RESTORATIVE–ORTHODONTIC INTEGRATION

Facially Driven Interdisciplinary Integrated Digital Orthodontics: A Proof of Concept

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Abstract: The more clinicians learn about interdisciplinary dentistry and expand their facial analysis skills, the more they realize the importance of starting planning with the ideal smile design in mind. In this sense, for many restorative cases, starting the treatment with tooth movement can yield numerous advantages, such as improved biological, structural, functional, and esthetic outcomes and a more conservative, less invasive treatment. However, in a conventional planning model, in most cases orthodontics is usually not integrated, mainly because of an incorrect diagnosis. This typically is due to the clinician or restorative dentist neglecting to visualize the benefits of moving teeth or the patient not wanting orthodontic treatment because of a lack of understanding or perceived value. Similarly, orthodontists also may fail to offer a comprehensive treatment because they do not envision the restorative needs in advance or how the new tooth position will relate to the patient's face. To help clinicians address these issues, this article presents concepts of a facially driven interdisciplinary digital workflow that facilitates the restorative–orthodontic integration through the combined use of digital smile design concepts and orthodontic aligners.

Traditionally, when clinicians followed a conventional treatment sequence it was only possible to visualize the restorative result after executing all the planned procedures, and some specialties were deprived of input to the case. As a result, clinicians often may have missed key steps along the way and fallen short of achieving the optimal esthetic and functional outcome. In the past, analog diagnostic wax-ups and model setups were the instruments that provided the vision of the outcome before the procedure was performed, but these methods obviously had significant limitations. Clinicians could not create different designs easily or make precise comparisons between where they were in the process and where they wanted to be, nor could they compare different scenarios. Moreover, and perhaps most importantly, the design could not be linked to treatment simulations, precluding clinicians from being able to fully see the impact of each procedure on another, and disallowing them to clearly visualize which combination of procedures was the most ideal for each case. For example, a smile rehabilitation case may benefit from the implementation of orthodontic treatment; however, if the case is not properly diagnosed, orthodontic treatment may be overlooked. The literature has shown benefits of digital smile design in planning complex orthodontic cases.[1]

Likewise, in many cases the orthodontist may not realize the need to improve the tooth form and thus may neglect to offer the ideal treatment plan. It is common to see final orthodontic outcomes that require additional restorations to achieve the desired smile; this problem stems from the orthodontist failing to see the need for this combination from inception, before starting the case.

Another evident problem is that orthodontic appliances have never been the object of patients' desires. The reasons are quite obvious: long-lasting, uncomfortable, and expensive treatments.[2] Although extremely important, clinicians may undervalue the use of orthodontics and, knowing that patients generally don't like orthodontic treatment despite its benefits, may instead opt for more aggressive treatments that require greater tooth preparation and offer less stability in order to obtain an esthetic result. This "restorative

camouflage" treatment plan approach can generate higher risk for such issues as periodontal problems, dental fractures, esthetic compromises, decays, endodontic injuries, and temporomandibular joint disorders. This is why the treatment provided by restorative dentists can benefit from the moving of teeth beforehand and why it is important for orthodontists to be able to identify the need for an interdisciplinary plan. Avoiding orthodontic treatment may save time and investment in the short term but not in the long term, and explaining this to patients can be a challenge.[3]

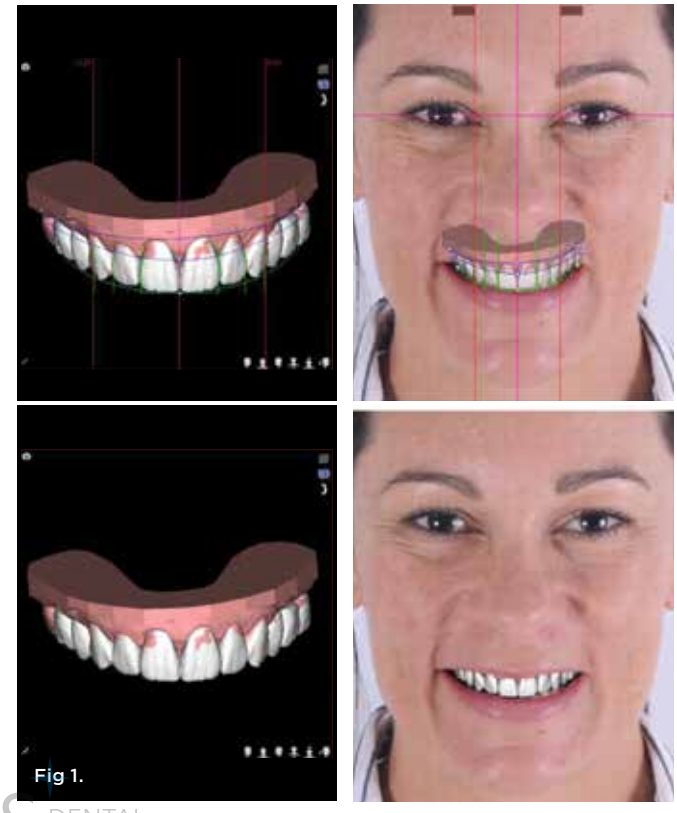
To be rehabilitated, often times a patient's smile ideally needs the combination of tooth movement and restorations.[3] However, such a case may be improperly diagnosed, meaning that the orthodontist does not recognize the need for restorations, and/or the restorative dentist fails to see the benefits of moving teeth at the beginning of the treatment. The facially driven interdisciplinary digital workflow can help both parties see the benefit of this combination. Orthodontic treatment when incorporated and planned in accordance with the ideal smile design can reduce the complexity of the rehabilitation and enable unnecessary procedures to be avoided by moving teeth and stimulating bone remodeling.

Over the years, many orthodontic appliances and techniques have been created to promote better, faster, and more predictable tooth movement; these include conventional fixed brackets, self-ligating brackets, lingual orthodontics, and, more recently, removable aligners. All of these methods aim to promote a physiological force system to create an adequate inter-arch and intra-arch relationship.[4,5] The advantage of using removable aligners (the authors specifically use the Invisalign® system, Align Technology, Inc.) in the facially driven interdisciplinary digital workflow is having the capability to virtually plan all movements according to ideal smile design in harmony with the face and have teeth movement integrated with interdisciplinary procedures.[6,7]

The collaboration between digital smile design (DSD) concepts and the use of orthodontic clear aligners effectively: (1) allows clinicians to perceive whether or not there is a need to move teeth, (2) provides 3-dimensional (3D) visual information so that the team can understand the benefits of teeth movement and become convinced of its importance, (3) enables the team to understand the ideal plan, and (4) facilitates the patient's acceptance of the need to invest their finances and time in orthodontic treatment.[8] The interdisciplinary team can work with the DSD Planning Center (dsdplanningcenter.com) to together create the ideal 3D smile design in harmony with the patient's face. This workflow follows a particular sequence, which is described below.

Technique

Patient documentation. The starting point of the workflow is the acquiring of documentation that includes photographs, intraoral or lab scanning, videos, and cone-beam computed tomography (CBCT) scans in multidisciplinary cases in which orthodontics, orthognathic surgery, and/or implant surgery are combined. All of this documentation is sent to the DSD Planning Center. Photography should include various views of the patient, including frontal, occlusal, 12 o'clock, and sagittal. Dynamic analysis is provided through video.



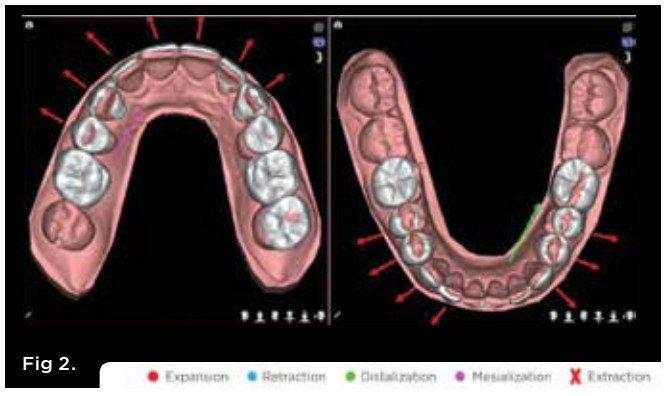


Fig 1. Ideal smile design. Tooth proportions are determined based on a smile frame. An ideal smile is simulated by superimposing the digital wax-up to the patient's photography. **Fig 2.** Orthodontic planning suggested by the software.

Creating the ideal digital smile design. Before planning is started, the ideal smile design should be defined, and the determination should be made as to whether or not orthodontic treatment is needed. To create a natural smile, the face should be used as a reference to determine the ideal tooth size, proportion, and color, the smile curve, and the white (tooth) versus pink (gingiva) proportion (Figure 1).

Treatment planning and simulations. Using virtual planning software (NemoStudio, Nemotec, nemotec.com) and reverse engineering concepts, and with the ability to overlap the patient's initial situation with the ideal smile design, the ideal plan takes shape and is available for all team members to evaluate and offer their professional opinion. In this way, orthodontics and other specialties that participate in oral rehabilitation can work together, one complementing the other, to build the final ideal project. At this stage, it is possible to simulate the restoration and test the necessary steps, making any possible mistakes virtually so that the treatment can be done right when performed in the mouth. This process continues until the best action plan is visually and accurately understood, with all team members acting directly, thus significantly reducing the risk of an incorrect diagnosis and incomplete treatment plan (Figure 2).

Fig 3.

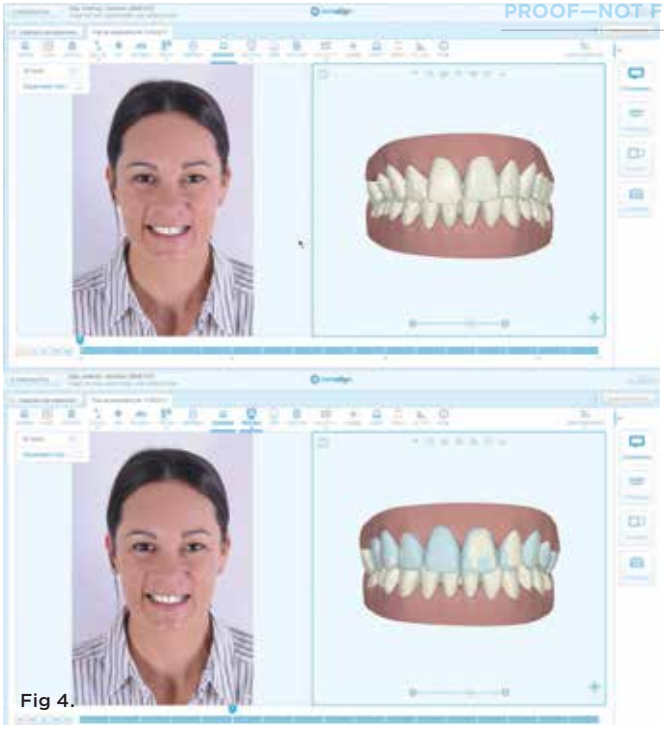


Fig 4.

Fig 3. Clinical proof of motivational mock-up. Comparison between initial smile (left) and ideal smile determined by the mock-up (right).
Fig 4. Orthodontic virtual planning software showing face before (above) and after orthodontic movements (below) for maxillary expansion. Teeth vestibular faces in blue represent the simulated restorations.

Treatment plan presentation and motivational mock-up. The presentation of the plan to the patient should start with the final ideal smile, presented via a motivational mock-up and images that overlap the initial smile and final ideal smile even if there is no restorative need. At this point the goal is to create an emotional link with the patient so that he or she is motivated to carry out the proposed treatment in a comprehensive way (Figure 3).

Digital orthodontics guided by the smile design. Through the collaboration between DSD and Invisalign, it is possible to accurately transfer the approved ideal design into the ClinCheck® orthodontic virtual planning software (Align Technology, Inc.), thereby ensuring that the orthodontist, with the assistance of the DSD Planning Center, will respect the final position idealized by the project. Through the biomechanical characteristic of the aligners, the ideal force system can be created to move the teeth to this position with great precision and predictability. The integration of these two technologies makes it possible to transform virtual projects into actual results that totally respect the design idealized at the beginning, without leaving the digital workflow (Figure 4).

Minimally invasive restorative treatment. Because orthodontics is guided by the ideal smile, the dental position after orthodontic treatment allows for minimally invasive preparation (Figure 5).

Final outcomes and digital quality control. After each and every clinical procedure, a quality control can be executed; thus, treatment maintenance is ensured by comparing results at different follow-up periods (Figure 6 and Figure 7).

Discussion

As clinicians expand their facial analysis and comprehensive skills, the importance of a reverse planning approach based on an ideal smile design becomes increasingly evident.[9] Thus, the better clinicians become at designing smiles in harmony with the face, the more they are able to see the relationship between "ideal" and "actual," and the more apparent the benefits of orthodontics in restorative cases become. In essence, this process moves clinicians from being mouth-driven disciplinary planners to facially driven interdisciplinary planners.[10]

By using a 3D facially driven smile design and understanding the benefits of orthodontic movement prior to other rehabilitation procedures, specialists from the various areas of dentistry will be able to better explain the importance of orthodontics to the patient. Among the beneficial points to note are: (1) improved masticatory function through proper positioning of the tooth root within the alveolar bone, better alignment and distribution of occlusal loads, and

a better relationship between the maxillary and mandibular arches; (2) improved positioning of the teeth, promoting minimally invasive preparations; (3) enhanced leveling of the teeth, minimizing or eliminating gum surgery; (4) improved gingival esthetics provided by bone, soft-tissue, and papillary remodeling in cases with bone crest deficiencies and for implant placement; (5) optimized smile design and facial harmony; and (6) better space distribution and tooth positioning, allowing the construction of a proper emergence profile and coronary morphology.[8]

Orthodontic aligners provide a user-friendly experience for patients as they are removable, hygienic, and relatively comfortable and esthetic compared with traditional orthodontics. Furthermore, one of the main complaints of patients is orthodontic treatment time.[11] In this regard, when taking into account the artificial intelligence of the ClinCheck software, the technological capabilities of the specially engineered material and optimized attachments of the Invisalign aligners, the experience of the dentist/orthodontist, and the use of collective intelligence through the interdisciplinary planning carried out by the dental team with the DSD Planning Center, orthodontic treatment can be provided in a significantly shorter amount of time. In addition, methods for accelerating tooth movements, such as an osteoperforation procedure, are increasingly being used in association with aligners, enabling faster alignment change and more predictable movements. This technique consists of bone perforations to induce inflammatory markers such as chemokines and cytokines, which are responsible for osteoclast recruitment, bone remodulation, and osteoclast maturation in the area.[12-14] Although the cost of treatment with aligners is on average higher than with conventional methods, the value added by the sum of all of these technologies and protocols makes modern orthodontics with digital smile design a treatment that is generally more desirable and acceptable by patients.

Conclusion

There are essentially three challenges clinicians must hurdle to initiate the process of benefiting their patients with tooth movement. First, they must convince themselves of this benefit. One can only fix and offer to patients what one can see. The technology described herein can help in this regard. Second, it is important to convince the specialist team, mainly the restorative dentist. Again, the use of technology can aid in this aspect by generating 3D visual communication. The third hurdle is convincing the patient of the need for and benefits of tooth movement in conjunction with their restoration. Once again, because of adult patients' general reluctance to extend their treatment time with orthodontics, clinicians need to utilize technology to improve patient education and motivation.

Fig 5. Minimally invasive tooth preparation for anterior restorations. **Fig 6.** Final intraoral view. **Fig 7.** Final facial view.

DISCLOSURE

Do the authors have any other disclosures to report?

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