Influence of Deep Margin Elevation on Fracture Strength and Fracture Type of Indirect Composite Onlays

Emine Kıtın[1], Oktay Yazıcıoğlu[1]

[1]Department of Restorative Dentistry, Faculty of Dentistry, İstanbul University, Turkey

OBJECTIVE

The aim of this in-vitro study is to investigate if Deep Margin Elevation(DME) procedure affects the fracture strength and fracture type of onlay restorations made of three different indirect composite materials.

MATERIALS AND METHODS

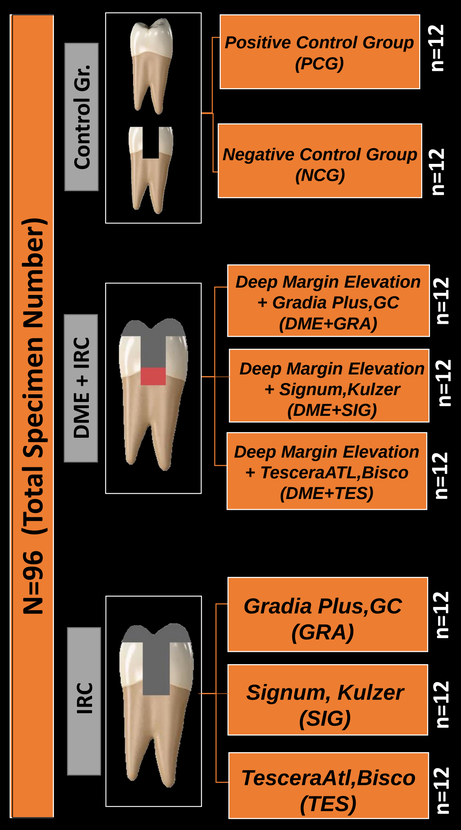


Figure 1: Overview of the groups design.

- The study was approved by Istanbul University Ethics Comity(Number:2021/31)
- Ninety-six freshly extracted, similar-sized upper premolar teeth were randomly divided into eight groups (n=12), embedded into self-cure acrylic resin and standardized MOD onlay cavities were prepared on both proximal boxes located 2.00 mm below the Cemento-Enamel junction as shown in Figure 2.
- Three different indirect resin composites(IRCs) were used for onlay restorations with and without DME for six groups and two control groups were created as Figure 1.
- Deep Margin Elevation(DME) procedure was performed with the application of 3M™ Scotchbond Etchant (3M ESPE, St. Paul, MN, USA) for 15 sec. and after washing and gentle drying, 3M™ Singlebond ™ Universal Adhesive(3M ESPE, St. Paul, MN, USA) was applied to proximal boxes and polymerized with 3M™ Elipar™ S10 light cure device (3M ESPE, St. Paul, MN, USA). Then a thin layer of Filtek Supreme Flowable (3M ESPE, St. Paul, MN, USA) and Z250 Microhybrid Universal Composite (3M ESPE, St. Paul, MN, USA) for 2mm thickness was applied with SuperMat™ matrice system (KerrHawe, Orange, CA, USA) and light cured separately(Figure 3 and Figure 4).
- Indirect Resin Composites were manufactured according to the manufacturer's instructions and each onlay was cured at its special curing unit. The inner sides of onlay restorations were sandblasted with 50µm Aluminium oxide powder at 2.5 bar pressure for 15 sec., approximately 10 mm far from the inner surface.
- Before the cementation procedure, cavity surfaces were subjected to tribochemical silica sandblasting with CoJet (3M Espe Seefeld, Germany).
- For the cementation procedure, 3M™ Singlebond™ Universal Adhesive was applied to the both bonding surface of onlay and cavity surface with rubbing for 20 sec. And the solvent was evaporated with gentle oil-free air for 5 sec.
- RelyX™ Ultimate Adhesive Resin Cement (3M ESPE, St. Paul, MN, USA) was applied and dispensed to the bonding surface of the onlay and seated to the cavity with firm pressure. Tack cured for 2 sec, excessive cement removed with a scaler, and then polymerized for 20 sec for each surface with 3M™ Elipar™ S10 light cure device.
- All samples were stored in distilled water at 37°C for 24h and exposed to Thermo-mechanical cycling(5000 cycles, 5-55 °C, and 30 sec dwell time) for artificial aging.
- A compressive loading test(1mm/1sn) was performed with Universal Testing Machine(Shimadzu Corporation, Japan). Failure values(Newton) and fracture types(Restorable, Nonrestorable) were recorded and samples were examined by Scanning Electron Microscope(Figure 5).
- Shapiro-Wilk Test was used for the normality of data distribution. Comparisons of indirect composite materials and DME procedure variables were performed using Mann-Whitney U Test and Independent Sample T-Test($p<0.05$).

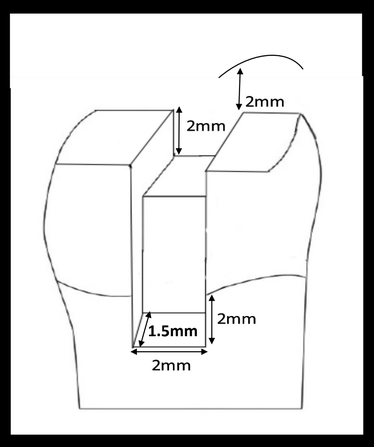


Figure 2: Dimensions of Cavity preparation

Figure 3: Materials used for Deep Margin Elevation

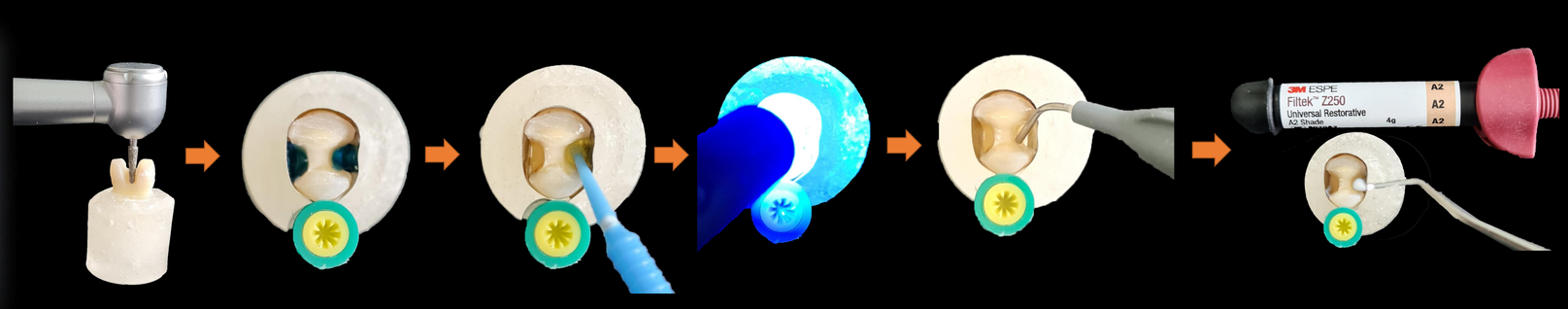
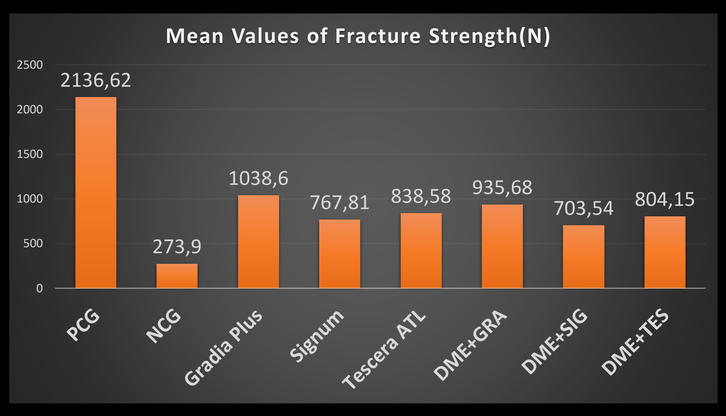


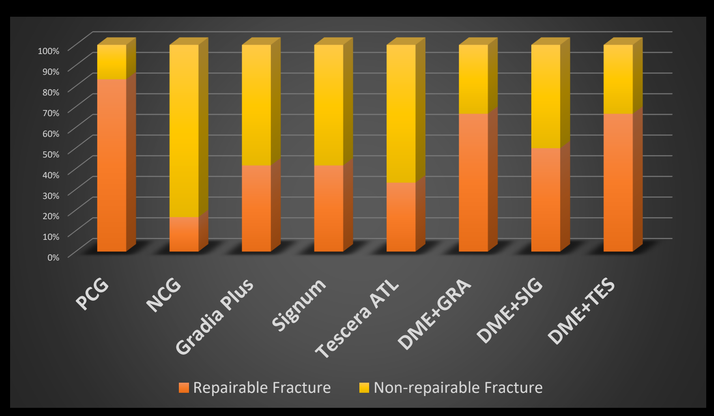
Figure 4: Application of Deep Margin Elevation procedure

RESULTS

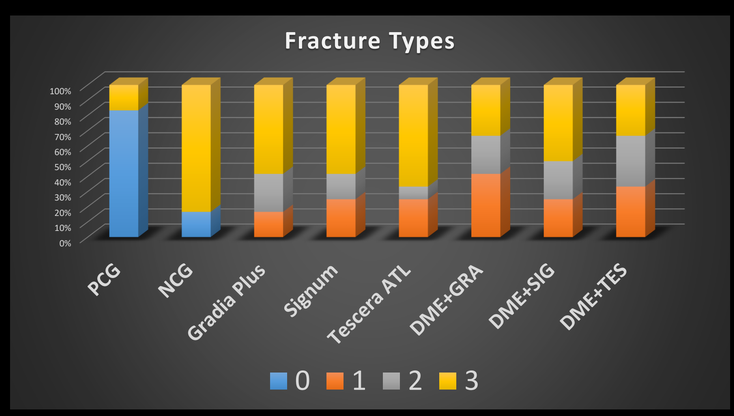
Statistically; PCG (intact teeth) has significantly the highest FS (2136,6±350,6N) and NCG has the lowest FS (273,9±88,1) in all groups. Comparing the FS of IRCs numerically; it is found that GRA>TES>SIG for both DME applied and DME unapplied groups. DME did not affect the FS of onlay restorations to a statistically significant level($p=0.149$) but conspicuously affected the fracture type($p<0.001$) of the restorations. While the restorable fracture rate was 61% in DME-performed groups, it was 39% in the groups DME not performed(Graphic 1,2,3).



Graphic 1: Mean Values of Fracture Strength (N)



Graphic 2: Fracture types as regards repairabilty



Graphic 3: Fracture types as regards simulated bone level

(0) : fractures affecting solely the tooth tissue above the simulated bone level
(1) : fractures affecting solely the restoration,
(2) : fractures affecting both the restoration and the tooth above the simulated bone level
(3) : fractures affecting both the restoration and the tooth below the simulated bone level.
0-1-2: Repairable Fracture
3: Non-repairable Fracture

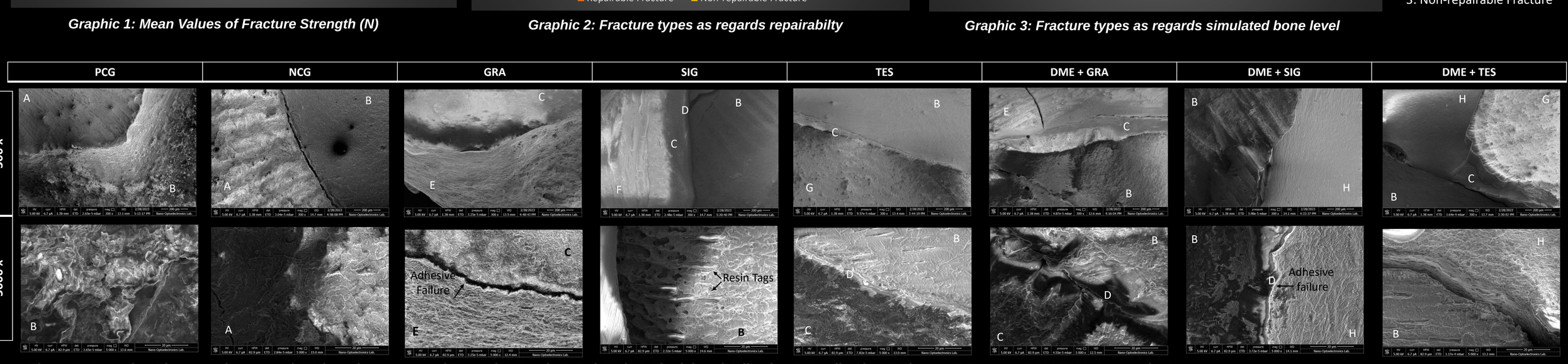


Figure 5: Scanning Electron Microscope(SEM) Analyses Images(Enamel:A Dentin:B RelyXUlt:C Singlebond Adhesive:D Gradia Plus:E Signum:F Tescera:G 3M Z250 Composite:H

CONCLUSION

Within the limitations of this study, DME application did not affect the fracture strength value of onlay restorations. However, DME application improved the fracture type and more restorable fractures occurred in DME-applied groups among DME unapplied groups.

Funding/Conflict of Interest: The present work was supported by the Scientific Research Projects Coordination Unit of Istanbul University. Project Number:38173 No Conflict of Interest.