Integrated orthodontic and restorative procedures: Orthodontic space management, digital technologies, and injectable technique

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Following orthodontic treatment, minimally invasive restorative techniques are often required to achieve optimal esthetics and function. The injection molding technique (IMT) involves the application of a flowable composite into a transparent silicon index. Because of its fluid nature, the composite quickly fills the silicon tray and integrates smoothly with the tooth structure. This procedure in orthodontics, along with new orthodontic technologies, is crucial in addressing complex multidisciplinary patients. This article illustrates the use of conservative dentistry with IMT in a 14-year-old girl with agenesis of the maxillary lateral incisors (teeth 1.2 and 2.2). The prerestorative orthodontic treatment began with the digital design of a skeletally anchored palatal device to mesialize the maxillary posterior teeth. The interdisciplinary treatment was completed with the restoration of the anterior teeth using IMT. Aiming to provide noninvasive, patient-centered interdisciplinary treatment, IMT proves to be an excellent procedure for optimizing orthodontic treatment by restoring the final tooth in a predictable, cost-effective, and highly esthetic manner. (Am J Orthod Dentofacial Orthop Clin Companion 2025;XX:XX-XX)

The need for minimally invasive restorative techniques frequently arises at the end of orthodontic treatment, when reshaping is required to complete the esthetic result of the therapy to keep the biological burden as low as possible. Comprehensive and well-planned integration of orthodontic and restorative procedures is crucial for the successful management of complex multidisciplinary patients. After completing the orthodontic therapy, patients often need to improve the final result, especially in the presence of dental abrasions, anomalies in tooth shape and size, and Bolton discrepancies. Dental recontouring through mere odontoplasty is insufficient to address significant changes in tooth morphology,[1] as seen in patients with orthodontic space closure with agenesis of the maxillary lateral incisors.

New digital technologies (eg, intraoral scanning, cone-beam computed tomography [CBCT], digital orthodontic setups, and digital smile design [DSD]) can facilitate the 3-dimensional planning of interdisciplinary treatments. Digital previsualization[2] is helpful for treatment planning and the final restorative phase, guiding wax-ups and mockups for defining final tooth shapes based on esthetic and functional evaluations. The initial design phase is also simplified using open-source software, which is fundamental during previsualization.[3,4]

The objective of this case report was to illustrate a comprehensive interdisciplinary treatment approach in a young patient with congenitally missing maxillary lateral incisors. This approach involved a complete digital workflow in planning the required orthodontic tooth movements, followed by minimally invasive postorthodontic restorations using the composite injection molding technique (IMT).

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INJECTION MOLDING TECHNIQUE

The IMT is a restorative technique developed by Douglas.[5,6] It leverages the physical and mechanical capabilities of the new generation of flowable composites, which are injected through a transparent silicon index, to produce medium- to long-term mockups. This solution is particularly beneficial for young patients, providing a valid alternative to conventional direct restorations until definitive rehabilitation with all-ceramic veneers can be performed. Recently, this technique has gained significant interest because of its time and cost efficiency compared with traditional prosthetic solutions.[7,8] This has led to the development of new and increasingly precise protocols, described by Marco Veneziani as the IMT using the innovative, customized hybrid index (CHI).[9]

Nowadays, after collecting digital standard orthodontic records (including facial and intraoral photographs, x-rays, and initial study casts), these data were organized in software platforms that allow for integrated management of all information. Using proprietary or open-source software, the final shapes and sizes of the teeth are digitally designed. Once the desired outcome is determined, a first trial of the final result, called a mockup, is performed directly in the patient's mouth using temporary resin. This mockup can be easily modified and adapted for a perfect shape and fit according to the patient's desires and needs.

In the classic technique described by Terry et al,[5,10,11] a silicon index is applied to the definitive wax-up. The space between the tooth and the silicon mold is filled with flowable composite to build the desired shape in a single injection. Therefore, a flowable composite is used and adhesively cemented, similar to the classic composite restoration technique.

With the introduction of the innovative "CHI" by Marco Veneziani,[9] it is possible to use fluid or heated (thermoviscous) composites, separating the layers of dentin, enamel, and opalescent incisal masses, thus notably improving the esthetic result compared with the previous technique.

The CHI mask is a multilayer index consisting of 3 different elements: (1) a highly transparent 60 Shore silicon inner layer in direct contact with the injected composite (flowable or thermoviscous), (2) a second stiffer silicon layer of 70-80 Shore as support, and (3) a thermoformed resin shell (1-mm thickness) as a rigid outer layer.

The injection holes are calibrated according to the type of Compule tip or syringe needle used. The IMT can be achieved using 2 different approaches: (1) a monolithic 1-stage approach with 2 different modes—1 step (simultaneous injection of all teeth) or 2 steps (injection with alternating teeth), and (2) a layered multilevel approach.

In the 1-stage technique, only a single template is used to inject the entire tooth volume. This is the simplest solution, allowing for the fast reconstruction of all dental elements with the same material. However, stratification and color diversification are not possible.

The 2-stage layered injection technique is an innovative approach that involves layering a heated packable composite dentin body, an opalescent enamel, and a final layer of enamel. This approach improves the overall esthetic outcome and needs 2 different CHIs—1 for the dentin body and 1 for the enamel—and 3 different injection steps.

CASE REPORT

The young 14-year-old female patient presented with bilateral agenesis of the maxillary lateral incisors accompanied by a persisting deciduous right lateral incisor and spontaneous mesial eruption of the left canine, resulting in near-complete space closure. The right molars and canines exhibited a Class I relationship, whereas the maxillary left canine had a full Class II relationship, and the maxillary left molar had shifted into a 3-mm Class II occlusion. Overjet and overbite were both 3 mm (Fig 1).

The maxillary dental midline was deviated 3 mm to the left. Cephalometric analysis indicated a normodivergent Class I skeletal growth pattern (Fig 2).

After a thorough discussion with the patient and her parents, the treatment plan was designed to include extraction of the deciduous maxillary right lateral incisor, followed by symmetrical space closure to eliminate the need for prosthodontic replacement of the missing teeth. This approach avoids future reliance on a resin-bonded fixed partial denture or implant-supported crown in adulthood. The patient and her parents were informed of the resulting therapeutic Class II molar and canine relationships and the importance of restoring the canines and first premolars to achieve functional occlusion and an esthetically pleasing outcome.

During the first phase of treatment planning, a DSD was performed to simulate the necessary tooth movements in the anterior zone, with a special focus on centering the maxillary dental and facial midlines (Fig 3).

The prerestorative orthodontic treatment started with the digital design of a palatal device (T-mesial slider) for the mesialization of the maxillary right posterior teeth.[12] The stereolithography files obtained from the initial intraoral scan and the digital imaging and communications in medicine images obtained from the CBCT were matched and supported by artificial intelligence software (Blue Sky Bio, LLC, Libertyville, Ill). The automatic tooth segmentation process was activated to facilitate visualization of the miniscrew insertion. Subsequently, a surgical guide was created for the insertion of 2 temporary skeletal anchorage devices in the anterior paramedian area of the palate according to the indications of Ludwig et al.[13] The partial palatal maxillary right first molar band was digitally designed with the free Meshmixer 3D software (Autodesk San Francisco, Calif). The device was completed with a self-ligating vestibular multibracket appliance using an indirect bonded tray (Fig 4).

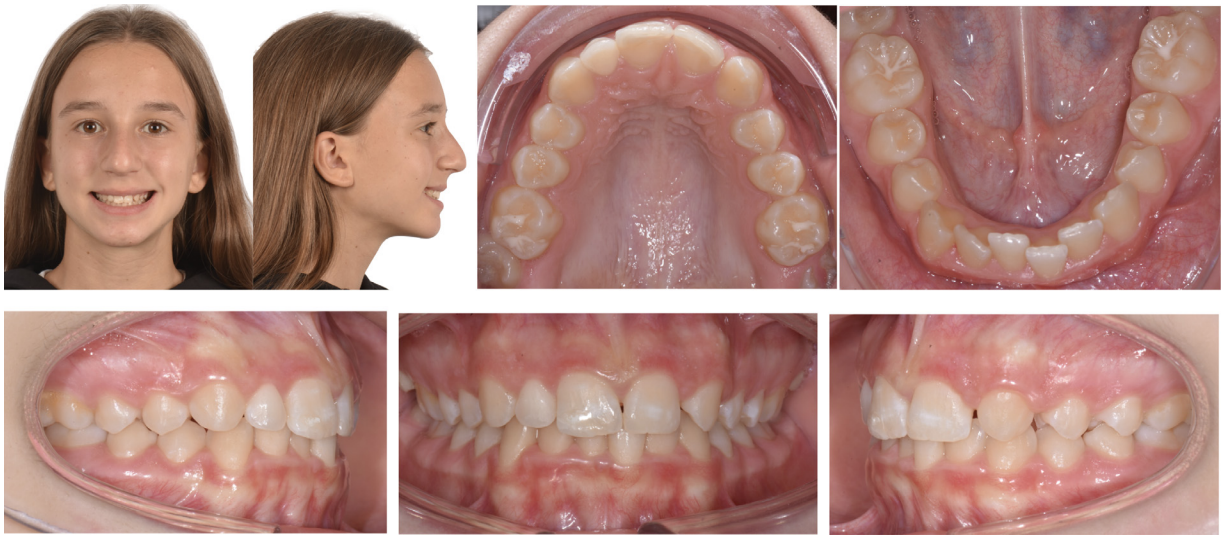

Fig 1. Pretreatment initial facial and intraoral photographs.

After completing the orthodontic space closure, the morphology of the canine, now positioned as a lateral incisor, and the first premolar, which will replace the canine, must be harmonized. As planned, bilateral canine and molar full Class II relationships were achieved, along with a correct overjet and overbite. The canines were successfully mesialized into the positions of the missing lateral incisors. In addition, the maxillary and mandibular midlines were corrected and were now aligned with the facial midline (Fig 5).

The anterior limit of the teeth was preserved. This mesial movement was accomplished with proper root angulation, maintaining the torque of the maxillary incisors (Figs 6 and 7).

To provide an optimal orthodontic result, a traditional but DSD-driven wax-up on a 3-dimensional-printed stereolithographic model was performed by a dental laboratory. The new shapes and volumes of the wax-up were transferred to the mouth with a silicon index and by molding a self-curing bis-acrylic resin with a spot etching technique (Fig 8 panels A-E). The application of the direct resin mockup with the new tooth shapes allowed the orthodontist to visualize and explain to the patient and her parents that, because of altered passive eruption, surgical crown lengthening in the maxillary esthetic zone would be necessary for achieving a pleasing smile.

Then, a split-full thickness flap from the maxillary right first premolar to the maxillary left first premolar with preservation of the palatal papillae was elevated, and an adequate vestibular osteoplasty for surgical crown lengthening was performed. When substituting the canine for the lateral incisor, the emergence profile may be challenging to reproduce because of the wider cervical width around the cementoenamel junction. Therefore, a minimal reduction of the mesiodistal width of the teeth was performed, along with the crown lengthening procedures, using a sonic diamond tip for stripping (Komet SFD1F, SFM1F) on a sonic handpiece. Furthermore, the buccal canine convexity was slightly reduced by enameloplasty with fine-grain diamond burs (Fig 9).

Fig 2. Initial panoramic and cephalometric radiographs.

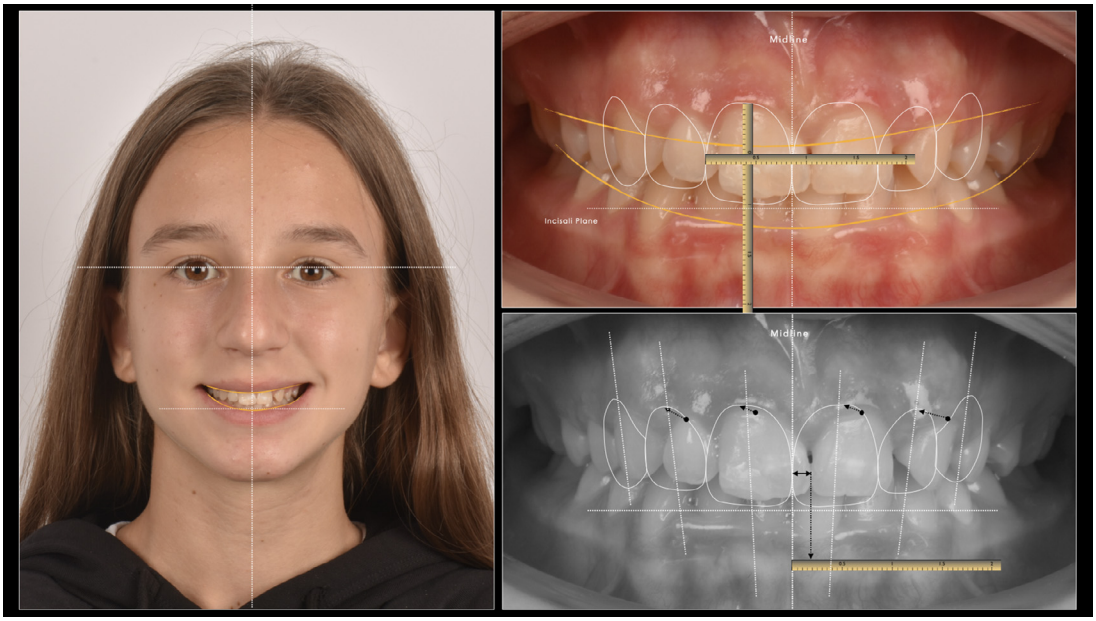

Fig 3. Pretreatment initial records: digital preview by means of DSD and digital teeth measurement with a calibrated digital ruler.

Fig 4. Orthodontic treatment progress.

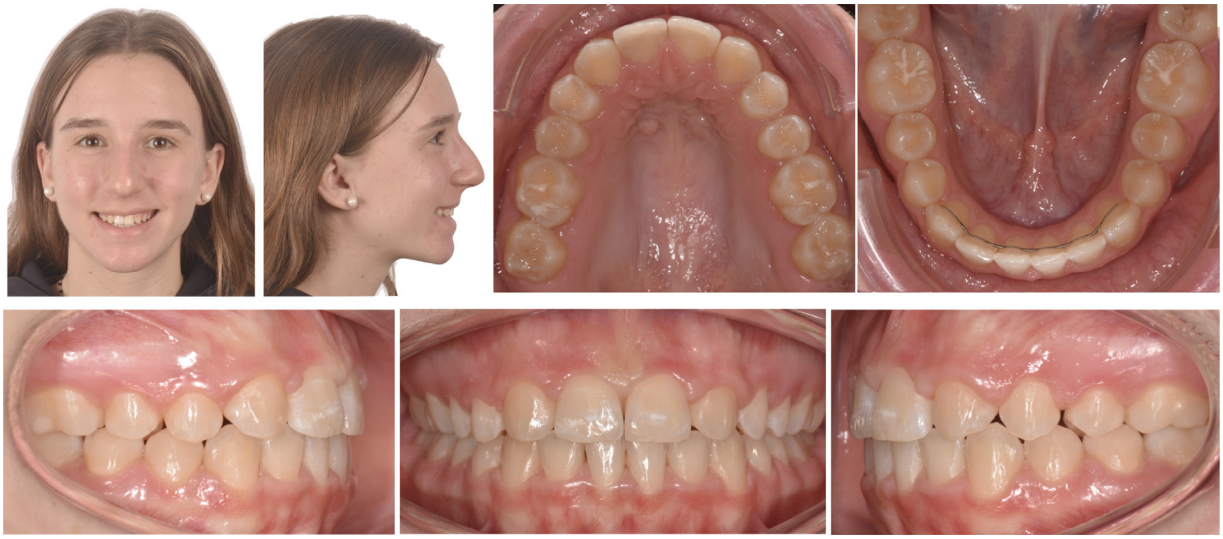

Fig 5. Posttreatment facial and intraoral photographs.

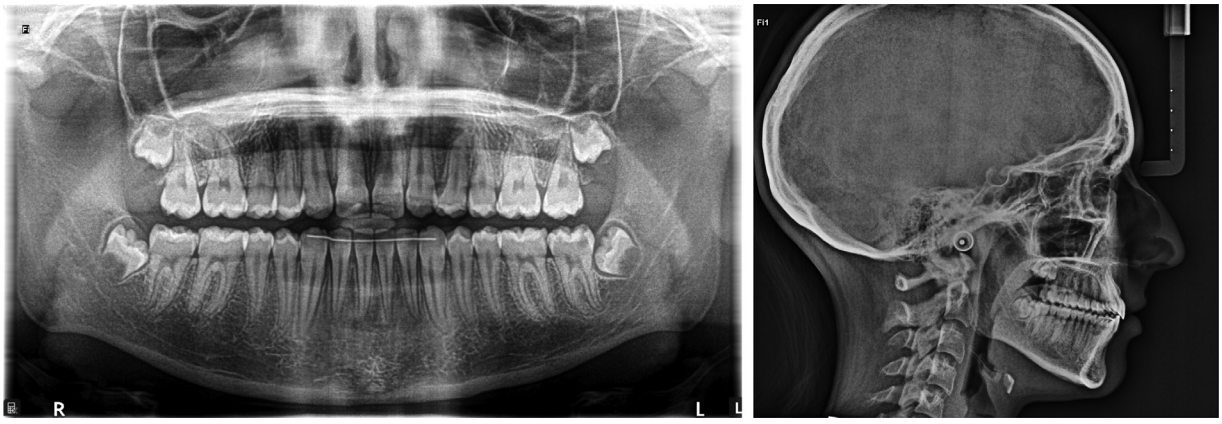

Fig 6. Posttreatment panoramic and cephalometric radiographs.

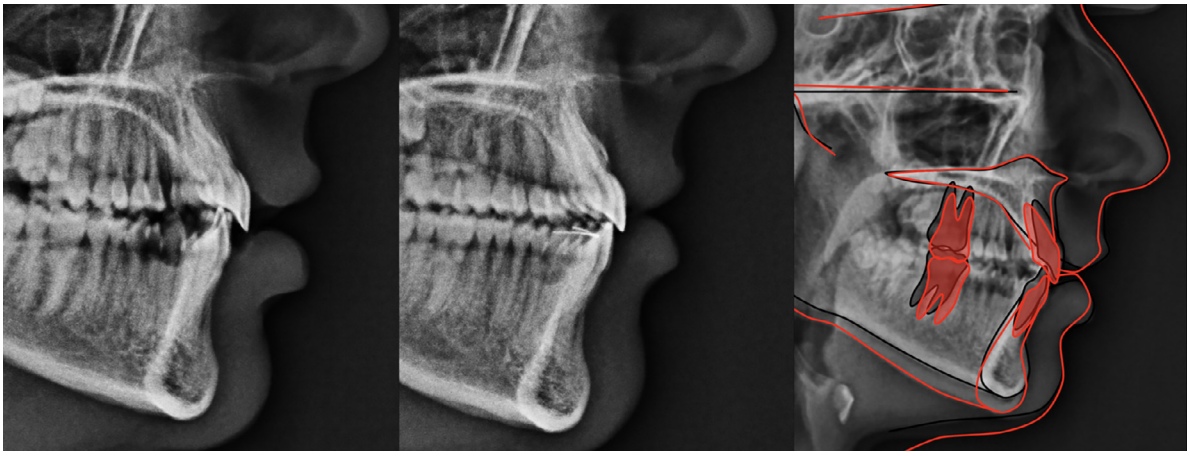

Fig 7. Change in the anterior limit of dentition.

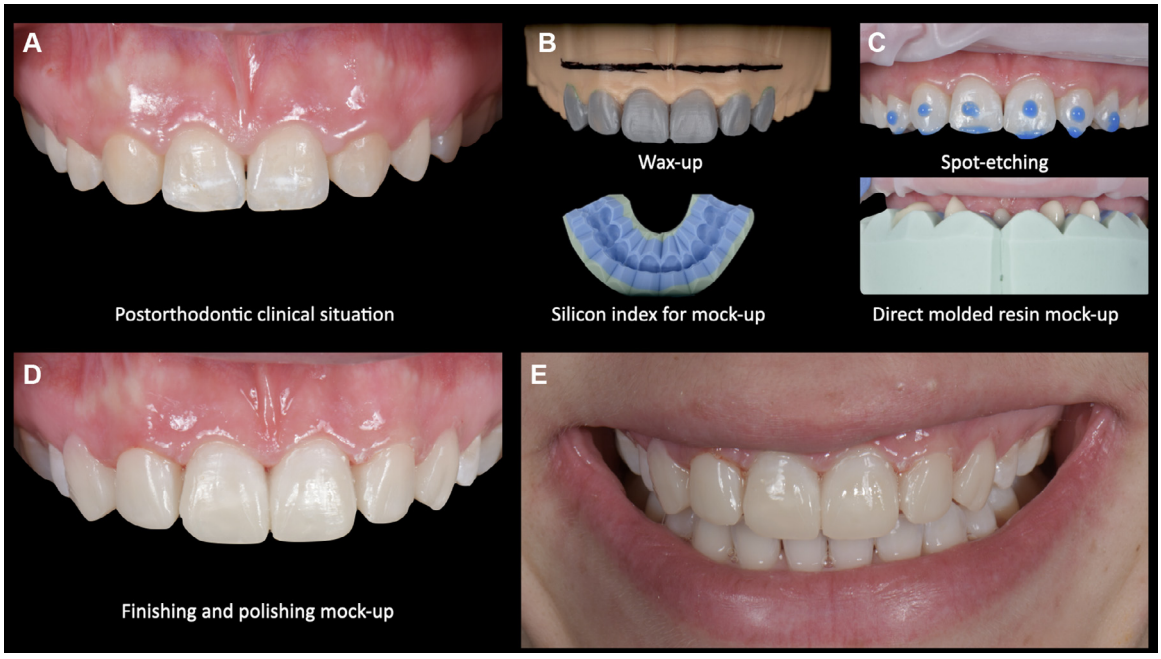

Fig 8. Intraoral view before surgical and restorative treatment: **A,** Postordontic clinical situation; **B,** Wax-up of the 6 anterior teeth and direct resin mockup; **C,** Spot etching on the buccal side and placement of the silicon index filled with self-curing bis-acrylic resin; **D,** Careful finishing and polishing; **E,** Full smile and face with the clinical previsualization.

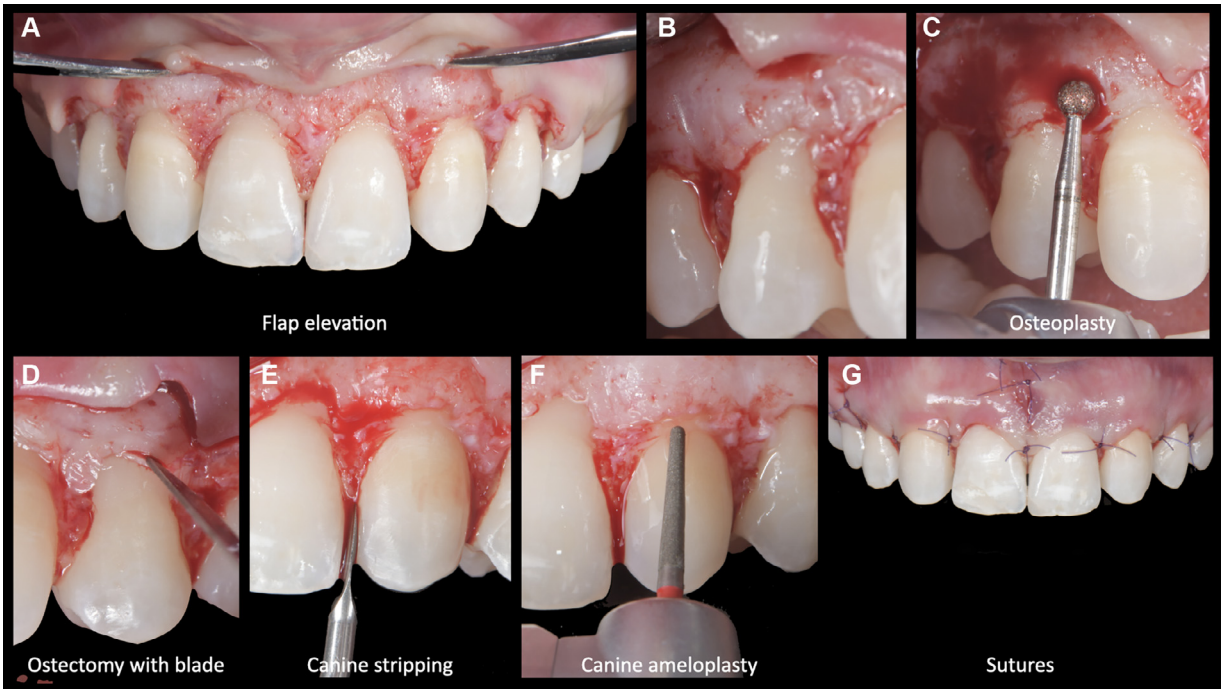

Fig 9. Surgical crown lengthening to solve the altered passive eruption: Intrasurgical osteoplasty, ostectomy, interproximal reduction, and recontouring of the canines.

The injectable technique, usually, is completely additive; when it is necessary to perform a minimal tooth preparation, an enamel recontouring without any conventional finishing line may be performed.

Restorative treatment started after 4 months of tissue maturation using the additive minimally invasive IMT with a high-filled flowable composite injected through the innovative CHI (Fig 10). A monolithic 1-stage approach with 2 steps was used. The first step involves soft sandblasting, an alternating (every-other-tooth) isolation with a Teflon tape, adhesive procedures (2-step self-etching adhesive system), and, finally, the injection phase with flowable composite (Universal Injectable, GC) and polymerization through the index (Fig 11, *A-D*). One can appreciate the clinical result after the first alternating injectable step without any bubbles and with an ideal reproduction of the anatomy created by wax-up (Fig 12, *A*). Accurate finishing procedures are necessary

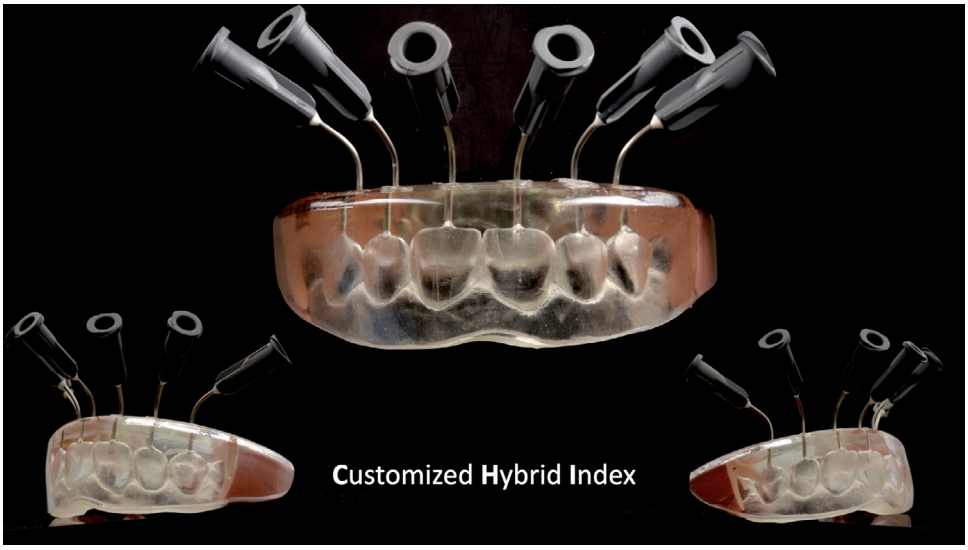

Fig 10. Innovative, customized hybrid index by Veneziani-Quintavalla for injection technique.

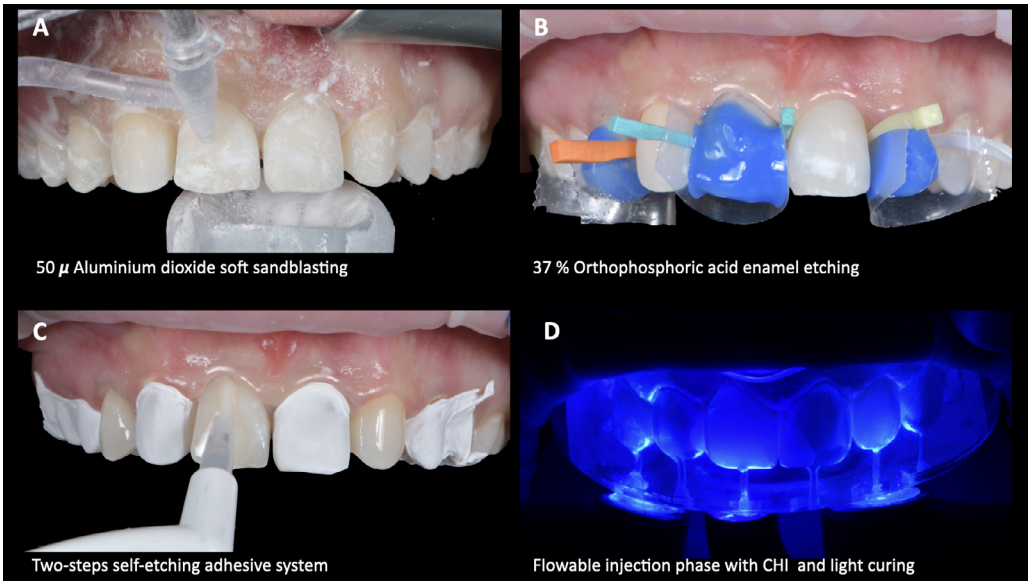

Fig 11. The monolithic 1-stage approach 2 steps: **A,** Soft sandblasting; **B** and **C,** Alternating isolation with Teflon tape and adhesive procedures; **D,** The injection phase with flowable composite and polymerization through the index.

with utmost attention not to induce bleeding, which would compromise the second injection phase. The second step follows the same protocol for the completion of the remaining teeth (Fig 12, *B*). During the subsequent finishing phase, all the small excesses were carefully removed by means of medium-grit diamond bur and reciprocating handpiece, and final polishing involved diamond pastes and cotton felt pads. The final photograph shows a very natural-looking tooth anatomy with harmonious proportions, optimal color and light reflection, and healthy gingival tissues (Fig 12, *C*).

The final right and left lateral occlusal views evidence (also compared with the initial situation) the ideal morphofunctional and esthetic rehabilitations after the comprehensive minimally invasive orthosurgical-restorative approach (Fig 13). The final picture of the face shows a good dentolabial and facial integration of the morphofunctional and esthetic rehabilitation (Fig 14). A close-up view

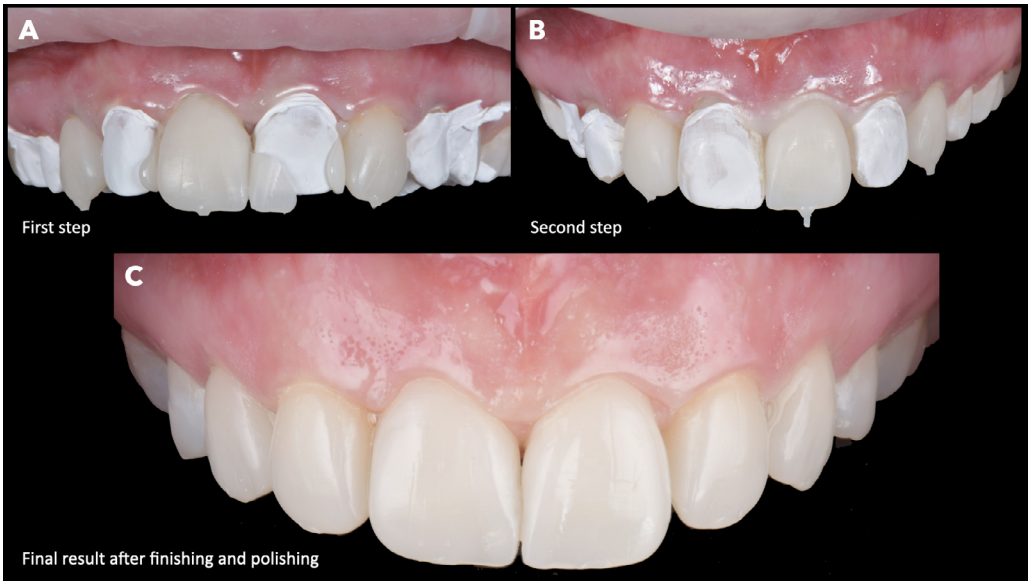

Fig 12. A, Intraoral view after the first phase of flowable injection every-other-tooth; **B,** Intraoral view after the second phase of flowable injection every-other-tooth; **C,** Finishing and polishing: natural anatomy with right teeth proportions, an optimal color and light reflection.

Fig 13. Pretreatment and posttreatment intraoral photographs.

of the central incisor highlights the ideal shape, texture, and incisal opalescence, confirming the high potentiality of the injectable technique for delivering excellent, cost-efficient outcomes (Fig 15).

Fig 14. Posttreatment smiling facial photograph.

DISCUSSION

The injectable technique is a straightforward treatment option for patients seeking esthetic enhancement.

This case report outlines the practical application of the IMT to reshape the tooth morphology in a young patient with agenesis of the maxillary lateral incisors.

This innovative approach offers a viable alternative for patients who are either too young, unwilling, or unable to afford costly and invasive ceramic veneers. A noteworthy advantage of composites over ceramics is the simplicity of repair and substitution if needed, which is particularly beneficial for patients still undergoing changes in vertical gingival, dentoalveolar, or skeletal dimensions. Moreover, composite restorations can easily be polished during subsequent interventions to maintain their pleasing esthetic appeal.

In recent years, the mechanical characteristics of flowable composites, such as wear resistance, strength,

Fig 15. A close-up view of the central incisors highlights the ideal shape and texture and incisal opalescence.

polishability, translucency, and other qualities, have improved. Compared with first-generation flowable composites, the new highly filled fluid resin exhibits superior mechanical qualities, including heightened flexural strength, resilience, modulus of elasticity, wear resistance, and enhanced polishing, which increases the application of IMT.

In combination with new digital technologies—such as intraoral scanning, CBCT, AI-assisted tooth segmentation, and the digital design of orthodontic appliances and surgical guides—this restorative technique enables a simplified and predictable interdisciplinary workflow for managing complex treatment in the esthetic zone.

CONCLUSIONS

Modern dentistry increasingly advocates the importance of close interdisciplinary collaboration among dental specialists, as well as the integration of new technologies and techniques, to achieve the best possible treatment outcomes for patients—outcomes that would be unattainable with traditional individual procedures. However, all team members must be equally skilled, willing to communicate, share common objectives, and be aware of the possibilities and limits of their endeavors.

Although the treating orthodontist is responsible for defining tooth positions and volumes, the restorative dentist will detail the final shape with minimally invasive adhesive procedures. From this new integrated vision of various specialties, the IMT represents an extremely effective tool for completing orthodontic treatment. It significantly reduces chair time and costs compared with traditional ceramic veneers and provides a more predictable design of tooth shape and volumes compared with direct composite restorations. The use of CHI improves the performance of IMT.

CRediT authorship contribution statement

Marco Veneziani: Writing – original draft, Writing – review & editing, Conceptualization, Visualization, Methodology, Data curation. **Fabio Federici Canova:** Writing – original draft, Software, Visualization. **Ute E.M. Schneider:** Supervision. **Lorenz Moser:** Supervision.

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CONFLICTS OF INTEREST

Marco Veneziani: EDRA publisher Royalties for book: Solutions, OSTEOCOM Royalties for lecture and video; payments were made for lectures and courses: Dental campus, GC Italia, 3M, Kulzer, University of Geneva, Mimetika Group Geneva, ANDI Catania, Komet Italia, ANDI Treviso. Support for attending meetings and/or travel: Dental campus, GC Italia, 3M, Kulzer, University of Geneva, Mimetika Group Geneva, ANDI Catania, Komet Italia, ANDI Treviso, K2 Conference & Event Management Co. Receipt of equipment, materials, drugs, medical writing, gifts, or other services: Kulzer, GC, Kuraray, VOCO, 3M Solventum, SDI, Edelwise, Micerium, Komet. From all of the former companies received some composite materials and burs to test.

Fabio Federici Canova: Surgical Guide for Orthodontic Dental Implants (Italian patent No. 102022000020961; November 10, 2022).

All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest.

STATEMENT OF INFORMED CONSENT

Informed consent has been obtained from the patient.

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