ANALYSIS OF MICROWAVE DEWAXING AND ITS ADVANTAGES OVER CONVENTIONAL AUTOCLAVE DEWAXING - A REVIEW

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ABSTRACT

Dewaxing is the process of removing wax from the ceramic mould which is covered with wax or melting the wax pattern out of ceramic mould. The heating should be rapid enough to minimise expansion of the wax in order to avert ceramic mould cracking and dimensional alteration. The current survey considers the benefits of helping out Dewaxing through the microwave over customary autoclave strategy for Dewaxing. The Microwave Dewaxing is feasible, fundamentally diminishing the fuse of soil and water, which is inescapable in the Autoclave Dewaxing process. This research is to utilise the advantages of Microwave Dewaxing and to get more knowledge about Microwave Dewaxing, exploring the efficacy of Microwave Dewaxing, and to know the efficiency of Microwave Dewaxing. This is a review study setting, evaluating the advantages of Microwave Dewaxing technique over Conventional Autoclave Method. Data for the study were collected from search engines like PUBMED, GOOGLE SCHOLAR, MeSH, Cochrane and Semantic Scholar. A total number of 35 articles were searched and a total number of 29 articles were selected. A number of articles with known concepts are 7, a total number of 8 articles with recent updates. The data obtained from the present study concludes that it may be useful for practitioners to make high quality dentures with minimal time expenditure when compared to Conventional Autoclave Dewaxing methods. This research will also be helpful to get more knowledge about the advantages of Microwave Dewaxing over Convention Autoclave Dewaxing systems.

KEYWORDS: Dewaxing, Flexural strength, Microwave, Porosity, Reliability.

INTRODUCTION

Dewaxing is the process of removing wax from the ceramic mould which is covered with wax or melting the wax pattern out of ceramic mould. The heating should be rapid enough to minimise expansion of the wax in order to avert ceramic mould cracking and dimensional alteration. Several techniques are available for the Dewaxing process, one among them is Microwave Dewaxing (Yahaya *et al.*, 2015)(Ariga *et al.*, 2018). Microwave can be one of the sustainable alternative sources of energy for the Dewaxing process. Microwave is part of the non-ionising waves of the electromagnetic spectrum; it covers frequency ranges

from 0.3GHz to 300GHz with corresponding wavelengths of 1m to 0.001m (Brum *et al.*, 2009)(Jyothi *et al.*, 2017). In Microwave Dewaxing, the heating is uniform and controllable. It doesn't require high pressure steam. It gives instant Dewaxing, and unlike conventional autoclave methods, it doesn't need start up time (Mishra and Ranjana, 2010)(Duraisamy *et al.*, 2019). It saves the Dewaxing process time by 50-80%, it's energy requirement is only 40%, it is environment friendly and operator friendly, it has a low CO2 emission comparatively 80% low CO2 production. In the ordinary Dewaxing step, a base mold is placed into a Dewaxing tank of the autoclave with the sprue port thereof confronting downwardly, trailed by a quick heating by means of superheated steam (Temel *et al.*, 2005)(Selvan and Ganapathy, 2016; Duraisamy *et al.*, 2019). Autoclave processing is commonly used for Dewaxing nowadays. However, since the use of microwaves is also steadily growing in the field of dentistry (Das *et al.*, 2008) (Ganapathy *et al.*, 2016). The present review studies the advantages of carrying out Dewaxing through the microwave over Conventional Autoclave method of Dewaxing. The Microwave Dewaxing is practical, essentially diminishing the joining of soil and water, which is inescapable in the Autoclave Dewaxing process. This research is to utilise the advantages of microwave dewaxing and to get more knowledge about Microwave Dewaxing, to explore the efficacy of Microwave Dewaxing, and to know the efficiency of Microwave Dewaxing.

MATERIALS AND METHODS:

This is a Review study setting, evaluating the advantages of Microwave Dewaxing Technique over Conventional Autoclave Method. Data for the study were collected from search engines like PUBMED, GOOGLE SCHOLAR, MeSH, Cochrane, Semantic scholar. A total number of 35 articles were searched among withich a total number of 29 articles were selected. A number of articles with known concepts are 7, a total number of 8 articles with recent updates. Articles related to Dewaxing, articles related to Microwave Dewaxing and articles related to Conventional Autoclave Dewaxing were included. Articles not related to Microwave Dewaxing and articles not related to Conventional Autoclave Dewaxing are excluded. Period or duration considered for reference articles from 1990 to 2020.

Dewaxing:

During the process of Dewaxing, surface and dimensional characteristics of wax are transferred to the plaster of paris. There are many methods of Dewaxing. In the conventional autoclave method of Dewaxing, "Dilatation gaps" are formed. And this Dewaxing process is followed by the solidification process in which problems like thermal expansion and related problems are usually formed (McKee, Hobbs and Hall, 1993)(Subasree, Murthykumar and Dhanraj, 2016). The Conventional Autoclave Dewaxing method which is the procedure right now being used, requires a progression of steps and expends a great deal of time for the steam creation in a regular Autoclave method. This strategy needs a preheating framework (Rani, 2013) (Ranganathan, Ganapathy and Jain, 2017). The ceramic moulds should meet the particular amount of temperature and it should be a controlled heat to require strength, prevent porosity and collapsibility. Heat moved inside the mold in the manner, by conduction as opposed to by a by a slower combination of convection and/or thermal radiation plus conduction, as in other. A mechanical assembly for Dewaxing a mould form including, an inlet zone, a heating zone containing a source of radiating microwave energy, and an exit zone, conveyor means extending through said inlet zone, said heating zone and said exit zone, means for delivering a shell mold sequentially and continuously through said zones, and collector means for collecting molten wax melted out of said shell mold in said heating zone (Goller, 1991)(Vijayalakshmi and Ganapathy, 2016).

Advantages of microwave dewaxing:

The Microwave Dewaxing method of wax pattern removal involves the rapid generation of heat at the optimum place required, at or near the pattern or mold material because of the penetrating power of high frequency radiation (Zong *et al.*, 2013)(Ganapathy, Kannan and Venugopalan, 2017). In Microwave

Dewaxing, the heating is uniform and controllable. It doesn't require high pressure steam. It gives instant Dewaxing, and not like Conventional Autoclave method, it does not need start up time. It saves the dewaxing process time by 50 - 80%, it's energy requirement is only 40%, it is environment friendly and operator friendly, it has a low CO2 emission, comparatively 80% low CO2 production. Moreover damage during Dewaxing in the microwave method is low while in conventional autoclave method, it is high. The microwave technology relies on volumetric heating. Heat energy is transferred electromagnetically and relatively, evenly and quickly throughout the part, but not as a thermal heat flux (Babiak and Poppema, 1991)(Ashok and Suvitha, 2016). This enables better process temperature control and less overall energy use, and results in shorter time expense. It also enables the processor to direct heat specifically toward the part to be dewaxed (Gooch, 2011)(Ashok *et al.*, 2014).

Disadvantages of conventional autoclave method:

The Conventional Autoclave Dewaxing process involves a rapid pressurisation to 85 psi (5.8 bar) and in some cases a gradual increase to 140 psi (9.6 bar). After heating, there is a 15-20 minute dwell, and then a controlled depressurisation at 15-30 psi/min (1-2 bar/min)(Sias, 2005; Venugopalan *et al.*, 2014). Has a relatively high possibility of cracking the impression carrying plaster. So as to limit plaster breaking, the Dewaxing Autoclave should rapidly move warm vitality into the denture base and melts the surface wax needs to surge, while in the microwave technique no compelling reason to surge (Yip and Carmel, 2000)(Kannan and Venugopalan, 2018). Dewaxing Conventional Autoclave systems include the steam generator while no need of a steam generator in Microwave method. Conventional Autoclave Method of Dewaxing produces high CO2 emission while microwave method is eco friendly. Conventional Autoclave method of Dewaxing needs a start up time while Microwave Dewaxing procedure doesn't need a start up time(Sutton, 1992)(Basha, Ganapathy and Venugopalan, 2018)(Ajay *et al.*, 2017).

CONCLUSION:

For the Dewaxing process the utilization of Microwaves is consistently developing in mechanical procedures. The Microwave Dewaxing is reasonable, altogether diminishing the joining of earth and water. The progressive change in straight shrinkage is less when contrasted with steady change in volumetric shrinkage. This study is limited by advantages of Microwave Dewaxing method over Conventional Autoclave Dewaxing. With this, we can conclude that the data obtained from the present study may be useful for practitioners to make high quality dentures within minimal time expenditure when compared to Conventional Autoclave Dewaxing methods. This research will also be helpful to get more knowledge about the advantages of Microwave Dewaxing over Convention Autoclave Dewaxing systems.

AUTHOR CONTRIBUTION:

Jayavabushana V, contributed to the development of the data acquisition and drafting of manuscript; Keerthi Sheshanka contributed to the design, editing and critical revision of the manuscript. Gayathri R contributed to the supervision and proofreading of the manuscript.

CONFLICT OF INTEREST:

All authors declare no conflict of interest in the study.

REFERENCE:

[1] Ajay, R. et al. (2017) 'Effect of surface modifications on the retention of cement-retained implant crowns under fatigue loads: An In vitro study', Journal of Pharmacy And Bioallied Sciences, p. 154. doi: 10.4103/jpbs.jpbs_146_17.

[2] Ariga, P. et al. (2018) 'Determination of Correlation of Width of Maxillary Anterior Teeth using Extraoral and Intraoral Factors in Indian Population: A Systematic Review', World Journal of Dentistry, pp. 68–75. doi: 10.5005/jp-journals-10015-1509.

[3] Ashok, V. et al. (2014) 'Lip Bumper Prosthesis for an Acromegaly Patient: A Clinical Report', Journal of Indian Prosthodontic Society, 14(Suppl 1), pp. 279–282. doi: 10.1007/s13191-013-0339-6.

[4] Ashok, V. and Suvitha, S. (2016) 'Awareness of all ceramic restoration in rural population', Research Journal of Pharmacy and Technology, p. 1691. doi: 10.5958/0974-360x.2016.00340.1.

[5] Babiak, J. and Poppema, S. (1991) 'Automated Procedure for Dewaxing and Rehydration of Paraffin-Embedded Tissue Sections for DNA Flow Cytometric Analysis of Breast Tumors', American Journal of Clinical Pathology, pp. 64–69. doi: 10.1093/ajcp/96.1.64.

[6] Basha, F. Y. S., Ganapathy, D. and Venugopalan, S. (2018) 'Oral Hygiene Status among Pregnant Women', Research Journal of Pharmacy and Technology, p. 3099. doi: 10.5958/0974-360x.2018.00569.3.

[7] Brum, F. J. B. et al. (2009) 'Microwave dewaxing applied to the investment casting process', Journal of Materials Processing Technology, pp. 3166–3171. doi: 10.1016/j.jmatprotec.2008.07.024.

[8] Das, S. et al. (2008) 'Prospects of microwave processing: An overview', Bulletin of Materials Science, pp. 943–956. doi: 10.1007/s12034-008-0150-x.

[9] Duraisamy, R. et al. (2019) 'Compatibility of Nonoriginal Abutments With Implants: Evaluation of Microgap at the Implant-Abutment Interface, With Original and Nonoriginal Abutments', Implant dentistry, 28(3), pp. 289–295. doi: 10.1097/ID.0000000000000885.

[10] Ganapathy, D. et al. (2016) 'Effect of Resin Bonded Luting Agents Influencing Marginal Discrepancy in All Ceramic Complete Veneer Crowns', Journal of clinical and diagnostic research: JCDR, 10(12), pp. ZC67–ZC70. doi: 10.7860/JCDR/2016/21447.9028.

[11] Ganapathy, D. M., Kannan, A. and Venugopalan, S. (2017) 'Effect of Coated Surfaces influencing Screw Loosening in Implants: A Systematic Review and Meta-analysis', World Journal of Dentistry, pp. 496–502. doi: 10.5005/jp-journals-10015-1493.

[12] Goller, A. (1991) 'An Improved Correction Procedure for Industrial Microwave Moisture Measurement in Grainy Bulks', 21st European Microwave Conference, 1991. doi: 10.1109/euma.1991.336342.

[13] Gooch, J. W. (2011) 'Dewaxing', Encyclopedic Dictionary of Polymers, pp. 203–203. doi: 10.1007/978-1-4419-6247-8_3468.

[14] Jyothi, S. et al. (2017) 'Periodontal Health Status of Three Different Groups Wearing Temporary Partial Denture', Research Journal of Pharmacy and Technology, p. 4339. doi: 10.5958/0974-360x.2017.00795.8.

[15] Kannan, A. and Venugopalan, S. (2018) 'A systematic review on the effect of use of impregnated retraction cords on gingiva', Research Journal of Pharmacy and Technology, p. 2121. doi: 10.5958/0974-360x.2018.00393.1.

[16] McKee, P. H., Hobbs, C. and Hall, P. A. (1993) 'Antigen retrieval by microwave irradiation lowers immunohistological detection thresholds', Histopathology, 23(4), pp. 377–379. doi: 10.1111/j.1365-2559.1993.tb01223.x.

[17] Mishra, S. and Ranjana, R. (2010) 'Reverse Solidification Path Methodology for Dewaxing Ceramic Shells in Investment Casting Process', Materials and Manufacturing Processes, pp. 1385–1388. doi: 10.1080/10426914.2010.496125.

[18] Ranganathan, H., Ganapathy, D. M. and Jain, A. R. (2017) 'Cervical and Incisal Marginal Discrepancy in Ceramic Laminate Veneering Materials: A SEM Analysis', Contemporary clinical dentistry, 8(2), pp. 272–278. doi: 10.4103/ccd.ccd_156_17.

[19] Rani, D. (2013) 'Recycling of Pattern Wax In The Investment Casting Process Using Microwave Dewaxing', IOSR Journal of Engineering, pp. 05–10. doi: 10.9790/3021-03520510.

[20] Selvan, S. R. and Ganapathy, D. (2016) 'Efficacy of fifth generation cephalosporins against methicillin-resistant Staphylococcus aureus-A review', Research Journal of Pharmacy and Technology, p. 1815. doi: 10.5958/0974-360x.2016.00369.3.

[21] Sias, F. R. (2005) Lost-wax Casting: Old, New, and Inexpensive Methods. Woodsmere Press. Available at: https://books.google.com/books/about/Lost_wax_Casting.html?hl=&id=e_09Enaf4tIC.

[22] Subasree, S., Murthykumar, K. and Dhanraj (2016) 'Effect of Aloe Vera in Oral Health-A Review', Research Journal of Pharmacy and Technology, p. 609. doi: 10.5958/0974-360x.2016.00116.5.

[23] Sutton, W. H. (1992) 'Microwave Processing of Ceramics - An Overview', MRS Proceedings. doi: 10.1557/proc-269-3.

[24] Temel, S. G. et al. (2005) 'A simple and rapid microwave-assisted hematoxylin and eosin staining method using 1,1,1 trichloroethane as a dewaxing and a clearing agent', Biotechnic & Histochemistry, pp. 123–132. doi: 10.1080/10520290500303190.

[25] Venugopalan, S. et al. (2014) 'Magnetically retained silicone facial prosthesis', Nigerian journal of clinical practice, 17(2), pp. 260–264. doi: 10.4103/1119-3077.127575.

[26] Vijayalakshmi, B. and Ganapathy, D. (2016) 'Medical management of cellulitis', Research Journal of Pharmacy and Technology, p. 2067. doi: 10.5958/0974-360x.2016.00422.4.

[27] Yahaya, B. et al. (2015) 'Effects of Activated Charcoal on Dewaxing Time in Microwave Hybrid Heating', Procedia CIRP, pp. 467–472. doi: 10.1016/j.procir.2014.07.039.

[28] Yip, S. and Carmel, Y. (2000) 'Fundamental Issues in Microwave Processing of Ceramics: Modeling and Experiments'. doi: 10.21236/ada382868.

[29] Zong, J. B. et al. (2013) 'Steam Dewaxing Casting Controller Based on S7-200 PLC', Applied Mechanics and Materials, pp. 882–885. doi: 10.4028/www.scientific.net/amm.385-386.882.