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From conception to implementation: Step-by step case presentation with Alternate Injection Moulding Technique

By **Maria Fostiropoulou**, Greece

Direct anterior restorations are time-consuming procedures that heavily rely on the clinician's expertise. Handling traditional composites to achieve aesthetic outcomes in complex cases can be challenging, often leading clinicians to favor indirect restorations for extensive treatments.[1] The injection moulding technique, initially introduced by Douglas Terry and John Powers in 2014, has emerged as a viable alternative for performing direct restorations more predictably, as it allows the precise intraoral transfer of a wax-up using a transparent index.[2,3] This technique reduces technical sensitivity, is simpler to execute with moderate skill requirements, and is cost-effective.[4]

This clinical report presents a modification of the standard injection moulding technique, referred to as alternate injection moulding, applied in a case with aesthetic concerns due to missing teeth, diastemas and irregular tooth proportions.[5] The alternate technique requires both a partial and a full wax-up, utilizing two separate models and two transparent silicone indexes, respectively. This approach provides several benefits, including enhanced index stability, minimized excess material, improved embrasure contours and more precise contact points.[6,7]

A 57-year-old female, non-smoker patient was referred to the Postgraduate Clinic of Restorative Dentistry of National and Kapodistrian University of Athens, Greece, for aesthetic rehabilitation of the anterior maxillary region. The patient's primary concern was to enhance her smile aesthetics using the least invasive approach. Her medical history was unremarkable, with no medications being taken at the time of consultation.

Fig.1: Pre-operative view buccal

Fig.2: Pre-operative view palatal

Fig.3: Frontal view on the occlusion

A comprehensive clinical examination revealed the absence of the upper right canine, which had been extracted during prior orthodontic treatment. Multiple diastemas and black triangles were observed, along with altered tooth proportions primarily due to wear of the central incisors. The lateral incisors exhibited buccal inclination. Initial intraoral and extraoral photographs were taken (Fig. 1-3). Periodontal assessment showed no signs of inflammation or disease and radiographic evaluation revealed no pathological findings.

The main objective was to enhance the patient's aesthetics by optimizing tooth proportions, closing diastemas and black triangles, and reshaping the upper right first premolar to resemble a canine. Given the patient's preference for a minimally invasive approach, an additive treatment strategy was prioritized. Since the patient was satisfied with her tooth color, bleaching was excluded from the treatment plan. Considering these factors, the ideal course of treatment involved the placement of seven composite veneers (teeth 1.5–2.3), utilizing the alternate injection moulding technique.

First, the teeth were professionally cleaned and calculus was removed. A digital impression was taken using an intraoral scanner and in collaboration with our lab technician, an additive wax-up was designed. This wax-up was transferred intraorally through a mock-up using a silicone index made of condensation silicone and a dual-cured bis-acrylic resin (Tempsmart DC, GC) allowing for visualization of the final outcome and assessment of aesthetics and phonetics. Occlusal parameters were also evaluated in this step to verify function and confirm the viability of the design. As the patient had approved the treatment plan and was satisfied with the proposed tooth shapes and proportions, with no modifications needed, a total and partial digital wax-up were created, and two printed models were fabricated based on these designs to facilitate the alternate injection moulding technique.

For the fabrication of the silicone indexes, a 92-Shore laboratory silicone was utilized in the first step to provide a rigid vertical stop. Subsequently, clear vinyl polysiloxane (EXACLEAR, GC) was dispensed in a non-perforated metal tray to create the two transparent silicone indexes. Both indexes had the appropriate thickness of 7-10mm to avoid distortion during placement. After removing the excess silicone with a scalpel and verifying the accurate fit of the indexes on the models, perforations for the injectable composite were made from the inside, along the long axis of the tooth, positioned centrally on the incisal edge. These perforations were created using the same metal syringe tip that would later hold the flowable composite for the injection process (Fig. 4).

For shade selection, the button technique was employed, and images were captured using a DSLR camera (D7200, Nikon Corporation) (Fig. 5.), with additional images taken using a cross-polarization filter (Polar_Eyes, Bioemulation) (Fig. 6). To take advantage of the chameleon effect the composites exhibit, the same shade, A2 G-ænial Universal Injectable GC, was selected for all teeth.

A second mock-up was conducted, and the teeth were prepared through this mock-up using a 1-mm depth cutting bur (DM10, Komet) (Fig. 7-8).

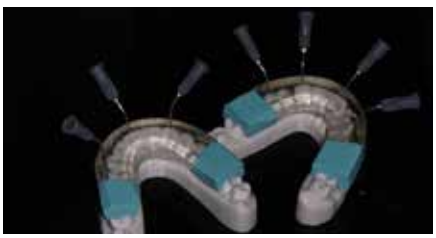

Fig.4: Creation of the EXACLEAR silicone keys

Fig.5: Shade selection with the button technique

Fig.6: Shade selection with a cross-polarization filter

Fig.7: Mock-up

Fig.8: Teeth preparation through mock-up

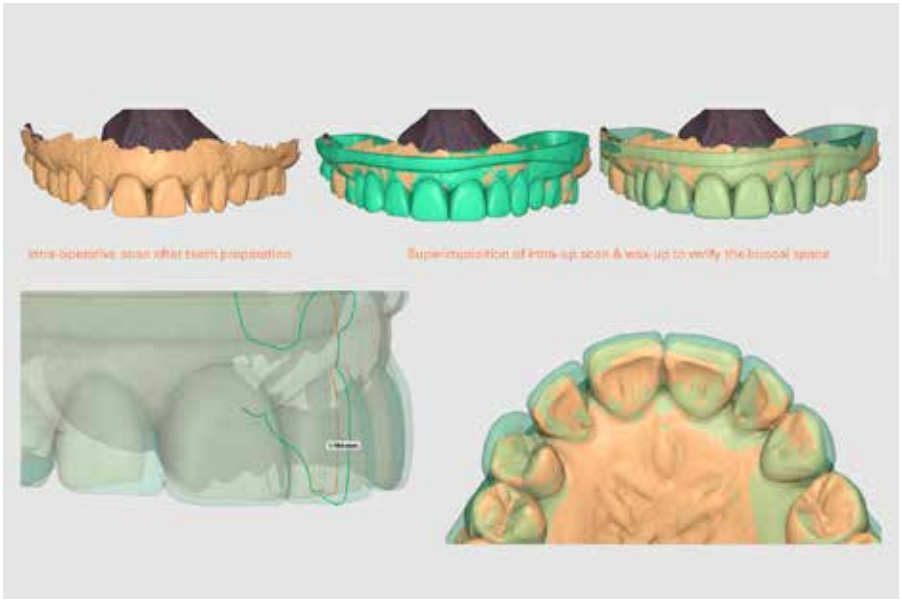

Fig.9: Digital verification of buccal space

Upon completion of the preparations, an intraoperative scan was performed, which was then superimposed with the wax-up STL file to verify the uniform buccal space for the composite material. This step was crucial to prevent composite translucency issues (Fig. 9).

Following tooth preparation, multiple teeth were isolated using rubber dam (NicTone Heavy, MDC) and optimal gingival retraction was achieved with dental floss ligatures (Fig. 10-11).

The superficial enamel surface was sandblasted with 53-µm aluminum oxide particles (AquaCare, Velopex) to roughen the surface and enhance bond strength. Teeth not included in the treatment plan were protected with metal strips. Every other tooth was etched with 37% orthophosphoric acid for 30 seconds, while adjacent teeth were also protected with metal strips (Fig. 12). After thorough rinsing and drying, G-Premio BOND (GC) was applied on the etched teeth while the adjacent (non-etched) teeth were protected with PTFE tapes. The adhesive was air-thinned for 5 seconds with maximum air pressure and light-cured for 10 seconds per tooth (Fig. 13).

After application of the bonding agent, the partial silicone index was placed and checked for accurate fit. PTFE tapes, positioned before bond application, remained in place (Fig. 14). G-ænial Universal Injectable A2 was injected into alternating teeth, filling the entire facial surface, and light-cured for 40 seconds. Excess composite material was meticulously removed using a № 12 scalpel blade and metal polishing strips until all excess was eliminated, ensuring no

Fig.10: Rubber-dam placement with dental floss ligatures

Fig.11: Rubber-dam placement (palatal view)

Fig.12: Etching every other tooth with 37% orthophosphoric acid

Fig.13: G-Premio BOND application

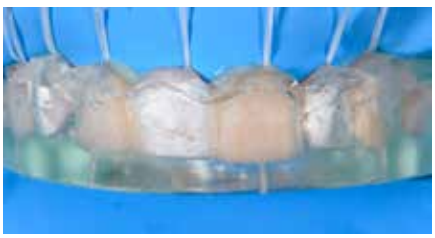

Fig.14: Partial silicone key placement

Fig.15: After injection of every other tooth

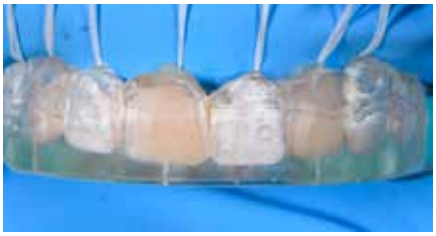

Fig.16: Total silicone key placement

gaps and achieving the optimal contour of the injected teeth (Fig. 15). Before proceeding with the injection of the remaining teeth, the total silicone index was placed, and its fit was carefully checked. This step is crucial to ensure that all excess material from earlier stages has been properly removed, preventing interference with the seating of the total index. Once fitting was confirmed, the same adhesive protocol was followed: etching the enamel surface for 30 seconds with 37% orthophosphoric acid, applying G-Premio BOND, air-thinning, and light-curing each tooth for 10 seconds. The previously injected teeth were protected with PTFE tapes throughout this process. With the PTFE tapes in place, the total silicone index was positioned, G-ænial Universal Injectable A2 was injected into the remaining teeth, and the material was light-cured for 40 seconds (Fig. 16). Final light curing of the vestibular surfaces was carried out for 20 seconds, applying a glycerin gel to prevent the formation of an oxygen-inhibited layer.

The most challenging aspect of this technique is the meticulous removal of excess material, which is critical for ensuring proper marginal adaptation and aesthetic integration of the restorations. Finishing the restorations, particularly in the cervical and interproximal areas, is facilitated by a № 12 scalpel blade (Fig. 17) and finishing strips (Fig.18). Special care must be taken during this step, as excessive finishing with strips on the proximal surfaces can lead to open contact points and potential food entrapment. Fine diamond burs are highly effective for contouring the cervical area, ensuring a smooth transition from natural tooth structure to the restoration, without overhanging margins (Fig. 19).

An 8-µm articulating paper was used to assess occlusal contacts. Only minimal occlusal adjustments were required, thanks to the technique's precise replication of the wax-up in the final restorations. The accuracy of the transparent silicone index also ensured that the vestibular surface exhibited satisfying primary morphology, requiring little to no reshaping. Transition lines were drawn using a pencil, and minor adjustments were made with aluminum oxide-coated discs (Sof-Lex, 3M) (Fig. 20).

Polishing was completed using a 3-step composite polishing system with elastic discs (Jiffy, Ultradent) and diamond paste at low RPM and low pressure to enhance the gloss while preserving the surface texture (Fig. 21). This step is crucial for all direct restorations, especially in the esthetic zone, as it ensures the longevity of the result. Highly polished composites prevent plaque accumulation, retain their gloss for extended periods and are less prone to absorbing colorants and stains.

Fig.17: Excess removal with scalpel blade No.12

Fig 18: Excess removal with metal polishing strips

Fig 19: Finishing with fine diamond burs

Fig 20: Refining the transitional lines with aluminum oxide-coated discs

Fig 21: Polishing with diamond paste

Fig 22: Final result after 2-weeks frontal view

Fig 23: Final result after 2-weeks side view

Fig 24: Final result after 2-weeks palatal view

At the two-week follow-up appointment, color matching was reassessed after the hard tissues were fully rehydrated. The restorations exhibited excellent color adaptation and seamless integration with the surrounding soft tissues, promoting healthy gingival condition (Fig. 22-24). The patient was pleased with the outcome, both in terms of aesthetics and function. After 6 months follow-up, no gingival inflammation, bleeding on probing, loss of surface gloss or staining of the restorations were detected (Fig. 25).

Fig 25: 6-month follow-up

The refined injection moulding technique presented in this case report represents a viable treatment option, particularly for patients seeking aesthetic improvements through a minimally invasive, additive-only approach without the higher costs of indirect restorations. Key advantages of the injection moulding technique include its predictability, reproducibility, simplicity, minimal invasiveness, and cost-effectiveness. The alternate approach minimizes resin flow onto adjacent teeth, eliminating the need for extensive interproximal adjustments and time-consuming excess material removal after polymerization. Compared to traditional direct anterior restorations, this technique delivers a more precise outcome while significantly reducing clinical time.[8]

References:

1. Perdigão, J.; Araujo, E.; Ramos, R.Q.; Gomes, G.; Pizzolotto, L. Adhesive dentistry: Current concepts and clinical considerations. J Esthet Restor Dent. 2021, 33, 51-68. doi: 10.1111/jerd.12692.
2. Terry DA, Powers JM. A predictable resin composite injection technique, Part I. Dent Today. 2014;33(4):96-101.
3. Terry DA, Powers JM, Mehta D, Babu V. A predictable resin composite injection technique, part 2. Dent Today. 2014;33(8):12.
4. Geštakovski D. The injectable composite resin technique: biocopy of a natural tooth - advantages of digital planning. Int J Esthet Dent. 2021;16(3):280-299.
5. Coachman C, De Arbeloa L, Mahn G, Sulaiman TA, Mahn E. An Improved Direct Injection Technique With Flowable Composites. A Digital Workflow Case Report. Oper Dent. 2020;45(3):235-242. doi:10.2341/18-151-T
6. Geštakovski D. The injectable composite resin technique: minimally invasive reconstruction of esthetics and function. Clinical case report with 2-year follow-up. Quintessence Int. 2019;50(9):712-719. doi:10.3290/j.qi.a43089
7. Ypei Gia NR, Sampaio CS, Higashi C, Sakamoto A Jr, Hirata R. The injectable resin composite restorative technique: A case report. J Esthet Restor Dent. 2021;33(3):404-414. doi:10.1111/jerd.12650
8. Peumans, M. Geštakovski, D.; Mattiussi, J.; Karagiannopoulos, K. Injection moulding technique with injectable composites: quick fix or long-lasting solution? Int Dent Afr. 2023, 13, 14-22.