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Occlusal Pressure Analysis of Complete Dentures after Microwave Disinfection: A Clinical Study

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Abstract

Purpose: This clinical study evaluated the effect of microwave disinfection protocols on the occlusal pressure pattern of dentures.

Materials and Methods: Dentures were constructed for 40 patients and evaluated as follows (n = 20). Group 1: Patients had the maxillary dentures submitted to microwave disinfection, once a week, for 4 weeks. Group 2: Patients had the maxillary dentures submitted to microwave disinfection, three times a week, for 4 weeks. Occlusal contacts were recorded on five occasions: 30 days after denture insertion and before first disinfection (baseline or control group); 1 week after disinfection; 2 weeks after disinfection; 3 weeks after disinfection; 4 weeks after disinfection. Occlusal contacts were analyzed by T-Scan III. Intergroup analysis was performed using the Mann-Whitney test and intragroup analysis using the Friedman test with significance of 5%.

Results: The results showed no significant difference between groups during the periods. The data on parameters loss of denture adaptation or complaints showed that patients used their dentures regularly for eating and expressed comfort and satisfaction in all experimental periods. The evaluation of functional occlusion revealed that the distribution of the occlusal contacts remained unaltered after disinfection.

Conclusion: Microwave disinfection protocols as studied in this report did not influence occlusal contacts of the complete dentures.

Dentures in the oral cavity can produce a number of ecological changes that facilitate accumulation of bacteria and yeast. The adherence of Candida species to host cells and the colonization of denture intaglio surfaces are recognized as crucial first steps in the initiation and propagation of denture stomatitis. Improvement of candidiasis-like inflammation on palatal mucosa could be achieved with antiseptics (such as chlorhexidine digluconate and sodium hypochlorite) or antimycotic drugs and an effective oral hygiene regimen to control denture biofilm; however, *C. albicans* cells may develop resistance to antifungal agents[1,2] and may cause reinfection of the soft tissues. Moreover, it has been reported that mature biofilms are more resistant to antimicrobial agents, and such films may also be more difficult to remove mechanically.[3] Thus, the recurrence of infection shortly after treatment has frequently been observed and has been attributed to reemergence of the original infecting fungal strain.[4,5] Microwave energy has been recommended as an alternative to traditional methods to disinfect complete dentures and to prevent or to treat denture stomatitis.[4,6] Although the lethal action of microwaves on various microorganisms has been well established, the use of this procedure may cause denture base distortion.[7] During microwave disinfection, acrylic resin reaches the boiling temperature of water (96°C) at approximately 130 seconds.[8] This could facilitate warping of denture bases caused by the release of the stresses stored within the resin during processing.[9,10] Dimensional changes associated with microwave disinfection have been documented,[11-15] and they can be related in part to the levels of residual monomer.[16]

Mima et al[17] conducted a study to indicate the minimal lethal microwave exposure for pathogenic microorganisms. They found that a protocol of 3 minutes at 650 W was effective in the sterilization of dentures. Two studies in vitro demonstrated that acrylic resin specimens inoculated with *C. albicans*[17] and contaminated dentures with different species of Candida isolated from HIV-infected patients[18] were sterilized after 3 minutes of irradiation at 650 W. In a clinical study, Ribeiro et al[19] showed that maxillary dentures microwaved for 3 minutes (650 W) resulted in sterilization of all dentures. Despite the reduction in exposure time, dentures may be submitted to several disinfection procedures for treatment of denture

stomatitis.[6] A preliminary clinical study evaluated the effect of microwave disinfection protocols for treating denture stomatitis, using 650 W for 3 minutes (once a week, for 4 weeks or three times a week, for 4 weeks), on the linear dimensional stability of complete dentures. Dimensional changes found were lower than 1%, demonstrating that this microwave disinfection protocol may be used without causing damage to dentures and supporting tissues.[20] Despite these findings, the complex anatomy of denture bases may result in an asymmetric distortion in different parts of the dentures[21] that may not be apparent but may produce some excessive pressure points of contact between opposing artificial denture teeth. Occlusal force could be increased when occlusal interference (contact that displaces a tooth, diverts the mandible from its intended movement, or displaces a removable denture from its basal seat)[22] is present.[23] This may be considered important because the quantity and the intensity of occlusal contacts determine the amount and the direction of the forces transmitted through denture bases to residual ridges. Moreover, occlusal interferences may affect denture stability and retention, which could affect masticatory function, comfort, and maintenance of residual ridge.[24] Articulating paper, foils, wax, and silicone have been used to detect occlusion contact.[25,26] However, these methods are not considered to be accurate because the different-sized marks can represent the same load, and therefore, computerized occlusal analysis has been used.[27-29]

The purpose of this study was to evaluate clinically the occlusal pressure, using T-Scan® III (Tekscan, South Boston, MA), of complete dentures after two microwave disinfection protocols for treating denture stomatitis, using 3 minutes at 650 W. The hypothesis was that the occusal pressure of dentures would be adversely altered by microwave disinfection.

Materials and methods

The study population consisted of 40 edentulous patients who were rehabilitated with complete dentures, with absence of debilitating systemic diseases. The patients' ages ranged between 44 and 82 years with a mean of 65 years. Patients were selected as Class I according to the American College of Prosthodontists Prosthodontic Diagnostic Index (ACP PDI) for completely edentulous patients.[30] The treatment protocol was approved by the Ethics Committee of the Araraquara Dental School, Sao Paulo State University (53/05). Each patient provided written consent to participate in this study. All participants were rehabilitated with maxillary and mandibular complete dentures. Acrylic resin denture teeth Biolux (Dental Vipi Ltda. Indústria e Comércio de Material Odontológico, Pirassununga, Brazil) were used in this study. The palatal thickness of the maxillary waxed dentures was maintained at 3 mm using a dial caliper gauge (Order No. 209-601; Mitutoyo Sul Americana Ltda, Suzano, Brazil) to measure the thickness across the palate. For both groups, the manufacturer's instructions for Lucitone 550 (Dentsply Indústria e Comércio Ltda, Petrópolis, Brazil) were followed with regard to standard packing, liquid: powder ratio (3:1), and polymerization cycle 165°F (72ºC) for 90 minutes and 212ºF (100ºC) for 30 minutes. All complete dentures were constructed with anatomic teeth set in bilateral balanced occlusion. The occlusal contacts were verified with articulating paper (Accu Film II - Red/Black. Double-sided .0008″ (21 microns); Parkell Inc, Edgewood, NY) in centric occlusion, right and left lateral mandibular movement, and protrusion. The finished dentures were tried in the patient's mouth and checked for harmonious occlusal contacts. The assessment of areas of compression and final occlusal adjustment were performed as needed. The sore spots were detected using a thin coat of pressure-indicating paste.

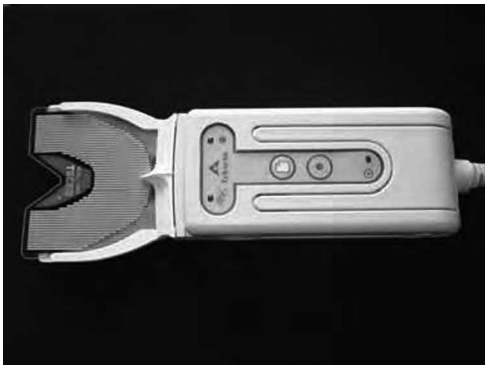

Figure 1 T-Scan III® equipment.

Thirty days after the dentures were inserted (functional adaptation), the maxillary complete dentures of the 40 patients were randomly divided into two groups. In group 1 (G1), 20 maxillary dentures were submitted to microwave disinfection (650 W/3 min), once a week, for 4 weeks. In group 2 (G2), 20 maxillary dentures were submitted to microwave disinfection (650 W/3 min), three times a week, for 4 weeks. In both groups, only maxillary complete dentures were submitted to microwave disinfection to simulate the treatment of denture-related stomatitis. The dentures were subjected to disinfection in a domestic microwave oven (Brastemp da Amazônia S. A.; Multibrás S.A. Eletrodomésticos, Manaus, Brazil) calibrated to 650 W, for 3 minutes, with the specimens immersed in 200 ml of water during the irradiation time, according to the protocol of each group.

T-Scan III equipment was used to record the occlusal contacts (Fig 1). T-Scan III allows simultaneous registration and imaging of the distribution of forces in relation to the maximum force exerted and the occlusal contact time sequences[31] (Fig 2). The single examiner was calibrated before the study started and recalibrated during data collection. Calibration was performed in a pilot study, and the outcome assessed blindly. In addition, the examiner was trained to use the equipment. Patients were seated upright, and the operator inserted the recording handle with a sensor sheet. Then the T-Scan III software was activated, and force levels were recorded for 10 seconds starting with zero loads and ending with the maximum load. Patients were instructed to keep their teeth in contact during the measurement. Between recordings, the device was removed from the mouth and repositioned. Using the T-Scan III, it was possible to verify the change of percentage values, after application of disinfection protocols in relation to the initial registration (baseline). The T-Scan III provided the percentage of occlusal force applied on the right and left sides of the arch producing a quantitative analysis of the distribution of occlusal contacts.

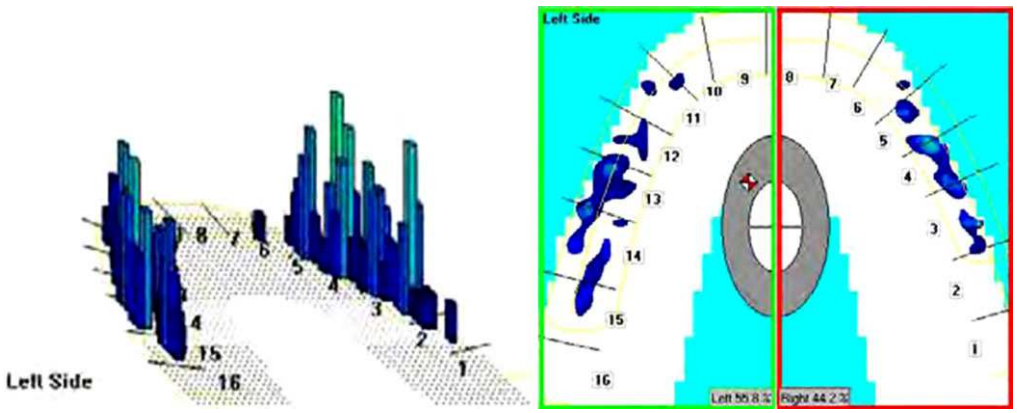

Figure 2 Data from T-Scan III® equipment.

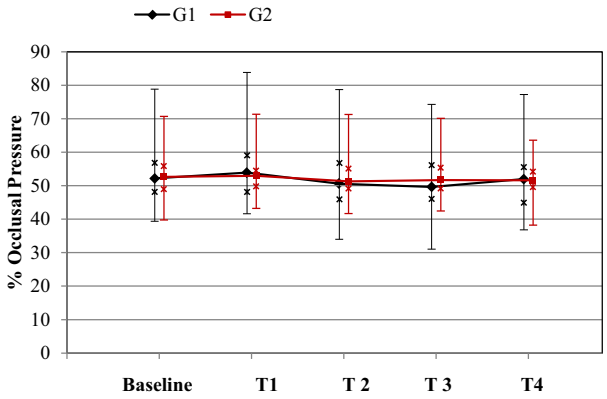

Figure 3 Graphical representation of descriptive statistics of average percentage of occlusal pressure.

Using this feature, the change in this percentage after microwave disinfection compared to the initial registration (baseline) was observed. To verify the possible changes, the percentage of the right side of the arch was selected considering that a possible reduction in percentage would reflect an increase on the contralateral side, because they were complementary (the total of the sides results in 100%). The recordings were made six times, and the average was recorded. All records were made by a single calibrated operator. Occlusal contacts were recorded on five occasions: 30 days after insertion of dentures and before the first microwave disinfection (baseline); 1 week after microwave disinfection (T1); 2 weeks after microwave disinfection (T2); 3 weeks after microwave disinfection (T3); 4 weeks after microwave disinfection (T4). The occlusal contacts were verified with articulating paper (AccuFilm II, double side .0008″) in centric occlusion, right and left lateral mandibular movement, and protrusion.

In addition, all dentures were assessed by the following parameters: pressure spots, loss of denture adaptation, or patient complaints. Intergroup analysis was performed using the Mann-Whitney test, and intragroup analysis using the Friedman test with significance of 5%. The sample size was calculated as 20 in each group (total = 40 patients) using G* power 3.1.2 software (Effect size f = 0.25), (α err prob = 0.05), (Power [1-β err prob] = 0.95).

Results

In the baseline (control group), there were no significant intragroup differences (T1, T2, T3, T4). There also were no significant differences between the two groups (G1 and G2) in all evaluated weeks ($p > 0.05$) (Fig 3).

The data on the parameters *loss of denture adaptation* or *complaints* showed that patients used their dentures regularly for eating and expressed comfort and satisfaction in all experimental periods. All patients demonstrated soft tissue or dental arches (not dentures) with no sore spots. The evaluation of functional occlusion revealed that the distribution of the occlusal contacts remained unaltered after disinfection.

Discussion

The lethal action of microwave irradiation on various microorganisms has been documented.[17-19] However, its effect on the physical and mechanical properties of denture materials must be carefully considered. Dimensional stability is an important physical property for denture bases to ensure they are able to maintain their shape during service. The majority of studies estimating dimensional change of denture base materials have been carried out in vitro and focused on linear dimensional changes.[11-14] In this context, a clinical study assessed a microwave disinfection protocol on the linear dimensional stability of complete dentures.[20] Measurements were taken before the first microwave disinfection (baseline) and after each week of disinfection (experimental groups). The experimental groups showed significantly greater shrinkage from the baseline in all evaluated weeks. During clinical monitoring, no significant findings were observed. Even though dimensional changes occurred, the clinical evaluation did not yield any changes in either group.[20] However, asymmetric distortions may not be detectable by evaluating only the linear dimensional change.[21] Occlusal discrepancies with dentures are multifactorial in origin, including warpage of denture base,[10] and they can result in

pressure concentrations that may cause pain and inflammation in the supporting tissues.

The present study evaluated the effects of two protocols of microwave disinfection (3 minutes at 650 W) on the occlusal contact patterns of complete dentures. During microwave disinfection, depending on the protocol used, the acrylic resin may undergo an increase in temperature beyond its glass transition temperature, which may facilitate denture warping.[8,14,16] The water in which the dentures were immersed reached boiling temperature after approximately 1 minute and 30 seconds and remained at this temperature to the end of the microwave cycle. It is possible that the higher temperature of the water may increase the diffusion of remaining residual monomer molecules and active sites of the polymer chain, resulting in further polymerization and making the resin vulnerable to warpage. Another important point is that during processing, heat-polymerized acrylic resins are heated beyond their glass transition temperature.[9] When the resins cool to room temperature, stresses are induced by differential shrinkage rates within the resin and the dental stone cast.[15] Thus, it can be suggested that when the dentures were heated during subsequent microwave disinfection processes, further dimensional change could have occurred because of the release of the inherent stress established during denture processing.[9] The complex shape of maxillary complete dentures may lead to distortion in different parts of the denture, resulting in deflective occlusal contacts. Different microwave irradiation power/time setting protocols have been used for disinfecting dentures, and several studies have, with contradictory results, investigated their effect on dimensional stability. Burns et al[11] showed that cylindrical specimens made of three conventional denture base acrylic resins maintained excellent stability (0.02% to 0.3%) after microwave disinfection for 15 minutes. Conversely, Pavan et al[13] reported that microwave disinfection at 604 W for 10 minutes produced discrepancies in the adaptation of maxillary acrylic resin denture bases to stone casts. Seo et al,[14] however, demonstrated that microwave disinfection at 650 W for 6 minutes increased the shrinkage of intact denture bases and of those that had been relined. It is possible that distortions induced by the shrinkage from microwave disinfection may result in movement of the denture teeth toward the midline and thus induce malocclusion. No information was found with regard to the effect of microwave disinfection for 3 minutes at 650 W on changes in the vertical direction.

In this study, the T-Scan III was used to assess possible changes in the occlusion contact areas of dentures after disinfection. In clinical research on occlusion, various methods have been used to assess the nature of occlusal contacts in the intercuspal position, such as articulating paper, foils, wax, silicone, etc.[25] Although simple and fast, it has been difficult to determine the presence and location of occlusal interferences with these methods. For example, Kerstein[27] reported that the reliability between size of occlusal marking and force is only 21%. Thick products increase the surface area of marks, and they can also stimulate proprioceptive reactions that can cause deviations in the mandible.[26] In addition, in complete dentures, the premature contacts could shift the denture position during occlusion, leading to pseudo-appropriate occlusal contacts in a false maximum intercuspation, mainly when the ridges are irregular.[28] Therefore, to verify the presence of the premature occlusal contacts objectively in complete dentures, it was necessary to evaluate the occlusal contact sequence. The accuracy and reproducibility of T-Scan has been criticized.[12] However, Koos et al[29] reported that the occlusal analysis performed with T-Scan III can be regarded as precise and reliable. According to Koos et al,[29] in 95% of all applications the 1.96-fold measurement error, the difference between the measured and true values, is less than 2%. Therefore, the method can be considered sufficiently precise and reliable for the analysis and evaluation of occlusal contact distribution in maximum intercuspation.[12] Koos et al[29] reported that the level of accuracy of this equipment is acceptable, and no interference arising from changes in foil or repeated measuring was detected in their study. Moreover, premature contacts and interferences in the dynamic occlusion can be identified.

The results of the present study demonstrated that microwave disinfection for 3 minutes at 650 W did not cause a significant change in the occlusal pressure pattern of the complete dentures. One possible explanation for these favorable results may be the related efficiency of the original polymerization of the denture base acrylic resin, Lucitone 550, which reduced the magnitude of post-cure of the residual monomer. A polymerization cycle with a terminal boil at a constant temperature was used. Another aspect can be related to the chemical composition of Lucitone 550, which contains a crosslinking agent with two double bonds that has been found to decrease water sorption. Moreover, the presence of the double-bonded crosslinking agent in Lucitone 550 might have enhanced the polymerization reaction of the resin. Urban et al[16] reported a lower percentage of residual monomer for this resin (0.08%). Also, another aspect is that the dentures were subjected to less than 3 minutes over or near the Tg of the denture base material.

During clinical monitoring (T1, T2, T3, T4), no additional pressure spots, loss of denture adaptation, or complaints by patients were observed in either group. Microwave irradiation had no effect on the distribution of the occlusal contacts. The examiner was calibrated before starting this study and recalibrated during the continuing study, so our results can be regarded as consistent.

Under conditions similar to those of this study, microwave irradiation may be a reliable alternative to conventional methods of disinfection of complete dentures without damaging the denture materials and may contribute considerably to treating and preventing denture stomatitis. It is important to emphasize that, although these results caused no additional pressure spots, loss of denture adaptation, or complaints by patients, they apply only to dentures made with Lucitone 550. Therefore, other types of resin used clinically (self-polymerizing, microwave-polymerizing, compression, and injection mold) should be considered in further investigations.

Conclusion

During microwave disinfection, acrylic resin denture bases may undergo an increase in temperature beyond acrylic resin's glass transition temperature; this may facilitate warping of denture bases caused by the release of the stresses stored within the resin during processing. Within the limitations of this in vivo study,

the authors concluded that microwave disinfection protocols using 3 minutes at 650 W did not affect the occlusal pressure pattern of complete dentures.

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