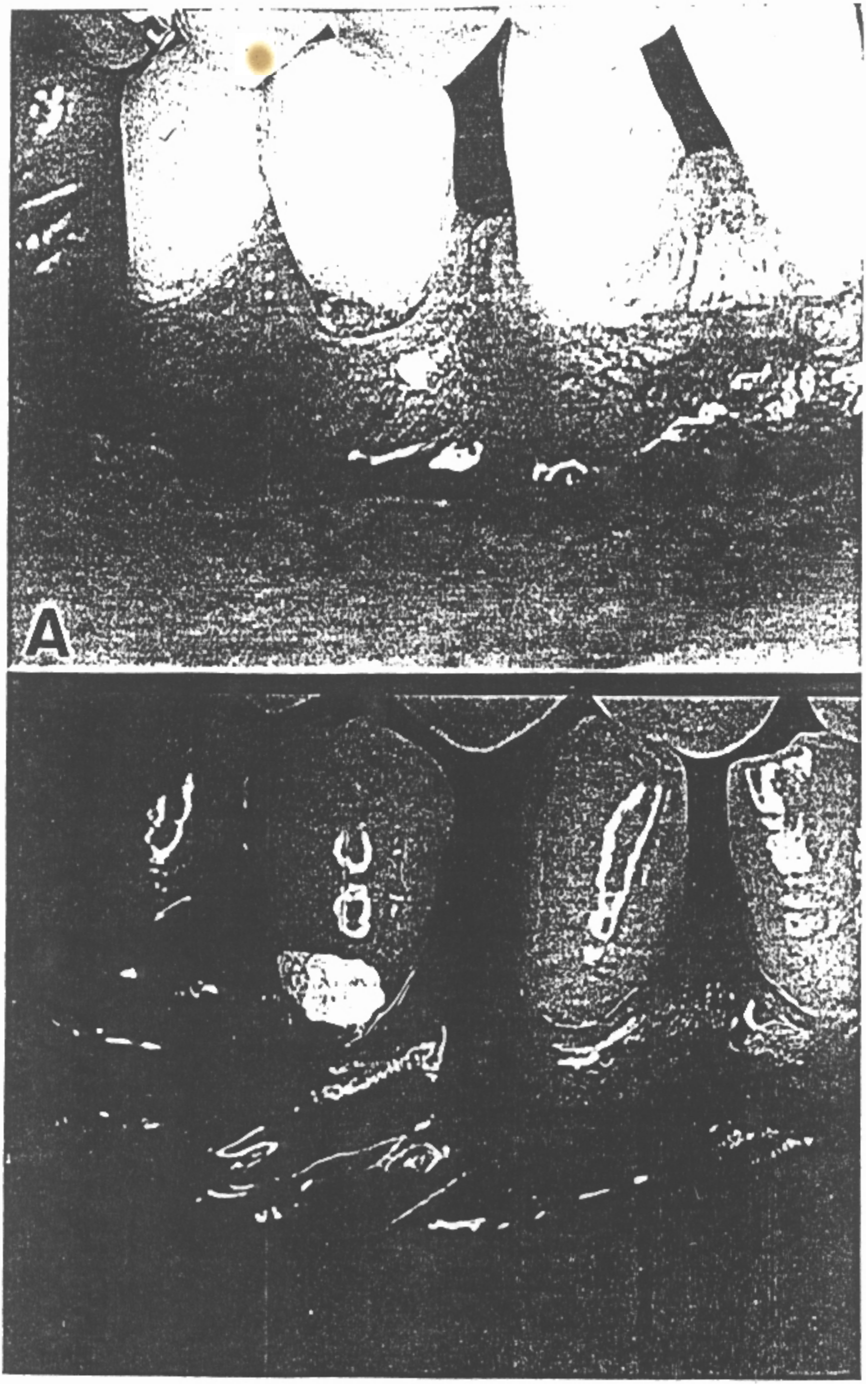
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