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# In Vitro Comparative Study to Assess the Microbial Growth on Various Esthetic Stainless Steel Arch Wires.

Dr Jayaprakash Tirumala Reddy, Professor and Head, department of orthodontics and orofacial orthopedics , MNR Dental college and hospital.
Dr. Parsa VenkataSaiPrasanna, post graduate student, Dr Soja Sara George, Assistant Professor, Dr.Vishnu Priya C.H,Assistant Professor,Dr.Sujan Kumar K.V, Professor,Dr.Tanmayi Akkina, Assistant professor .

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**ABSTRACT**:
**Objective:** Theobjective of the study is to evaluate and compare microbial growth on various esthetic coated stainless steel rectangular archwires
**Materials and Methodology:** The study was done to evaluate the microbial growth on various esthetic coated stainless steel arch wires. A sample of 15 arch wires each was taken and they were divided into 4 groups, group 1(control) - uncoated stainless steel arch wires(n=15), group 2–ceramic coated stainless steel arch wires (n=15), group 3–Teflon coated stainless steel arch wires (n=15), group 4-epoxy resin coated stainless steel arch wires(n=15). All thearch wires are cut into 3 equal parts and were incubated in the culturemedia to evaluate the growth of lactobacilli bacteria. The growth was evaluated by counting the colony forming units on the MRS agar by digital colony counting machine and subjected to statistical analysis using spss statistical software.
**Results:**There was a significant difference in the mean number of LB counts between the groups. The mean number of lactobacilli is significantly higher in ceramic coated stainless steel arch wires followed by epoxy coated stainless steel arch wires, uncoated stainless-steelarch wires, and least in Teflon coated stainless steel arch wires.
**Conclusions:** Esthetic coated stainless steel arch wires have shown a significant decrease in microbial growth when compared to uncoated stainless steel arch wires.
**Keywords:** Esthetic coated stainless steel arch wires, Lactobacilli, MRS agar.

## I. INTRODUCTION

As demand for esthetics in orthodontic treatment is increasing, the need for thedevelopment of newer materials like tooth colored arch wires, brackets, and esthetic appliances has increased. Commercially, there are various types of esthetic coated orthodontic arch wires like Teflon coated, epoxy coated, ceramic coated, rhodium coated, Nylon based matrix reinforced with silicone fibers, composite material reinforced with glass fibers, Titanium oxide and silver nano coated .One of the main risks with the orthodontic treatment is increased oral plaque accumulation around brackets and arch wires causing white spot lesions on teeth due to increased levels ofmicrobial growth. These esthetic coated wires can solve the problem of esthetic concern but the surfaceirregularities may cause plaque accumulation causing white spot lesions. The present study is done to evaluate the microbial growth on the esthetic coated arch wires.

## II. MATERIALS AND METHOD

A sample of 3 types of esthetic coated stainless steel arch wires and uncoated stainless steel arch wires acting as control weretaken and were divided into the following groups.
GROUPI -Control: A sample of 15 uncoated stainless steel arch wires of 0.017” x 0.025” dimensions - ORTHO ORGANISERS – fig 4.
GROUP II: A sample of 15 ceramic coated stainless steel arch wires of 0.017” x 0.025” dimensions - NMD DENTAL - fig 1.
GROUP III: A sample of 15 PTFE stainless steel arch wires of 0.017” x 0.025” dimensions - RABBIT FORCE - fig 2.
GROUP IV: A sample of 15 epoxy resin coated stainless steel arch wires of 0.017” x 0.025” dimensions - U-ORTHO - fig 3.

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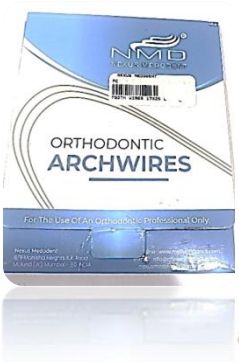




Figure1: Ceramic coated Figure 2: PTFE –Teflon coated Figure 3: epoxy coated


Figure 4: stainless steel

All the wire samples received from the manufacturer were cut into 3 equal parts and sterilized under UV light for 5 minutes. The lactobacillus culture grown on MRS agar was suspended within MRS broth - De man,Rogosa , Sharpe-fig 5 and diluted, the MRS broth -10 mlalong with the wiresare transferred to test tubes - fig 6 and cultured for 48 hours at 37 degree Celsius in 5 % $CO_2$ incubator - fig 7.The wires are removed and the bacterial suspensionin the test tubes is serially diluted at $10^5$ and transferred to MRS agar and the bacteria are cultured for 48 hours at 37 degrees Celsius in a 5 % $CO_2$ incubator -fig 7.The microbial growth on each wire is assessed by counting the colony-formingunits of lactobacilli in the agar – fig 8 using a digital colony counting machine - fig 10



Figure5: MRS- broth Figure 6: samples placed in culture media Figure 7: $Co_2$ incubator

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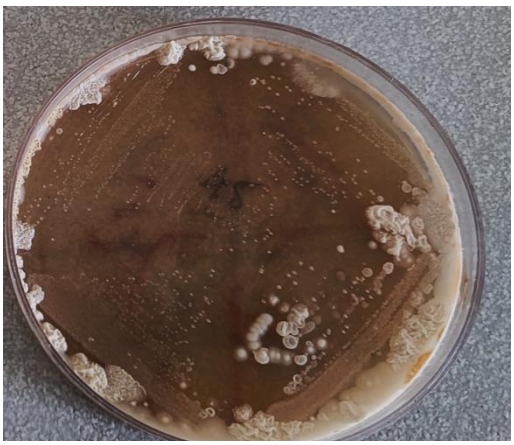

Figure 8:Bacterial colonies cultured in the MRS agar media

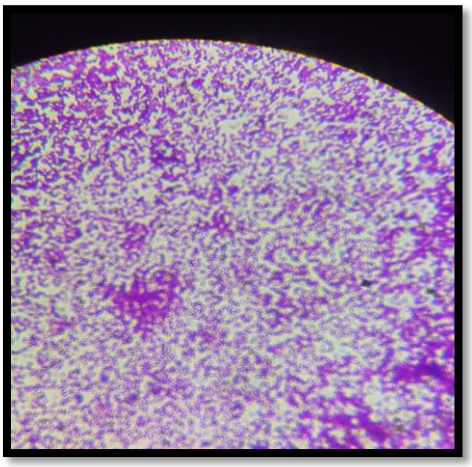

Figure9:Bacterial staining with lugol'siodine.Figure 10: Digital colony counting machine

## III. RESULT:

Table 1: Mean comparison of LB count between groups

| Groups | Mean | SD |
|---|---|---|
| Group 1 | 504.0000 | 80.80842 |
| Group 2 | 784.0000 | 87.34987 |
| Group 3 | 274.0000 | 47.22288 |
| Group 4 | 636.0000 | 85.61542 |

Table -1 represents the mean comparison of LB count between the groups. The mean

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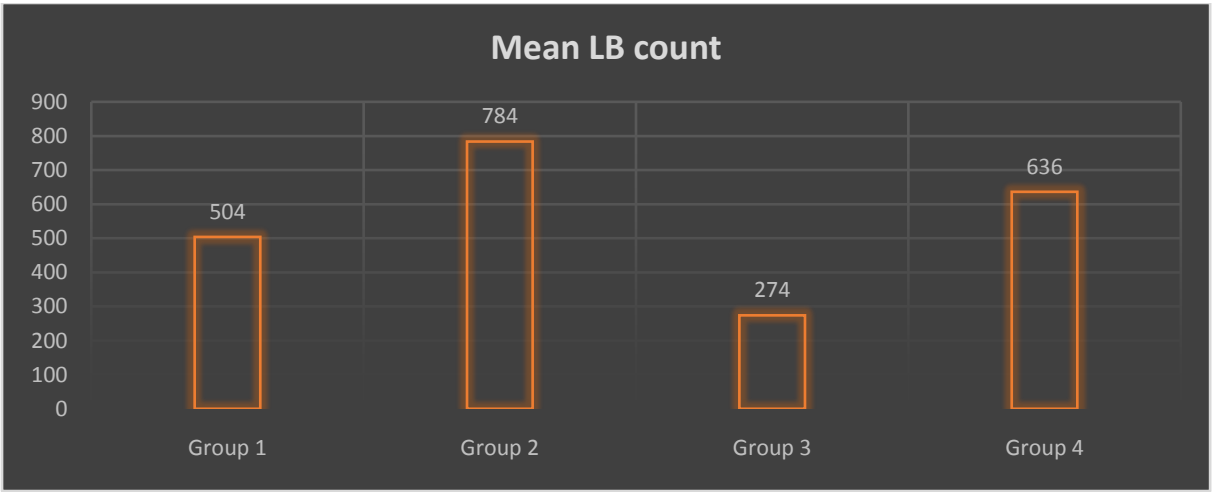
number of LB is significantly higher in Group 2- 784±80.7 followed by Group 4 - 636±87.56, Group 1- 504±80.8 and least in Group 3 - 274±47.2.

Table 1a: Pair-wise comparison- post hoc analysis (Tukey's test)

| Comparison between groups | | P value |
|---|---|---|
| Group 1 (control) | Group 2 | **0.000*** |
| | Group 3 | **0.001*** |
| | Group 4 | 0.067 |

ANOVA test; $p \leq 0.05$ considered statistically significant.

Table 1a represents the pairwise comparison between each group. Post hoc analysis revealed a significant difference between each pair, except between Group 1 and Group 4 (p=0.067).




Graph 1: mean comparison of LB count between groups

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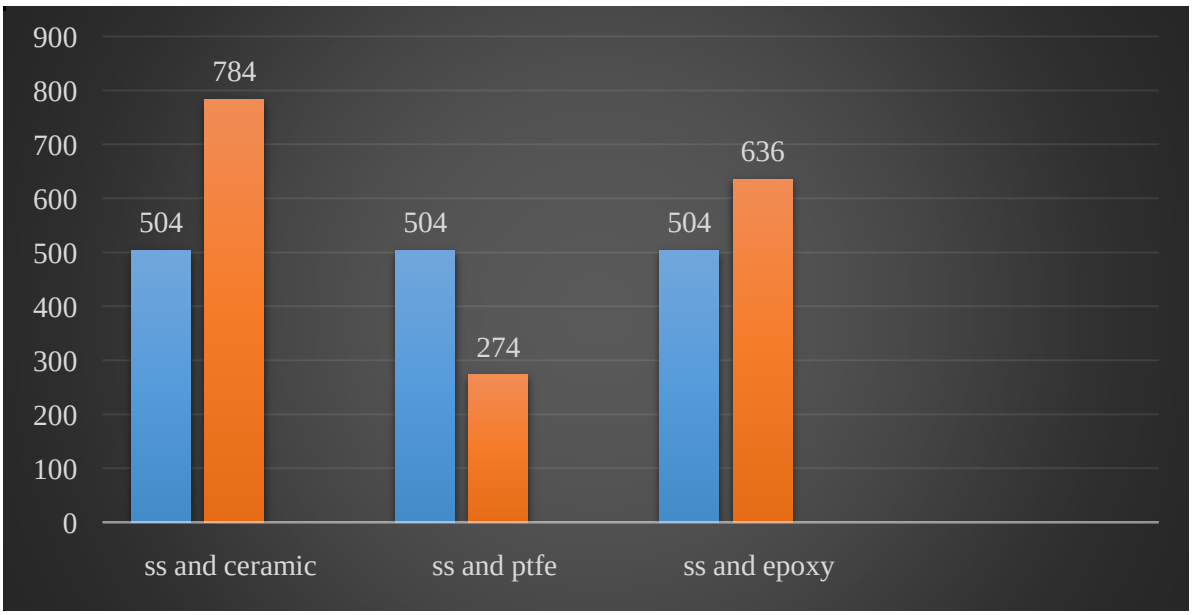


Graph 2: comparison of stainless steel with other coated arch wires

## IV. DISCUSSION

The present study was done to evaluate the microbial growth on various esthetic coated arch wires. Recent progress in the area of orthodontic coatings has developed a wide range of esthetic coated NI-TI and stainless steel wires. Various esthetic coated arch wirescommercially available are Teflon coated, epoxy coated, ceramiccoated, rhodium coated, Nylon based matrix reinforced with silicone fibers, composite material reinforced with glass fibers, Titanium oxide and silvernano coated, etc. Advantages of esthetic coated arch wires include 1. Improved esthetics 2. Reducedfriction 3. Corrosionresistance 4 enhanced patient comfort. Disadvantages include 1. Durability - as the coating may wear off over time 2. Limited range of strength compared to metallic arch wires 3. Cost - can be expensive.

According to an in-vitro study by Lee spetal[1], it is observed thatthe difference in the microbial growth on various arch wires is due to the difference between their surface characteristics such as surface energy and surface roughness. They reported that higher surface roughness and high surface energy lead to more S. mutansabsorption.

In the present in-vitro study there was a significant increase in microbial growth in ceramic coated arch wires and Teflon coated arch wires showed decreased microbial growth compared to other esthetic arch wires. The mean number of LB is significantly higher in Group 2 (ceramic ) - 784±80.7 followed by Group 4(epoxy ) - 636±87.56, Group 1( stainless steel –control ) - 504±80.8 and least in Group3 (Teflon ) - 274±47.2.Meatanietal[2]in their study stated that coating intra-oralappliances withTeflon reduces the amount of plaque accumulation

In an in vitro and in vivostudy done by MahsenTaha et al[3]they stated that there was a positive correlationbetween surface roughness and biofilm adhesion in vivo, but no correlationwas found in vitro.The surface energy of the arch wireinterrupts acid –alkaline and Vander walls reaction, which is critical for bacterial accumulation. Although biofilm adhesion to wires is governed by many other factors such as coating thickness, method of coating, and material coated, but surface roughness remains a key factor. It has been reported that any appliances used in the oral cavity having surface roughness greater than 0.2µm lead to increased microbialgrowth.

Coating the surface with esthetic material primarily decreases microbial growth as the esthetic coating can decrease surface roughness when coated to stainless steel or NI-TI arch wires. The increased microbial growth is the etiological factor for periodontal disease and enamel decalcification. To minimize the above side effects, wires with low surface roughness would be ideal. Some authors explain that different manufacturing techniques and final polishing thickness of the coating and chemical composition of the coatings affect the surface properties of the arch wire.

In an in vitro study doneby Moshabab A. AsiryET al[4],it was given that among coated wires, epoxy wires mean SD value for surface roughness is 1.29µm, has the highest surface roughness than Teflon coated wires whosemean SD value is 0.74µm. In an in vivostudy done by

SeyedHamidraji et al[5]on bacterial colonization on coated and uncoated arch wires concluded that epoxy coatedarch wires have significantly lower microbial growththan uncoated NI-TI wiresdue to their decreased surface roughness.The CFU of epoxy in the above study - was 233.3±40.88,CFU of epoxy in the present study -was 636±87.56.

In an in-vitro study done by Deise C Oliveiraetal[6,]he stated that clinical use of esthetic coated orthodontic arch wires may be considered to have similar risks for biofilm accumulation compared with uncoated wires. CFU/log 10 ofepoxy in above study - 4.93, CFU inpresent study - 636±87.56, CFU /log 10 of Teflon in above study - 4.56, present study - 274±47.2, CFU/log 10 of uncoated wires in above study - 4.65, CFU in present study - 504±80.8.In an in vitrostudy by In – hyekim et al[7] they concluded that esthetic coated arch wires can be favorable for decreasing microbial adhesion. CFU /log 10 valuesfor esthetic coated wires in the above study - 2.46, 1.99,2.38,2.10,present study CFU ofepoxy coated - 636±87.56,Teflon coated - 274±47.2, CFU /log 10 of uncoated arch wires in the above study - 7.70,4.70, CFU inpresent study - 504±80.8.In an in vivo studydone by PritishPolke et al[8]on biofilm adhesion on different types of arch wires stated that esthetic coated stainless steel arch wires showed the least affinity to biofilm absorption, as they have less retention to biofilmwhen compared to other uncoated arch wires.

Esthetic coated arch wiresprovide a more esthetic option compared to traditional metallic arch wires. This feature can be advantageous in improving patient confidence and satisfaction during orthodontic treatment. As it is observed that estheticcoated arch wiresshow decreasedmicrobial growth due to decreased surface roughness compared to uncoated arch wires, they can be used as an alternative for patients with periodontal diseases and poor oral hygiene.

Further in vivo studies are to be done using oral hygiene aids like various toothbrushes and mouthwashes and evaluate theireffect on bacterial growth. Further studies are indicated using various other esthetic coated arch wiresand the growth of other oral microbial organisms likes .s mutans,and candida albicans is to be evaluated. Long term studies using a large sample size are to be conducted. Variousstudies onnano coatings and their effect on anti-microbial properties are to be evaluated.

The present study on microbial growth on esthetic arch wires was conducted in an in-vitro environment in a culture media using a limited sample size. The in-vivo conditions like variation in the salivary pH., oral hygiene maintenance, and dietary habits can affect the oral microbialgrowth, hence the results may vary when the study is done in-vivo.

## V. CONCLUSION

The present study concludes thatesthetic coated arch wireshave shown a significant decrease in microbial growth when compared to uncoated stainless steel arch wires. Of all the wiresevaluated PTFE (Teflon) coated arch wires showed a least microbial growth compared to others, ceramic coated arch wire showed increased microbial growth. As the microbial growth on PTFE (Teflon)arch wires is the least, these wires can be recommendedin patients with periodontal diseases, poor oral hygiene, and white spot lesions.

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