

Original Research Article

COMPARATIVE CONTACT ANGLE ANALYSIS OF 1% CHLORHEXIDINE AND 2% METRONIDAZOLE MOUTHGEL - AN IN VITRO STUDY

ABSTRACT

Introduction: Chlorhexidine is considered to be gold standard drug in treating various oral infections. Metronidazole is effective for treating various anaerobic infections, including dental abscess and periodontal abscess. In current technical applications and material sciences, contact angle is a thermodynamic characteristic that describes the wettability of solid surfaces. The aim of this study is to compare the contact angle of chlorhexidine and metronidazole mouth gel.

Materials and methods: Total 10 samples of gel was used, involving 5 samples of 1% chlorhexidine gel and 5 samples of 2 % metronidazole gel. The contact angles were measured with the Ossila Goniometer after each sample was dispensed from a microsyringe on the facial surface of the microtomed tooth. The obtained values from the samples were determined, and the data was statistically analysed using SPSS software version 20.0. The paired t test was used to analyse the data.

Results: From the data collected it was found that the average contact angle of the mouth gels that is chlorhexidine and metronidazole gel were 51.58 & 67.04 respectively. T test showed p value of 0.157, (p value < 0.05). Hence, it is statistically not significant. Chlorhexidine gel had a lower average mean of contact angle than metronidazole gel, which means chlorhexidine gel had got better wettability when compared to metronidazole gel.

Conclusion: Thus, it can be concluded that chlorhexidine gel has a better tendency to wet the tooth or oral cavity surfaces when compared to metronidazole gel, thereby it can have better action in treating various oral conditions.

Keywords: Chlorhexidine, Metronidazole, Contact angle, Wettability, Gel, Innovative measurement

INTRODUCTION

Gingivitis is one of the most common diseases, affecting 82 percent of the world's adult population (1). Gingivitis and periodontitis are caused by dental plaque, which is an etiological factor (2). Plaque is mostly made up of bacteria encased in a matrix of salivary glycoprotein and extracellular matrix, and removing this bacterial biofilm is essential for treating gingivitis and periodontitis (3). Scaling and root planing destroy bacterial biofilms mechanically, although various studies have shown that mechanical debridement alone is sometimes insufficient in removing flora responsible for periodontal disorders (4).

Chemical plaque removal agents have gained popularity as an adjuvant to mechanical therapy as a result of this. As an adjuvant to mechanical plaque removal, antimicrobials such as Chlorhexidine and Metronidazole have been utilised. The gold standard mouthrinse for gingivitis treatment is chlorhexidine. Several studies have shown that using Chlorhexidine as an adjuvant treatment for periodontitis has no significant benefits. It possesses a wide antiseptic range as well as substantivity (5). Because of its specific antibacterial efficacy against obligate anaerobes, metronidazole has been used by a number of researchers. Gingivitis and periodontitis have both been successfully treated with it.

In current technical applications and material sciences, contact angle is a thermodynamic characteristic that describes the wettability of solid surfaces (6). Many factors influence contact angles, including surface geometry, roughness, contamination, deformation, and so on. Because of this sensitivity, this very macroscopic test can detect extremely small-scale impacts (7). It is described as an angle empirically measured on the liquid side (denser liquid side in the case of two liquids) between the tangent to the solid surface and the tangent to the liquid-fluid interface at the contact line between the three phases, according to its terminology. The contact point is defined as the place where two tangent lines connect. In the sense that it applies to all equilibrium and non-equilibrium circumstances, the preceding definition is generic (8). Our team has extensive knowledge and research experience that has been translated into high quality publications (9–28). The aim of this study is to compare the contact angle of 1% chlorhexidine and 2% metronidazole mouth gel.

MATERIALS AND METHODS

This in vitro study was conducted in white lab, Saveetha Dental College, Chennai, India. Total 10 samples of gel was used, involving 5 samples of 1% chlorhexidine gel and 5 samples of 2 % metronidazole gel. The contact angles were measured with the Ossila Goniometer after each sample was dispensed from a microsyringe on the facial surface of the microtomed tooth. The obtained values from the samples were determined, and the data was statistically analysed using SPSS software version 20.0. The paired t test was used to analyse the data. P value was set as 0.05 as level of significance.

RESULTS AND DISCUSSION

Table 1: Mean, Standard deviation and significance values between groups

| | N | Mean | Std. Deviation | Std. Error Mean | Significance |
|----------------------|----------|--------------|----------------|-----------------|--------------|
| Chlorhexidine | 5 | 51.58 | 29.150 | 13.036 | 0.157 |
| Metronidazole | 5 | 67.04 | 13.924 | 6.227 | 0.157 |

Gels are fascinating materials that can act as either solids or liquids due to a three-dimensional cross-linked network that is enlarged across their entire volume by a fluid (29)(30). The sessile drop or static contact angle is the most basic contact angle. When a liquid drop sits stationary on a surface, it is said to be in this state. Dynamic advancing and receding contact angles are measured to capture the entire range of angles for a given surface. The discrepancy between the advancing and retreating angles is known as contact angle hysteresis (31,32). Gels have various pharmacological functions and other unique properties. Sissle-drop goniometry can be used to determine the gels' contact angle. The sessile drop or static contact angle is the most basic contact angle. When a liquid drop sits stationary on a surface, it is said to be in this state. Dynamic advancing and receding contact angles are measured to capture the whole range of angles for a given surface. The discrepancy between the advancing and retreating angles is known as contact angle hysteresis. Hysteresis is caused by a surface's chemical and topographical heterogeneity,

solution contaminants absorption on the surface, or the solvent swelling, rearranging, or altering the surface (33).

Wetability is inversely proportional to contact angle. The sessile drop or static contact angle is the most basic contact angle. When a liquid drop sits stationary on a surface, it is said to be in this state. According to a previous study, low contact-angle values indicate a tendency for water to spread and attach to the surface, whereas high contact-angle values indicate a tendency for the surface to resist water. Yan used the sessile drop method to figure out how contact angle hysteresis and progressive contact angle work. The geometric approach (sessile drop method) provides for various assumptions and models of the measuring liquid drops for determining the contact angle. The models of liquid drops are classified into the spherical droplet model, the drop curve model (the Bashforth method), and the ellipsoidal method (34).

Chlorhexidine has a broad spectrum of action, making it effective against both Gram-positive and Gram-negative bacteria, as well as fungi. It exerts a bactericidal effect, increasing the permeability of bacterial cell membranes and changing protein properties. Chlorhexidine is considered to be gold standard drug in treating various oral infections. Metronidazole is effective for treating various anaerobic infections, including dental abscess and periodontal abscess. A systematic evaluation found that subgingival application of chlorhexidine gel as an addition to nonsurgical periodontal treatment for chronic periodontitis is very effective (35). From the data collected it was found that the average contact angle of the mouth gels that is chlorhexidine and metronidazole gel were 51.58 & 67.04 respectively. T test showed p value of 0.157, (p value < 0.05). Hence, it is statistically not significant. Chlorhexidine gel had a lower average mean of contact angle than

metronidazole gel, which means chlorhexidine gel had got better wettability when compared to metronidazole gel. The limitations of the study was less sample size and only static contact angle analysis for the mouthgels was done.

CONCLUSION

The average contact angle of chlorhexidine gel is lower than the average contact angle of metronidazole. Thus, it can be concluded that chlorhexidine gel has a better tendency to wet the tooth or oral cavity surfaces when compared to metronidazole gel, thereby it can have better action in treating various oral conditions.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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REFERENCES

1. Albandar JM, Jackson Brown L, Brunelle JA, Loe H. Gingival State and Dental Calculus in Early-Onset Periodontitis [Internet]. Vol. 67, *Journal of Periodontology*. 1996. p. 953–9. Available from: <http://dx.doi.org/10.1902/jop.1996.67.10.953>
2. Timmerman MF, Weijden GA. Risk factors for periodontitis [Internet]. Vol. 4, *International Journal of Dental Hygiene*. 2006. p. 2–7. Available from: <http://dx.doi.org/10.1111/j.1601-5037.2006.00168.x>
3. Newman MG, Takei H, Klokkevold PR, Carranza FA. *Newman and Carranza's Clinical Periodontology E-Book*. Elsevier Health Sciences; 2018. 944 p.
4. Cugini MA, Haffajee AD, Smith C, Kent RL, Socransky SS. The effect of scaling and root planing on the clinical and microbiological parameters of periodontal diseases: 12-month results [Internet]. Vol. 27, *Journal of Clinical Periodontology*. 2000. p. 30–6. Available from: <http://dx.doi.org/10.1034/j.1600-051x.2000.027001030.x>
5. Alaki SM. Preventing the Transfer of Cariogenic Microorganisms from Primary Molars to Permanent First Molars Using Chlorhexidine: A Thesis Submitted in Partial Fulfillment ... for the Degree of Master of Science (Pediatric Dentistry) .. 2000. 214 p.
6. Volpe CD, Della Volpe C, Siboni S. Use, Abuse, Misuse and Proper Use of Contact Angles: A Critical Review [Internet]. Vol. 3, *Reviews of Adhesion and Adhesives*. 2015. p. 365–85. Available from: <http://dx.doi.org/10.7569/raa.2015.097310>
7. Marmur A. Solid-Surface Characterization by Wetting [Internet]. Vol. 39, *Annual Review of*

Materials Research. 2009. p. 473–89. Available from:
<http://dx.doi.org/10.1146/annurev.matsci.38.060407.132425>

8. III. An essay on the cohesion of fluids [Internet]. Vol. 95, Philosophical Transactions of the Royal Society of London. 1805. p. 65–87. Available from:
<http://dx.doi.org/10.1098/rstl.1805.0005>
9. Ramesh A, Varghese S, Jayakumar ND, Malaiappan S. Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study [Internet]. Vol. 89, Journal of Periodontology. 2018. p. 1241–8. Available from:
<http://dx.doi.org/10.1002/jper.17-0445>
10. Paramasivam A, Priyadharsini JV, Raghunandhakumar S, Elumalai P. A novel COVID-19 and its effects on cardiovascular disease [Internet]. Vol. 43, Hypertension Research. 2020. p. 729–30. Available from: <http://dx.doi.org/10.1038/s41440-020-0461-x>
11. Del Fabbro M, Karanxha L, Panda S, Bucchi C, Nadathur Doraiswamy J, Sankari M, et al. Autologous platelet concentrates for treating periodontal infrabony defects. Cochrane Database Syst Rev. 2018 Nov 26;11:CD011423.
12. S. G, T. G, K. V, A. AF, Sukumaran A, Sudha PN. Development of 3D scaffolds using nanochitosan/silk-fibroin/hyaluronic acid biomaterials for tissue engineering applications [Internet]. Vol. 120, International Journal of Biological Macromolecules. 2018. p. 876–85. Available from: <http://dx.doi.org/10.1016/j.ijbiomac.2018.08.149>
13. Paramasivam A, Priyadharsini JV. MitomiRs: new emerging microRNAs in mitochondrial dysfunction and cardiovascular disease [Internet]. Vol. 43, Hypertension Research. 2020. p.

851–3. Available from: <http://dx.doi.org/10.1038/s41440-020-0423-3>

14. Jayaseelan VP, Arumugam P. Dissecting the theranostic potential of exosomes in autoimmune disorders [Internet]. Vol. 16, Cellular & Molecular Immunology. 2019. p. 935–6. Available from: <http://dx.doi.org/10.1038/s41423-019-0310-5>
15. Viridi M. Emerging Trends in Oral Health Sciences and Dentistry. BoD – Books on Demand; 2015. 854 p.
16. Vellappally S, Al Kheraif AA, Divakar DD, Basavarajappa S, Anil S, Fouad H. Tooth implant prosthesis using ultra low power and low cost crystalline carbon bio-tooth sensor with hybridized data acquisition algorithm [Internet]. Vol. 148, Computer Communications. 2019. p. 176–84. Available from: <http://dx.doi.org/10.1016/j.comcom.2019.09.020>
17. Varghese SS, Ramesh A, Veeraiyan DN. Blended Module-Based Teaching in Biostatistics and Research Methodology: A Retrospective Study with Postgraduate Dental Students [Internet]. Vol. 83, Journal of Dental Education. 2019. p. 445–50. Available from: <http://dx.doi.org/10.21815/jde.019.054>
18. Venkatesan J, Singh S, Anil S, Kim S-K, Shim M. Preparation, Characterization and Biological Applications of Biosynthesized Silver Nanoparticles with Chitosan-Fucoidan Coating [Internet]. Vol. 23, Molecules. 2018. p. 1429. Available from: <http://dx.doi.org/10.3390/molecules23061429>
19. Venkatesan J, Rekha PD, Anil S, Bhatnagar I, Sudha PN, Dechsakulwatana C, et al. Hydroxyapatite from Cuttlefish Bone: Isolation, Characterizations, and Applications [Internet]. Vol. 23, Biotechnology and Bioprocess Engineering. 2018. p. 383–93. Available

from: <http://dx.doi.org/10.1007/s12257-018-0169-9>

20. Alsubait SA, Al Ajlan R, Mitwalli H, Aburaisi N, Mahmood A, Muthurangan M, et al. Cytotoxicity of Different Concentrations of Three Root Canal Sealers on Human Mesenchymal Stem Cells. *Biomolecules* [Internet]. 2018 Aug 1;8(3). Available from: <http://dx.doi.org/10.3390/biom8030068>
21. Vellappally S, Al Kheraif AA, Anil S, Wahba AA. IoT medical tooth mounted sensor for monitoring teeth and food level using bacterial optimization along with adaptive deep learning neural network [Internet]. Vol. 135, *Measurement*. 2019. p. 672–7. Available from: <http://dx.doi.org/10.1016/j.measurement.2018.11.078>
22. PradeepKumar AR, Shemesh H, Nivedhitha MS, Mohamed Jubair Hashir M, Arockiam S, Maheswari TNU, et al. Diagnosis of Vertical Root Fractures by Cone-beam Computed Tomography in Root-filled Teeth with Confirmation by Direct Visualization: A Systematic Review and Meta-Analysis [Internet]. Vol. 47, *Journal of Endodontics*. 2021. p. 1198–214. Available from: <http://dx.doi.org/10.1016/j.joen.2021.04.022>
23. Ezhilarasan D, Lakshmi T, Subha M, Deepak Nallasamy V, Raghunandhakumar S. The ambiguous role of sirtuins in head and neck squamous cell carcinoma. *Oral Dis* [Internet]. 2021 Feb 11; Available from: <http://dx.doi.org/10.1111/odi.13798>
24. R H, Ramani P, Tilakaratne WM, Sukumaran G, Ramasubramanian A, Krishnan RP. Critical appraisal of different triggering pathways for the pathobiology of pemphigus vulgaris-A review. *Oral Dis* [Internet]. 2021 Jun 21; Available from: <http://dx.doi.org/10.1111/odi.13937>
25. Sarode SC, Gondivkar S, Sarode GS, Gadbail A, Yuwanati M. Hybrid oral potentially

malignant disorder: A neglected fact in oral submucous fibrosis. *Oral Oncol.* 2021 Jun 16;105390.

26. Vellappally S, Al-Kheraif AA, Anil S, Basavarajappa S, Hassanein AS. Maintaining patient oral health by using a xeno-genetic spiking neural network [Internet]. *Journal of Ambient Intelligence and Humanized Computing.* 2018. Available from: <http://dx.doi.org/10.1007/s12652-018-1166-8>
27. Kavarthapu A, Gurumoorthy K. Linking chronic periodontitis and oral cancer: A review [Internet]. *Oral Oncology.* 2021. p. 105375. Available from: <http://dx.doi.org/10.1016/j.oraloncology.2021.105375>
28. Aldhuwayhi S, Mallineni SK, Sakhamuri S, Thakare AA, Mallineni S, Sajja R, et al. Covid-19 Knowledge and Perceptions Among Dental Specialists: A Cross-Sectional Online Questionnaire Survey [Internet]. Vol. 14, *Risk Management and Healthcare Policy.* 2021. p. 2851–61. Available from: <http://dx.doi.org/10.2147/rmhp.s306880>
29. Doi M. Gel Dynamics [Internet]. Vol. 78, *Journal of the Physical Society of Japan.* 2009. p. 052001. Available from: <http://dx.doi.org/10.1143/jpsj.78.052001>
30. Matsuo ES, Tanaka T. Patterns in shrinking gels [Internet]. Vol. 358, *Nature.* 1992. p. 482–5. Available from: <http://dx.doi.org/10.1038/358482a0>
31. Yang J, Yamato M, Kohno C, Nishimoto A, Sekine H, Fukai F, et al. Cell sheet engineering: Recreating tissues without biodegradable scaffolds [Internet]. Vol. 26, *Biomaterials.* 2005. p. 6415–22. Available from: <http://dx.doi.org/10.1016/j.biomaterials.2005.04.061>

32. Gong JP, Kurokawa T, Narita T, Kagata G, Osada Y, Nishimura G, et al. Synthesis of Hydrogels with Extremely Low Surface Friction [Internet]. Vol. 123, Journal of the American Chemical Society. 2001. p. 5582–3. Available from: <http://dx.doi.org/10.1021/ja003794q>
33. Marmur A. Thermodynamic aspects of contact angle hysteresis [Internet]. Vol. 50, Advances in Colloid and Interface Science. 1994. p. 121–41. Available from: [http://dx.doi.org/10.1016/0001-8686\(94\)80028-6](http://dx.doi.org/10.1016/0001-8686(94)80028-6)
34. Huhtamäki T, Tian X, Korhonen JT, Ras RHA. Surface-wetting characterization using contact-angle measurements. Nat Protoc. 2018 Jul;13(7):1521–38.
35. Zhao H, Hu J, Zhao L. Adjunctive subgingival application of Chlorhexidine gel in nonsurgical periodontal treatment for chronic periodontitis: a systematic review and meta-analysis. BMC Oral Health. 2020 Jan 31;20(1):34.