*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861. Volume 12, Issue 3 (Nov.- Dec. 2013), PP 01-05*
*www.iosrjournals.org*

# Microwave – A Novel Wave in Dentistry

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***Abstract: Background:*** *It is rightly said 'cleanliness is next to God'. Achieving the effective sterilization is paramount for the best healthcare service. Autoclave is the gold standard of sterilization. Still a need for new method of sterilization is being felt which would be less time consuming and provide a rapid turnover of instruments, while at the same time having less intricate machinery, be compact and user-friendly for a dental clinic. Microwave a little explored method of sterilization has the potential to answer all the requirements while at the same time being at par with autoclave in terms of efficacy. This provided an impetus to compare the sterilization efficacy of autoclave and domestic microwave using biological indicator Geobacillus stearothermophilus spore strips at various time intervals.*

***Method:*** *Three cycles were carried out in microwave. 1st cycle was carried out at 1000W for 8 minutes, 2nd cycle at 1350W for 16 minutes and 3rd cycle at 1350W for 19 minutes. Likewise one cycle was carried out in autoclave at 121$^0$C, 15lbs for 15 minutes. Afterwards, the spore strips were incubated in Adult blood culture media for 7 days at 56$^0$C.*

***Results:*** *No growth was observed in autoclave, while gradual decrease in turbidity was seen in microwave from 1 to 15 minutes, at 1350W, 2450MHz from 16 minutes onwards no growth was observed.*

***Conclusions:*** *Microwave at 1350W, 2450MHz for 16 minutes is as effective as autoclave.*

***Keywords****: Sterilization, Geobacillus stearothermophilus, Autoclave, Microwave.*

## I. Introduction

Infection control has been a subject of interest to the health care professionals' over the last few decades, due to concern about the transmission of infectious - contagious disease. Exposure to HIV has been reported by 0.5% dentists/year.[1] Media coverage of exposure incidents is becoming more intense. The life-time cost of effective infection control is far less than one malpractice settlement.[2] The dental profession has possessed traditional standards of cross-infection control, but recent expression of real concerns by both the public and the profession over the transmissibility of infectious diseases in the dental office has demanded a formalized and extended measures. Failure to adequately clean, disinfect and/or sterilize dental instruments contaminated with pathogenic organisms from a previous patient will endanger subsequent patient. [3]

This route of pathogenic microorganisms transfer is known as cross-contamination and the resulting infection is referred to as cross-infection. The highest potential for cross-infection is between dentists, surgery assistants and patients because blood and saliva contaminated instruments are present. Universal precautions consider that all patients have to be accepted as an infectious patient and apply these precautions to all patients.[4] However, infection control policies in developing countries have not been widely documented .[5] Most hospitals have no infection control programs due to the lack of awareness of the problem or absence of properly trained personnel .[6]

Autoclaving as a means of sterilization is a universally accepted time tested method. However autoclaving has its own limitations', [7] time consuming and various instruments like plastic handled and glass instrument are not compatible to sterilize, as they are highly sensitive to the high temperature.

Thus the need for conducting the present study was to find a simple, effective, economically feasible technique of sterilization for instruments which could be implemented at dental healthcare centers and at outreach programmes. Such an alternative method of sterilization besides being scientifically sound should be effective, acceptable and above all, simple to design and operate.

Microwave oven working on the principle of dielectric heating, [8] is one of the less explored sterilization modalities seeming to satisfy all the required criteria. However, thorough exploration of literature revealed many contrasting results, but no studies tested the sterilization efficacy of microwave oven in comparison to autoclave.

Thus, the aim of the present study was to assess the sterilization efficacy and minimum time required in domestic microwave oven maintained at 10000 W and 1350 W respectively for various time intervals in comparison to autoclave.

## II. Materials and method

The present study is an in vitro study. *Geobacillus stearothermophilus* spore strips containing $10^5$ spores per strips {Raven biological laboratories, U.S.A; Himedia} were used to check the sterilization efficacy of microwave in comparison to autoclave. One spore strip was tested for the viability of spore and to serve as a control group. The outer wrapper was peeled and the spore strip was put in a test tube containing Adult Blood Culture media and incubated at 56ºC for 7 days according to manufacturer's instruction.

After conformation of viability of spores, cycles of microwave and an autoclave was carried out. Nine spore strips were taken and the outer wrappers were peeled. The peeled spore strips were kept in nine sterilized test tubes, one spore strip in each test tube. 1 tube labeled as "A" standing for autoclave. The rest 8 test tubes were labeled as 1,2,3,4,5,6,7 and 8 according to sterilization time interval of 1min, 2 min, 3 min, 4min, 5min, 6min, 7min and 8min. Then a cycle in autoclave (Confident; automated front loading desktop type) was carried out. The test tube labeled "A" was kept among instruments and the whole package was sterilized at$121°C$, 15 lbs for 15 minutes.

A domestic microwave oven (LG wonder convection- MC 805AA) was taken and a borosil beaker filled with distilled water containing metallic instrument was kept on the turntable of microwave,[9] Plastic instrument, cotton and gauze were kept on turntable directly. The endodontic files were kept in endobox. These entire instruments were kept to check their compatibility in microwave.

Microwave 1st cycle was carried out at 1000W; 2450MHz till 8 min.The test tube labeled from 1 to 8 minutes were kept on turntable along with the instruments. At the end of each minute, 1 test tube was taken out in sequential manner according to labeling.

As the sterilization efficacy was not seen after 1st cycle, 2nd cycle was repeated in microwave, increasing power and time interval at 1350W till 16 min. 3rd cycle was repeated at 1350W, 2450 MHz till 19 min in microwave to reconfirm the observation.

After completion of cycles, Adult Blood Culture media was added to all the test tube containing spore strip and kept for incubation at $56°C$ for 7 days. [10] At the end of 7 days, the test tubes were removed from incubator and turbidity in test tube was assessed. The number of Colony Forming Units (CFU) present per ml of incubated media was determined by the McFarland scale. [11]

Then smears were prepared on the slides and subjected to gram staining, [12] as turbidity in the test tube could be either due to germination of spore to their vegetation forms or fungal contamination. In order to confirm that turbidity is due to germination of spores and not because of fungal contamination, gram staining procedure was done. The examination of studies was done by microbiologist who was blinded about the details of the study. If sterilization is not effective then spores would germinate to their vegetative form in the presence of Adult Blood Culture media which would be evident under microscopy.

The data obtained was dichotomous in nature (presence or absence of bacilli) and hence was not subjected to statistical analysis.

## III. Results

- Turbid and slight turbid was seen in test tubes after the completion of 1st , 2nd and 3rd cycle in microwave till 15th min. Whereas tube 'A' from autoclave cycle, tube '16' from microwave 2nd cycle and tubes 16 to 19 from microwave 3rd cycle were completely clear at the end of 7 days. This proved that sterilization is effective in microwave at 1350W and at 16th min (Table 1 and Fig.1, 2,3 and 4)

Table 1: Changes in culture media after incubation cycle between Autoclave and Microwave

| | Turbid | Slight Turbid | Clear |
|---|---|---|---|
| Autoclave | - | - | ✓ |
| Microwave 1st cycle | 1-6 min | 7-8 min | |
| Microwave 2nd cycle | 1-6 min | 7-15 min | 16 min |
| Microwave 3rd cycle | 1-6 min | 7-15 min | 16-19 min |

Fig 1: Comparison of effectiveness between Microwave and Autoclave

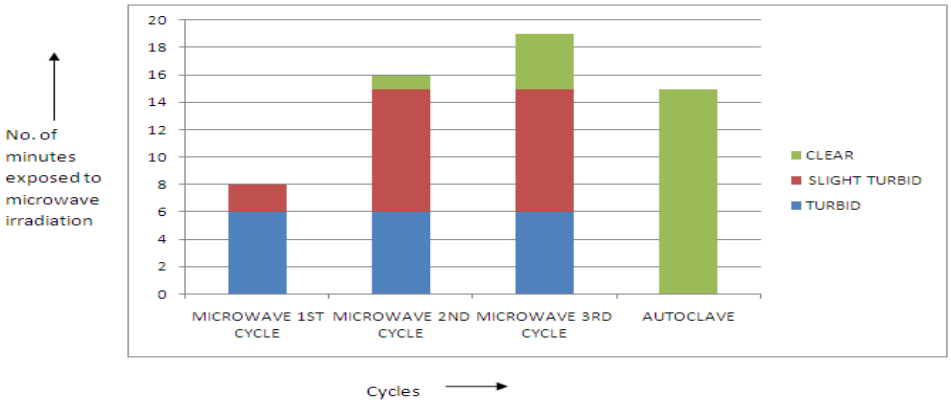
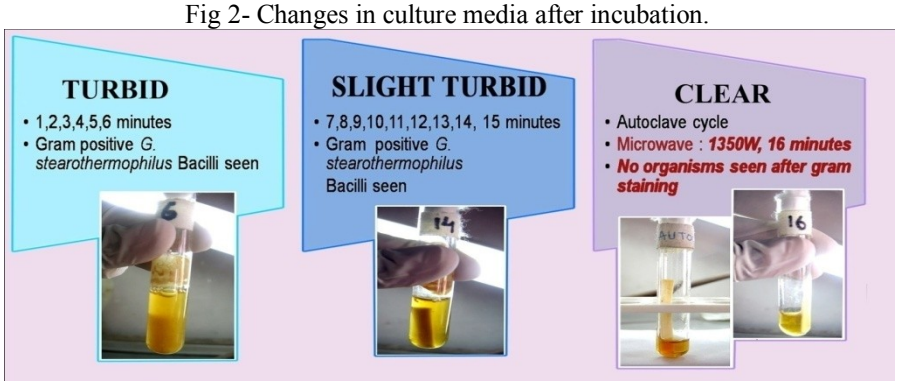



Fig 2- Changes in culture media after incubation.




- fig 3 :No. of CFU/ml was determine by McFarland scale and following result was obtained:

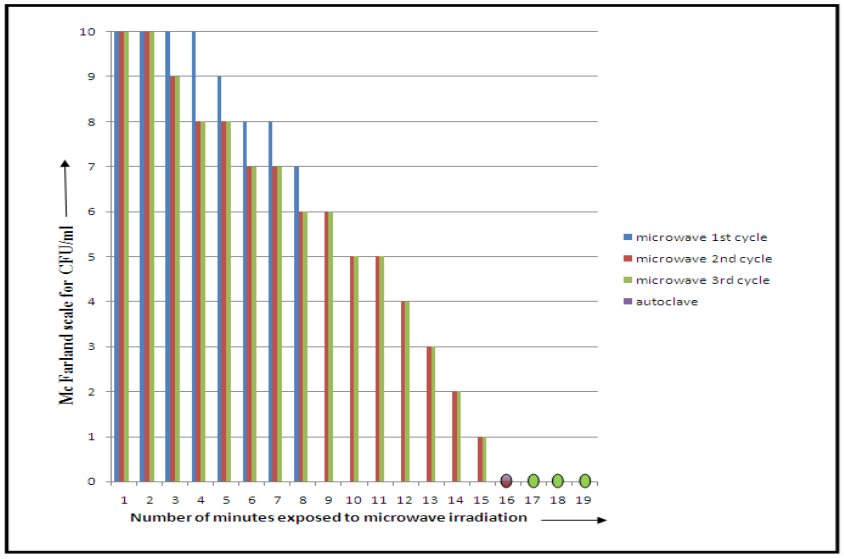
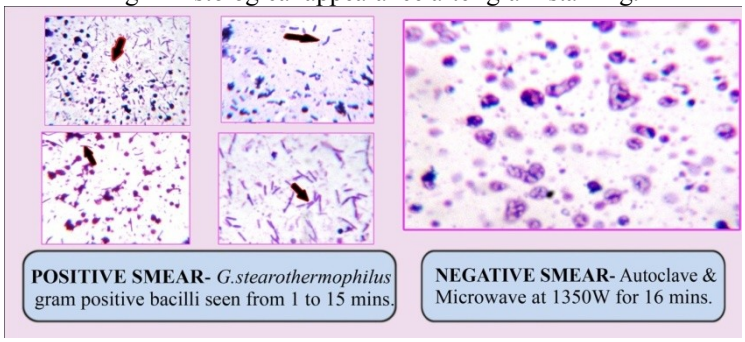



Fig 4-Histological appearance after gram staining.



## IV. Discussion

Due to the nature of their profession, dentists and dental assistants should not forget the risk of treating patients with probability of infectious diseases. Dentists, dental assistants and patients may be exposed to pathogenic microorganisms localized in oral cavity and respiratory tract including cytomegalovirus (CMV), HBV, HCV, herpes simplex virus (HSV) type 1 and 2, HIV, Mycobacterium tuberculosis, staphylococci, streptococci and other viruses and bacteria.[13] These microorganisms could be transmitted to the dental health care professionals by direct contact with a patients' saliva, blood, skin, and oral secretions, or by indirect contact through injuries caused by sharp contaminated instruments, or by droplet infection from aerosols or spatter .[13,14,15]

Autoclave is the universally accepted standard for sterilization, most widely used and most dependable. But consider a scenario during a busy day of practice, an emergency patient for extraction or acute pulpitis drops in and need urgent treatment. Then sterilization of used instruments for one patient is not practical as the turnover time of instrument in autoclave is minimum 45 min, microwave addresses this problem effectively at par with autoclave in less time and less utilization of energy.

In the present study it was observed microwave was effective at 1350W in 16 minutes. (Table 1, fig 1) Microwave can be used as an alternative method of sterilization considering it's less turnover time and power efficiency. Available literature till date shows that microwave technology consumes about 80 percent less energy than a comparable autoclave. [16]

Microwaves are radio waves with wavelength ranges from as long as 1 meter to as short as 1 mm or frequencies between 300MHz to 300GHz. [17,18] When defining a microwave irradiation protocol, the parameters to be considered are: the time of exposure, the level of power of oven, the material to be irradiated, the vehicle in which material is immersed. While the inhibitory effect of microwave irradiation on microbes is being researched extensively, how microwave brings about this effect is a matter of discussion.[7] Some mechanism suggest microorganisms inactivation by 'thermal effect', [18,19,20] while some mechanism suggest interaction of electromagnetic field directly and thus 'non thermal' effect.[8,21,22,23] But it can be concluded that, nature of lethality of microwave irradiation for microorganism may be a combination of thermal and non-thermal effect.[7]

*Geobacillus stearothermophilus* spore strips were used in the present study to test the sterilization efficacy because it is the best biological indicator with the ability to survive under extreme temperature and is non-pathogenic. [24, 25]

Specific media for the culture of *G. stearothermophilus* spores is modified tryptic soy broth as directed by manufacturer's instruction. Due to non-availability of modified tryptic soy broth, Adult Blood Culture media was used in the present study. Since control strip showed turbidity which means that the spores have germinated to their vegetative form in the presence of Adult Blood Culture media, the culture media used for the present study was supportive for the bacillus spores.

Microwave has numerous potentials in a regular dental setting. From sterilization of operative instruments to various other uses like disinfection of dental cast and impression, curing of acrylic resins, toothbrush sterilization etc. [26,27,28,29] It can emerge as a single answer to all infection control measures.

**Microwave advantages'**:

- It is quick with rapid turnover of instruments.
- There is no contact with any corroding and hazardous liquid or vapor chemical, as in chemiclave, reducing the risk of occupational hazards.
- Materials like glass, plastic, cotton, gauge etc can also be effectively sterilized.
- Ease of handling
- Cost effective
- Less energy consumption
- Compact, and less space utilization

**Disadvantages:**

- Metal instrument are not dried so chances of contamination
- With increased load of instruments during sterilization cycles, chances of development of hot and cold spot in there, so instruments must be arranged properly.

Weighing all the pros and cons of microwave, it can be said that microwave is the future of dental practice.

## V. Conclusion

The sterilization efficacy of microwave is comparable to the autoclave which is considered to be the gold standard for sterilization. Moreover, microwave sterilizes all types of dental instruments in short time and

consumes less power, overcoming shortcomings of autoclave. It doesn't require specialized skill for operation, practically feasible and economical. Hence, domestic microwave may be recommended as a substitute for sterilization at dental health care centers.

**Acknowledgement**

The authors acknowledge Professor Dr. Mridula N. Dravid, Hire government medical college, Dhule, India for her invaluable contribution in this study.

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