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The Effect of Indirect Bonding Tray Materials on Light Transmission and Degree of Conversion

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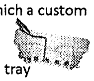
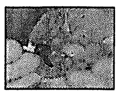
INTRODUCTION

In orthodontics, good bracket placement is the key to optimum occlusion/esthetics and efficiency. Indirect bonding is a method where brackets are placed onto casts from which a custom tray is fabricated capturing these bracket positions.





An adhesive is then applied to the custom base of each bracket in the tray which is then seated in the mouth and a curing light is used to transfer these brackets to the teeth one arch at a time.

Because the curing light must pass through the tray, a portion of that light will be absorbed or scattered by the tray and therefore has the potential to decrease the composite degree of conversion which could negatively affect the bond strength and treatment success.

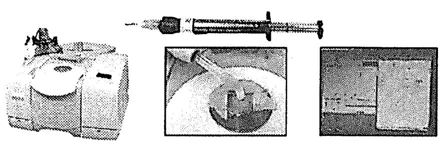
OBJECTIVES / HYPOTHESIS

- The purpose of this study was to determine if tray material, thickness, and length of cure have an effect on the light transmission and DC during indirect bonding.
- Hypothesis: There will be a difference between the attenuation coefficient (AC) of Star VPS and Emiluma/Lumaloc (EL/LL). Thickness, length of cure, and tray material will affect composite degree of conversion (DC).

MATERIALS & METHODS

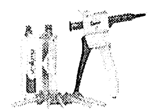
- Three transfer-tray materials (Star VPS, EL/LL, and Biocryl/Bioplast (B/B)) were evaluated.
- Light transmission was tested using an integrating sphere (Labsphere) to obtain the AC for Star VPS and EL/LL.

- The effect of tray materials on curing polymeric-based composite was determined by measuring the DC of a 1.5 mm flowable composite (Revolution, Kerr) after curing through varying thicknesses of tray material per brand and air as a control using a Fourier Transform Infrared Attenuated Total Reflection spectrometer (FTIR-ATR, Spotlight-400).



- Statistical Analysis:
  - AC: Normal distribution: Independent T-test
  - DC: Non-normal distribution: Friedman's 2-way ANOVA and Kruskal Wallis 1-way ANOVA; Tukey's Analysis

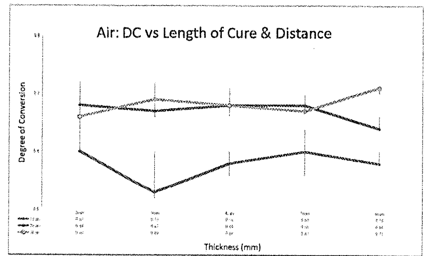
RESULTS

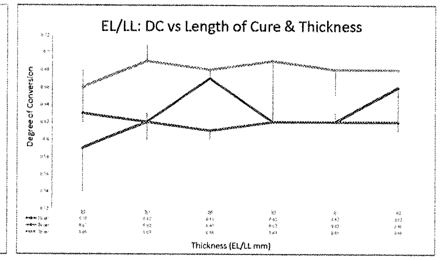


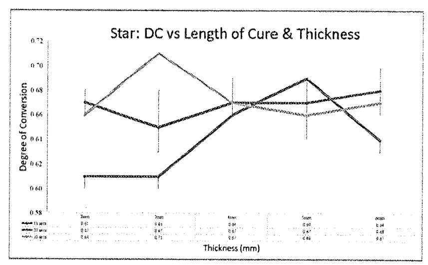
Attenuation Coefficient (AC) at 469nm:

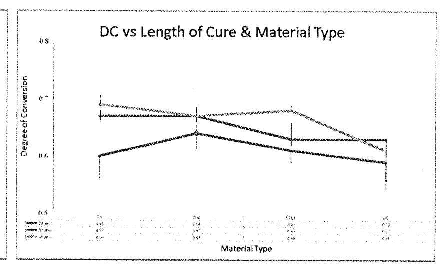
Star: μ= 0.0588 +/- 0.0001, EL/LL: μ= 0.0986 +/- 0.0002

Degree of Conversion (DC)

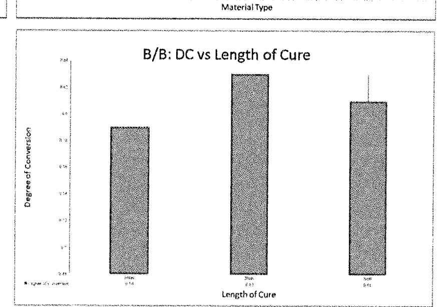








- Attenuation Coefficient:
  - Star VPS < EL/LL
- Degree of Conversion:
  - Air: Distance 0-6mm had no effect; Length of cure: 10s<20, 30s
  - Star VPS: Thickness and length of cure had an interaction effect: at 2, 3, 6mm, 10s<20, 30s; at 4, 5mm, 10=20=30s
  - EL/LL: Thickness variations: no effect; Length of cure: 10s<20, 30s; 20s>10s
  - B/B: One thickness; Length of cure: no effect
  - Material type: B/B < Air, Star, EL/LL; Air=Star=EL/LL; Length of cure: 10s<20<30s



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DISCUSSION

- AC: Star < EL/LL therefore Star transmits more light
- With AC of each material, using the equation,

$$I(x) = I_0 e^{-\mu x}$$

it is possible to determine the light intensity through any thickness of material.

Thickness(mm) (x)	I(x): Light intensity through material (mW/cm²) Star μ= 0.0588	EL/LL μ= 0.0986
2	1066.86	985.23
3	1005.94	892.72
4	948.50	808.90
5	894.33	732.95
6	843.26	664.13
7	795.11	601.77
8	749.70	545.27
9	706.89	494.07
10	666.52	447.68

- Studies recommend 400mw/cm2 minimally to achieve adequate polymerization therefore even at 10mm, each of these materials transmits enough light to be effective.
- Even though EL/LL transmits more light than Star VPS, there was no difference in DC.
- The DC curing through B/B had about 8% less polymerization than the other tray materials.
- The DC curing through Star VPS and E/LL was similar to the DC of the composite after curing through air.
- At 10, 20, and 30s, the DC was independent of the tray thicknesses evaluated. However, the DC was dependent on the length of the curing time in which curing for 10 seconds yielded about 6% and 8% less degree of cure than curing for 20 and 30 seconds respectively.

CONCLUSIONS

- There was a difference between the AC of Star VPS and EL/LL and therefore the hypothesis was accepted.
- Thickness had no effect on DC, however, length of cure and material type did have an effect on DC and therefore the hypothesis was partially accepted.
- Star VPS, EL/LL and B/B, at any thickness up to 6 mm, produced clinically acceptable DC for bonding.
- In general, prolonging the curing time through any material equates to an overall increase in DC.
- Although curing for 30 seconds rather than 10 seconds produced about 8% higher DC, more studies will need to be conducted for determining the significance between DC and bond strength.