The Modified Semidirect Onlay Technique With Articulated Elastic Model

ABSTRACT

The modified semidirect onlay technique with articulated elastic model involves the fabrication of a stone model that is quickly mounted on an articulator and it includes an elastic part that enables the fabrication of a restoration with proper occlusal anatomy. The technique overcomes the disadvantages of the direct technique such as polymerization shrinkage stress and difficulty in achieving proper contours and, compared to the indirect technique, treatment is completed in a single appointment, without laboratory cost. The novelty of the technique is that, since the restoration is fabricated on an articulated model it eliminates time for occlusal adjustments.

Keywords

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INTRODUCTION

Aesthetic bonded posterior restorations can be categorized as direct, indirect and semidirect.[1] In the direct technique, all restorative steps are performed intraorally, with resin composite, in one appointment. However, there are certain drawbacks, especially when extended cavities including cusp coverage are concerned, such as polymerization shrinkage and difficulty in achieving proper occlusal and interproximal anatomy.[2] Consequently, the direct approach is recommended for small and medium size cavities.

Indirect restorations with resin composite have overcome the aforementioned problems, as the fabrication of the restoration is performed extraorally, on a model. Occlusal and interproximal anatomy are controlled[3] and polymerization stress is limited only in the thin layer of the resin cement, resulting in a potentially better marginal adaptation and seal.[4-6] Moreover, physical and mechanical properties may be improved due to the post-polymerization procedure.[7,8] On the other hand, indirect technique requires two appointments, a provisional restoration and the cooperation with a laboratory that leads to an increased treatment time and cost. Therefore, the indirect technique is mostly suggested for multiple restorations when aesthetics and dynamic occlusion issues are important.

The semidirect technique was introduced in an attempt to deal with the problems related with the direct approach and to reduce the time and cost of the indirect technique. The technique includes three approaches. The first one, computer-aided design/computer-aided manufacturing (CAD/CAM)[9] has undergone major improvements over time, but the technology remains expensive and treatment cost is still high.[2,10]

The second approach is the intraoral one: composite is placed incrementally intraorally in a tapered cavity previously lubricated with glycerine gel. After photopolymerization the restoration is removed. Additional light/

heat polymerization is applied and the restoration is finished, polished and bonded. This approach can be very accurate in terms of marginal fit.[11] However, it can be very difficult and time consuming to remove the restoration from the cavity, even if undercuts are blocked prior to the initial insertion of the composite.[12] This is attributed to the cavity configuration[13] and the micro retentive features created by the burs during tooth preparation. Therefore, the use of this technique is limited only to simple design cavities with very divergent walls.

The third approach is probably the most cost and time effective. An elastic non-articulated working model is fabricated from an impression of the cavity and the composite restoration is prepared on it.[12,14-16] With this technique even more conservative cavity designs, with less divergent walls, can be restored.[12] The major advantage is that the clinician can treat the patient with a low-cost restoration fabricated outside the mouth, in a single appointment.

The longevity of semidirect posterior restorations is promising. No significant differences were found after 3.5 years of clinical service between direct and semidirect fine hybrid posterior composite restorations in medium size cavities with respect to clinical performance and marginal adaptation.[17] Moreover, in an 11-year clinical study, excellent marginal adaptation and low rate of secondary caries were observed.[18]

However, with the extraoral semidirect technique performed on a non-articulated cast the occlusal anatomy is restored arbitrarily, based on the anatomy of the proximal teeth. This could result in consuming a lot of time after bonding of the restoration for occlusal adjustments and re-polishing, not mentioning the possibility of infraocclusion, necessitating the intraoral addition of resin composite.

A technique to fabricate a mounted elastic model has been previously described.[19] However, both the antagonist and the working model were elastic and a plastic articulated base form was used, rather than a rigid metallic articulator, raising questions about the accuracy of the mounting and the resulting occlusion.

The aim of this article is to describe step by step a modified technique where the elastic model for the semidirect onlay fabrication is mounted quickly with the antagonist cast on a stable, gypsum-free articulator. The working cast is comprised of an elastic silicone part, where the onlay is fabricated and the rest is made of fast setting mounting stone. The antagonist cast is also fabricated from fast setting mounting stone and then mounted quickly with a gypsum-free, rigid articulator, ensuring stable occlusal contacts. The benefit of this technique is that appropriate occlusal anatomy of the composite restoration is achieved extraorally with no guessing, thus eliminating significant time for intraoral adjustments.

Case Report - Technique

A 30-year old female patient presented seeking restorative treatment. Tooth #24 had a defective MOD amalgam restoration, tooth #25 had a provisional restoration after endodontic therapy and there was also decay on the mesial surface of tooth #26. The patient was living abroad and was leaving the following day, therefore, there was only one appointment available to finish all restorations.

Shade selection was performed prior to any treatment and before rubber dam placement, with the tooth moist, as dehydration of the tooth results in lighter and more opaque tooth colour. Shade guides and intraoral photographs were utilized. Enamel and dentin shades were selected and correct shade was verified by light curing a small amount of composite on the tooth to be restored.

Before starting the preparation, occlusal contacts were checked with a 20µm articulating paper to estimate the margins and occlusal anatomy of the restoration. After rubber dam placement, all old restorations and caries were removed. Tooth preparation was very conservative and special attention was paid not to remove any sound tooth structure *(Figure 1)*.

Figure 1: Initial aspect of the tooth #25, after rubber dam placement and removal of the temporary restoration. Old restorations and carries have been removed from the adjacent teeth also. In this case the tooth had undergone endodontic treatment and both of the proximal ridges were missing, therefore cuspal coverage was decided for both palatal and buccal cusps.

It was decided that teeth #24 and #26 were treated with direct restorations, as the cavities were medium size. At tooth #25 the remaining cusps were reduced occlusally with a diamond bur (FG 156 012) *(Table 1)* for cusp coverage with the onlay. The tooth was endodontically treated, therefore gutta percha was removed from the coronal part of the root canal up to the bone level to avoid future tooth discoloration. It was decided that a semidirect restoration would be the most appropriate treatment due to the size of the cavity that was rather extended for a direct restoration and the lack of time for an indirect. Multiple restorations are a clear indication for the indirect technique, where a rigid model is used. However,

Table 1: Table of materials and instruments used for articulated elastic model technique

Generic Material	Trade name and Manufacturer
Diamond burs	FG 156 012, FG 197 025, FG 248F 012, HoricoDENTAL, Berlin, Germany
Adhesive system	Bond-it, Prentron, Orange, CA, USA
Flowable composite	Flow-it ALC, Pentron, Orange, CA, USA
Restorative resin composite	Flow-it ALC, Pentron, Orange, CA, USA
Alginate impression material	Kromopan, Lascod, Florence, Italy
Fast setting addition type silicon	Mach-2, Parkell, Edgewood, USA
Articulation stone	mega-Artikulationsgips, megadental GmbH, Büdingen, Germany
Gypsum-free articulator	MagicArt-2, Alphadent Co, Seoul, Korea
Polishing Kit	Astropol, Ivoclar Vivadent AG, Schaan, Liechtenstein
Articulation paper	20 µm Accufilm, Parkell, Edgewood, USA 8 µm Shimstock, Hanel, Langenau, Germany
Rubber dam	KKD, Sympatic Dam Medium, Kentzler-Kaschner Dental GmbH, Ellwangen/Jagst, Germany
Resin cement	Cement-it Universal C&B, Prentron, Orange, CA, USA
Polishing paste kit	Enamel Plus polishing paste Shiny kit (Shiny A, Shiny B Shiny S), Micerium, Avegno, Italy

in case of the semidirect technique utilizing the elastic model it is preferred that only one tooth is restored. Due to the elasticity of the model, fabricating multiple restorations on it could introduce errors, especially at the interproximal contact areas.

The exposed dentin was treated immediately after preparation with an adhesive system realizing the immediate dentin sealing technique (Bond-it). A full description of the materials and the instruments used with this technique is included in Table 1. All undercuts were eliminated using a medium viscosity composite resin. The coronal part of the root canal was filled with a flowable composite (Flow-it ALC) *(Figure 2*). Cavity preparation was finished with a fine diamond bur (FG 197 025) and all enamel margins were cleaned from adhesives and composite. The rubber dam was removed and alginate impressions (Kromopan) of both arches were taken.

Figure 2: After completion of the restorations of the adjacent teeth and occlusal reduction of both cusps of the tooth #25, the exposed dentin and the coronal part of the root canal are sealed with adhesive system and resin composite.

A fast setting and very rigid addition type silicon die material (Mach-2) was poured in the alginate impression on the tooth to be restored and the two adjacent teeth *(Figure 3*). After 2 minutes, fast-setting articulation stone (mega-Artikulationsgips) was poured in the rest of the impression. The antagonist

model was fabricated by pouring the fast-setting articulation stone in the alginate impression. After 10 min setting time the casts were removed from the impressions and trimmed. Consequently, the maxillary and mandibular casts were connected with the relevant member of a gypsum-free articulator (MagicArt-2) and articulated by tightening the grips with an Allen driver *(Figure 4)*.

Figure 3: Addition type silicon material has been poured and set in the alginate impression on the tooth to be restored and the adjacent teeth. After setting of the silicon, fast-setting articulation stone is poured in the rest of the impression.

Figure 4: Maxillary and mandibular casts mounted on the articulator without mounting stone. The onlay has been fabricated.

The onlay was fabricated on the articulated model with consecutive increments of resin composite of 1-1.[5] mm thickness. Each layer was light cured for 40 sec. A resin composite system with enamel and dentin shades was used (Artiste) in order to achieve better aesthetics. For the initial layers dentin shade composite was used mimicking the anatomy of dentin, while for the final layers enamel shade composite was placed in 0.5 mm thickness, to restore the occlusal and proximal anatomy. The occlusal contacts were properly adjusted on the articulated model *(Figure 5)*. Fine and ultra-fine burs were used to finish the restoration and silicon polishers (Astropol) to smooth the rough texture left by the burs and to give an initial gloss to the restoration.

Figure 5: Occlusal aspect of the working model after the fabrication of the onlay. The elastic part of the model is detachable.

The onlay was then tried-in intraorally. The proximal contacts were checked with 20 µm (Accufilm) and 8 µm thickness articulation paper (Shimstock) and were slightly adjusted. Once proximal contacts were adjusted, the fit and the colour of the restoration were evaluated intraorally. Minor discrepancies of the marginal fit and small colour differences can be corrected with the luting cement/composite. The internal surface of the restoration was treated with 50-µm alumina air particle abrasion to remove any contamination from the intraoral try-in procedure, and then it was steam cleaned.

After rubber dam placement (KKD, Sympatic Dam Medium) the cavity was cleaned with a plastic prophy cup and pumice slurry at low speed with a micromotor. Then, enamel was selectively etched for 30 sec with 37% phosphoric acid, rinsed with water spray for 30 sec and air dried. A thin layer of dual cure bonding resin (Bond-it) was applied on the onlay and on the cavity surface and it was air-thinned. An adequate amount of dual cure resin cement (Cement-it) was applied on the intaglio of the onlay.

The onlay was inserted into the cavity and carefully held in place by pressing with a rounded plugger on the occlusal surface. After two minutes the resin cement starts to polymerize and the excess was removed with the use of a microbrush. Dental floss was used to remove excess cement from interproximal areas. After two more minutes, glycerine gel was applied on the margins of the restoration and photo-polymerization was performed for at least 60 sec per surface with a LED curing unit *(Figure 6)*. Rubber dam was removed, the occlusion was checked carefully and adjusted where needed. As all previous steps were performed correctly, only minor adjustments were necessary *(Figure 7)*.

Figure 6: Try-in of the onlay before bonding. Proximal contours created with this technique are satisfactory.

Figure 7: Occlusal aspect of the restoration after bonding, rubber dam removal, occlusal checking and final polishing. Note that the occlusal anatomy has not been altered.

The margins were finished with an ultra-fine diamond bur (FG 248F 012) and silicon polishers (Astropol). Final polishing was performed with diamond pastes (Enamel Plus Shiny A, Shiny B) applied with a natural goat-hair brush (Enamel Plus Shiny S) and aluminium oxide paste (Enamel Plus Shiny C) applied with a felt wheel (Enamel Plus Shiny F) *(Figure 8*).

Figure 8: Occlusal-lingual view of the restoration after final polishing of the margins.

POTENTIAL PROBLEMS WHEN USING ALGINATE FOR THE FINAL IMPRESSION

The material used for the impression of the tooth preparation in this technique was alginate that sets in 90 sec, but, shows inferior accuracy compared to addition silicone materials (polyvinyl siloxanes). Therefore, the silicone working model may not be accurate and marginal adaptation of the final restoration may not be perfect. Silicone could have been selected as an impression material, but, it would adhere to the injected silicone die material, therefore a separator agent would be needed. Alternatively, condensation silicone or polyether with longer setting time could be used with similar accuracy than addition silicones and with the advantage of no adherence to the injected addition silicon die material. However, in cases of minor marginal discrepancies, bonding the restoration with heated restorative resin composite can eliminate this problem. If medium viscosity resin composite was selected an ultrasonic instrument could be used to properly seat it. One additional potential problem is that due to the elasticity of the working model the proximal contacts are often rather tight, requiring intraoral adjustment. Due to the aforementioned restrictions related with the impression and the working model materials this technique is not recommended for multiple posterior restorations.

Advantages of the semidirect onlay technique using an elastic model in general

- Lower polymerization shrinkage stress due to the extraoral fabrication.
- Better control of anatomy and contours.
- Restoration completed in a single appointment and in a relatively short time.
- Low cost compared to the indirect technique.
- Opportunity for the patient to rest during the extraoral fabrication – suitable for difficult patients.
- Provisional restoration is not needed.

Disadvantages of the semidirect onlay technique using an elastic model in general

- Possibility of marginal discrepancies.
- Often tight interproximal contacts – need for intraoral adjustments
- Possible occlusal discrepancies if not quick mounting performed

Advantages of the modified semidirect onlay technique with articulated elastic model vs. non-articulated

- Better control of occlusal anatomy and contacts due to the mounting with the antagonist model.
- The time required for mounting is minimal

CONCLUSIONS

Semidirect technique with quick mounting of the elastic model against the antagonist on a gypsum-free articulator offers the significant benefit of fabrication of a restoration with proper occlusal contacts and anatomy, in a short time period, eliminating need for post cementation adjustments.

Clinical relevance

The modified semidirect onlay technique enables the fabrication and cementation in the same appointment of a posterior restoration with proper occlusal contacts and anatomy, in a short time period and with relatively low cost, eliminating need for post cementation occlusal adjustments.

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