Micro-CT analysis of Porosities of Maxillofacial Biomedical Silicones and their effect on Colour

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Introduction:
Missing facial defects often result in devastating cosmetic, functional and psychological consequences and require a prosthetic replacement termed facial prosthesis (Figure 1) [1]. Silicone rubbers are the most popular materials used in the construction of facial prostheses; however, silicone suffers deterioration in its physical and mechanical properties and discoloration upon service mainly due to entrapped airbubbles during mixing. Conventional studies of investigating silicone pores gave limited results on pores numbers, volumes, and percentages. However, Hatamleh and Watts (2008) introduced the use of Micro-CT scanning as a novel non-destructive technique in investigating interfacial silicone porosity and their effect on bonding of silicone to glass fibres [2].

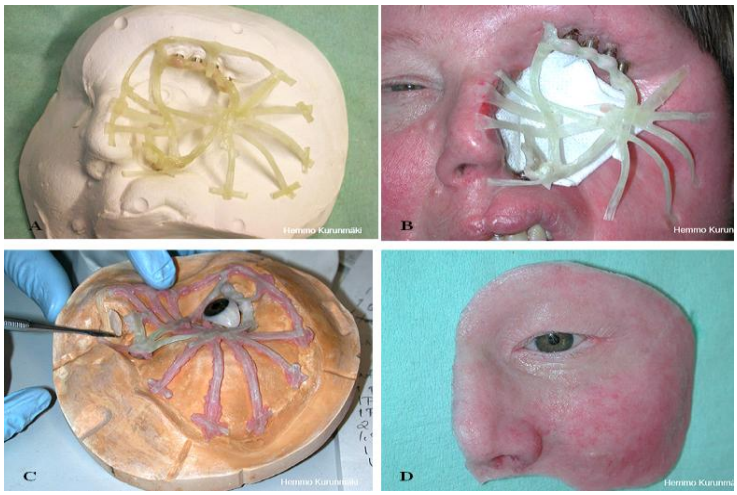

Figure 2: Restoration of a large facial disfigurement with fibre reinforced maxillofacial prosthesis. First the fibre framework is constructed over the case mould, (A), and tried on the disfigurement (B). Eye globe is placed in place and silicone is mixed and placed around the fibres (C). Finally the prosthesis ready for delivery (D) [1].

Aims
Prostheses colour production and stability as a result of pores entrapment during mixing has not been investigated for maxillofacial silicone prostheses. Thus, the aims of this study are to use Micro-CT scanning for porosity analysis of maxillofacial silicone elastomers. And to test the effect of the pores on the colour reproducibility and stability of silicone after two different aging conditionings.

Method
Thirty two disk-shaped specimens were prepared (8mm diameter, 3mm thickness) by mixing TechSil S25 silicone elastomer following two techniques: manual mixing (n=16) and mechanical mixing under vacuum (n=16). Half of the specimens in each group were intrinsically pigmented and the other half remained un-pigmented. Pore numbers, volumes and percentages of specimens were calculated using the Micro-CT (Figure 2). Colour change (ΔE) was measured at the difference between manually and mechanically mixed specimens.

Pores numbers and percentages were analysed using 1-way ANOVA and Dunnett's-T3 post-hoc tests ($p<0.05$). Independent t-test was used to detect differences ($p<0.05$) in ΔE between manually and mechanically mixed specimens, in both un-pigmented and pigmented states.

Results

Micro-Ct scanning showed that mechanical mixing under vacuum reduced number and percentage of pores in comparison to manual mixing, within pigmented and un-pigmented silicone specimens ($p<0.05$).

Detected pores affected silicone colour as perceptible ΔE between manual and mechanical mixing techniques were 5.93 and 5.18 for both un-pigmented and pigmented specimens, respectively.

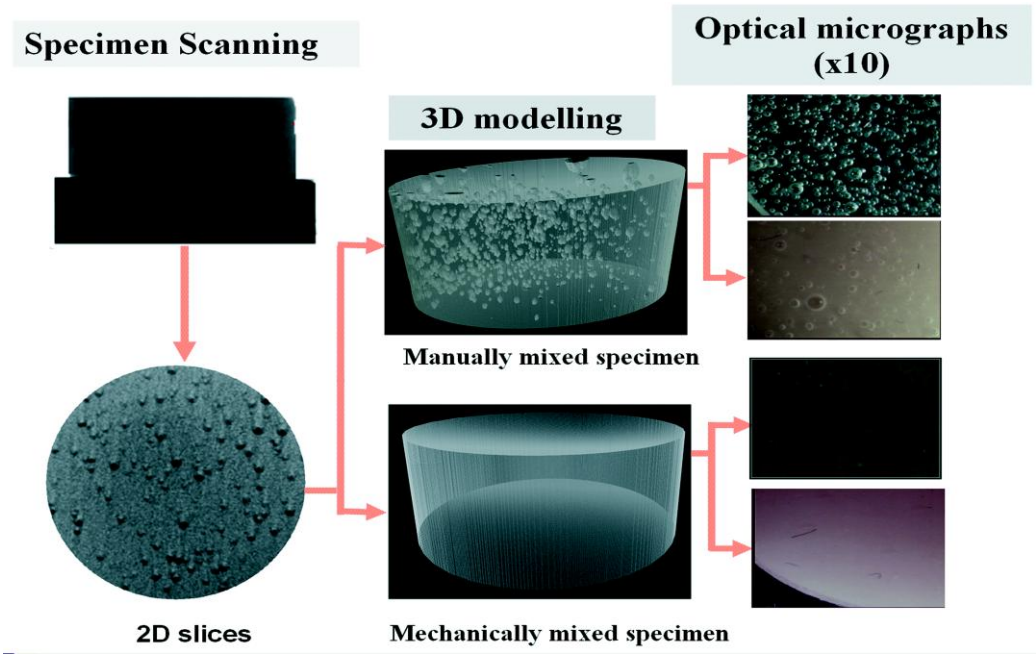

Figure 2: Diagram showing reproduction of 3-D models of silicone specimens (of both mixing methods), and optical micrographs (x 10) of pigmented (in pink) and un-pigmented specimens of the mixing methods

Conclusion

Micro-CT is proved to be useful tool in investigating porosity within dental materials especially maxillofacial silicones. Such non-destructive investigation enabled testing the effect of porosity on the silicone colour. Mechanical mixing under vacuum reduced pores numbers and percentages in comparison to manual mixing, and thus resultant colour change.

Significance:

This study has been accepted for publication at Journal of Prosthodontics, 2010.

References:

1. Kurunmaki, H., R. Kantola, M.M. Hatamleh, D.C. Watts, and P.K. Vallittu, A fiber-reinforced composite prosthesis restoring a lateral midfacial defect: A clinical report. J Prosthet Dent, 2008. 100(5): p. 348-52.

2. Hatamleh, M.M. and D.C. Watts, Porosities and bonding of maxillofacial silicone elastomer with embedded glass fiber-bundles. International Journal of Anaplastology, 2008. 2(1): p. 15-23.