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Case Report

Benefits of Digital Smile Design (DSD) in the conception of a complex orthodontic treatment plan: A case report-proof of concept

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Keywords
Virtual Smile Design
Computer-aided design
Patient care planning
Photographic methods
Orthodontic treatment plan

Summary

Introduction > Digital Smile Design (DSD) is a systematic protocol based on specific photographs and software analysis that is used worldwide. DSD aims to assist the practitioner in creating and planning a course of treatment, especially in a multidisciplinary approach, and provides a virtual simulation of the final result. Additionally, it is a tool that enables communication and discussion between all the dental team, including the dental laboratory, and also with the patient. Although widely described and used in prosthetic rehabilitation, this tool remains only anecdotally used in the world of orthodontics. The objective of this proof of concept was to describe the application of the Digital Smile Design protocol in the diagnosis of orthodontic treatment.

Materials and methods > A teenage patient was referred to our university clinic by a private orthodontic practitioner for a second opinion on the treatment at that time. The patient had a self-ligating orthodontic appliance. According to the history of the case and the oral situation at that moment, the patient required an accurately calculated plan for orthodontic tooth movement that would permit the achievement of future rehabilitation. Therefore, the decision was taken to use a DSD protocol to potentially complete the classic orthodontic examination.

Results > From the classic orthodontic examination, the patient presented a molar class I, midline deviations, the #21 and #23 were missing, #12 was conoid (microdontic) and, finally, #22 was in the position of #21. From the DSD results, three different views simulated the final results and therefore provided additional and relevant information, such as the correct position of the upper midline and the correct position of #12, #13, #22 and #23.

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Conclusion > This proof of concept showed the clinical relevance of the Digital Smile Design protocol as a new tool for complex orthodontic treatment planning, especially in a multidisciplinary approach. Further publications will be necessary in order to define a specific DSD protocol for orthodontic treatment.

Mots clés
Virtual Smile Design
Conception assistée par ordinateur
Planification des soins aux patients
Méthode photographique
Plan de traitement orthodontique

Résumé

Introduction > *Le Digital Smile Design (DSD) est un protocole systématique fondé sur des photographies spécifiques et une analyse logicielle utilisée dans le monde entier. Le DSD a pour objectif d'aider le praticien à créer et à planifier le déroulement d'un traitement, en particulier dans une approche multidisciplinaire, en fournissant une simulation virtuelle du résultat final. De plus, c'est un outil qui permet la communication et la discussion au sein de l'équipe dentaire, y compris avec le laboratoire dentaire, ainsi qu'avec le patient. Bien que largement décrit et utilisé en réhabilitation prothétique, cet outil n'est encore utilisé que de façon anecdotique dans le monde de l'orthodontie. L'objectif de cette démonstration de faisabilité était de décrire l'application du protocole Digital Smile Design dans le diagnostic du traitement orthodontique.*
Matériels et méthodes > *Un patient adolescent a été orienté par un orthodontiste libéral vers notre clinique universitaire pour un deuxième avis sur le traitement en cours. Le patient avait un appareil orthodontique auto-ligaturant. D'après les antécédents et la situation orale à ce moment-là, le patient avait besoin d'un plan de mouvement orthodontique calculé avec précision qui lui permettrait d'obtenir une réhabilitation future. Par conséquent, la décision a été prise d'utiliser un protocole DSD pour compléter l'examen orthodontique classique.*
Résultats > *Lors de l'examen orthodontique classique, le patient présentait une classe I molaire, une déviation de la ligne médiane, une absence de 21 et 23, la 12 était conoïde et, finalement, la 22 se trouvait à la place de la 21. À partir des résultats du DSD, trois vues différentes ont simulé les résultats finaux et ont donc fourni des informations supplémentaires et pertinentes, telles que la position correcte de la ligne médiane supérieure et la position correcte des dents 12, 13, 22 et 23.*
Conclusion > *Cette démonstration de faisabilité a mis en évidence la pertinence clinique du protocole Digital Smile Design en tant que nouvel outil pour la planification de traitements orthodontiques complexes, particulièrement dans une approche multidisciplinaire. D'autres publications seront nécessaires afin de définir un protocole DSD spécifique pour le traitement orthodontique.*

Introduction

A multidisciplinary approach is often required to achieve aesthetic and functional results in orthodontic patients. A common protocol to all dentistry specialties seems to be relevant in order to communicate, and to expect, consistent outcomes.
New technologies [1,2] and software programs [3–5] have been developed to diagnose, plan and design an interdisciplinary, aesthetic and functional end smile. Facial appearance, more specifically smile aesthetics, plays a preponderant role in patient satisfaction in terms of quality of life and self-esteem [6]. The final aesthetic result remains a central part that governs the success of treatment. Therefore, dynamic dentofacial analysis of the relationship between teeth, lips and face should be recorded so that perfect results are achieved [2,7].
The Digital Smile Design (DSD), described by C. Coachman, proposes a reproducible protocol with straightforward instructions based on photographs of the patient and is performed by digital processing on slide presentation software, such as Keynote (iWord, Apple, Cupertino, California, USA) or Microsoft PowerPoint (Microsoft Office, Microsoft, Redmond, Washington, USA). An additional characteristic of DSD is that it facilitates communication among the interdisciplinary team, including the dental technician and, when it is relevant, with the patient [8]. As a template, DSD is able to analyse the proportions and aesthetics of teeth, smile and face, and permits the possibility of improving the predictability of final plan results. Basically, digital resources like DSD have been introduced and largely developed in dentistry to plan prosthetic rehabilitation. A number of recent case reports and studies describe the successful use of the DSD approach in dentistry [9–13]. However, the use of DSD in an orthodontic treatment plan is still fairly uncommon.

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This present proof of concept evaluates the preliminary findings of the interest of the DSD protocol in the planning of orthodontic treatment, and evaluates the possibility of using this new tool to achieve perfect orthodontic outcomes.

Initial case description

A private practitioner referred a 14-year-old teenager, with a long history of treatments, to the Orthodontic Department at the University of Liège to obtain expert advice. The private practitioner wanted to precisely define the ideal final position of the teeth, according to the overall facial proportions and to the future prosthetic rehabilitation. The orthodontic treatment had started one year previous to this appointment. The patient presented a severe gingivitis associated with very poor oral hygiene.

Our team decided to perform a classic orthodontic examination procedure in tandem with a DSD procedure.

Data collection

Classic orthodontic examination procedure

Alginate impressions (Cavex Colorchange, Cavex Holland, BV), lateral cephalograms (Planmeca Inc.) and extraoral and intraoral classic photographs were taken to collect the orthodontic data. The orthopantomograms were provided by the private practitioner (*figure 1*). Furthermore, breathing and swallowing patterns were assessed, as well as the vitality and the percussion response for each tooth. Finally, classic clinical information was recorded.

Digital Smile Design procedure

Two extraoral and two intraoral photographs were taken, according to C. Coachman's Digital Smile Design protocol:

- in the same position, retracted front view and full smile front view with the teeth apart—fixed head position with a piece of a suction tip between the molars in order to have a gap of 1–2 mm between upper and lower front teeth (*figure 2*a);
- a 12 o'clock photo (*figure 2*b);
- an occlusal view of the upper arch from the central incisors to the first premolars (*figure 2*c).

The measurement of the two central incisors with a digital caliper (*figure 2*d).

Using computer software (Keynote, Apple Inc.), DSD steps were performed on the photography (*figure 3*).

Planning objectives

The goal of this procedure was to guide the orthodontist in the tooth displacement, which would lead to the most ideal, aesthetic and functional result, following the rules of orthodontics, and reaching the required future rehabilitation.

Results

Classic orthodontic examination results

A normal breathing pattern and an atypical swallowing pattern were found. The intraoral examination revealed a class II trend with a 3 mm overjet and a 4 mm overbite. The upper midline was deviated to the left. The #21, #22 and #35 were missing and #12 was conoid (microdontic). #23 was in the position of #21. #11 presented a severe apical root resorption. Multiple other teeth presented minor to moderate root resorption. All teeth

FIGURE 1
Orthopantomogram

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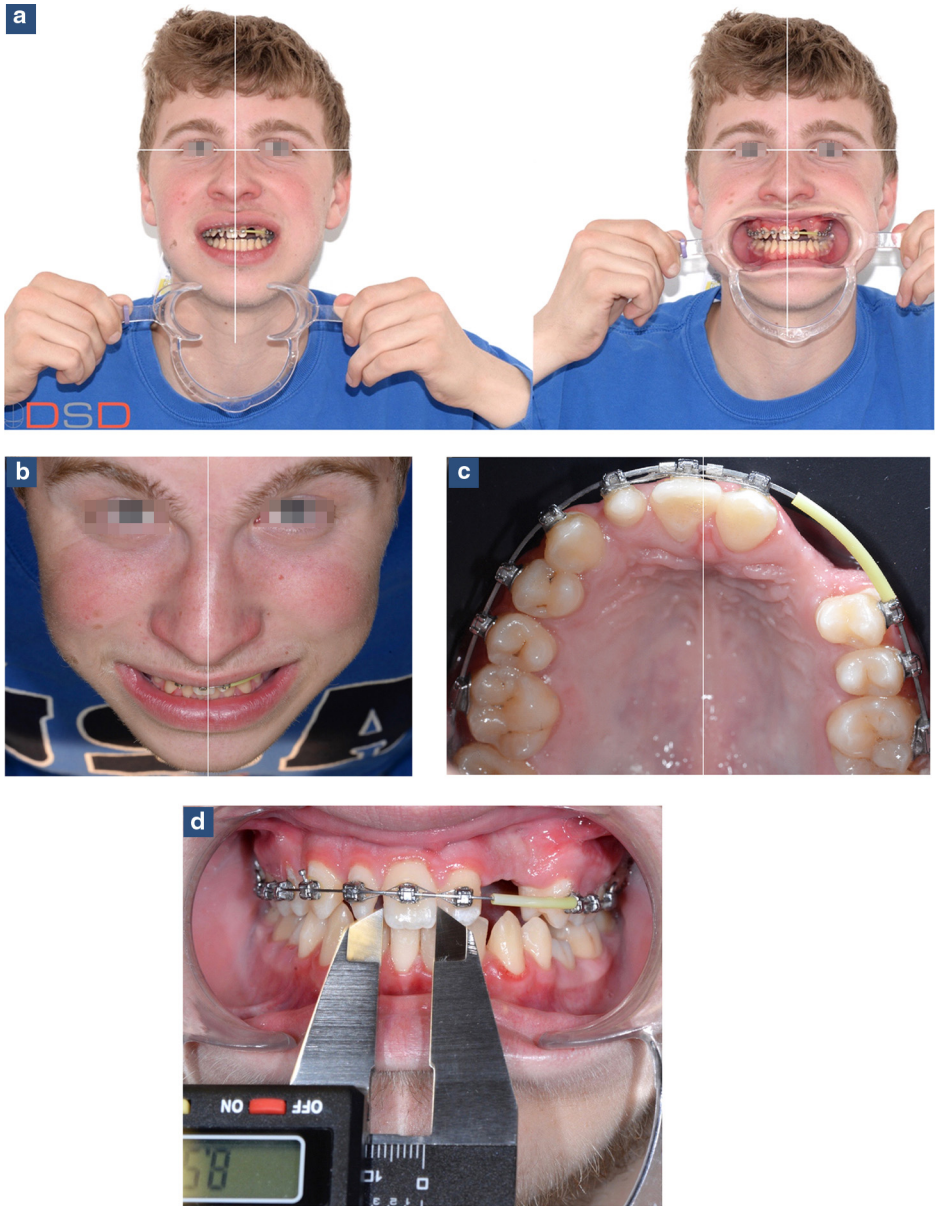

FIGURE 2

a–d: DSD photos: a: front and full smile front view; b: a 12 o'clock view; c: occlusal view of the upper arch; d: two central incisors with a digital caliper view

presented normal response to electrical and heat pulp tests and were negative upon percussion and palpation.

Digital Smile Design results

The DSD results can be seen in *figures 4–6*.

The results were presented again in three different views: frontal (*figure 4*), occlusal (*figure 5*) and 12 o'clock view (*figure 6*). Again, the green line represents the correct midline. The white shape represents the correct position and size of each tooth.

As the DSD occlusal and frontal view show, the position of #13 was correct, whereas the position of #12 and #11 needed to be distalized. The size of #12 needed to be increased in order to restore the correct dimensions, and the tooth in position #21 (which is the #23) could stay in its place with an increase of its dimensions, according to the white shape related to the size of a central incisor. Space for the future rehabilitation of #22 and #23 needed to be opened.

On the DSD 12 o'clock view the same results have been drawn.

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FIGURE 3
Analysis steps (summary)

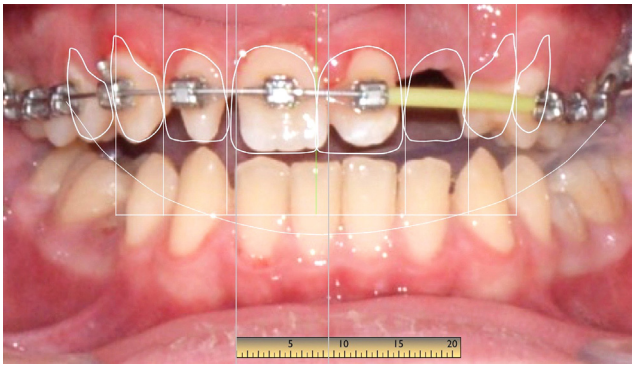

FIGURE 4
DSD result–frontal view

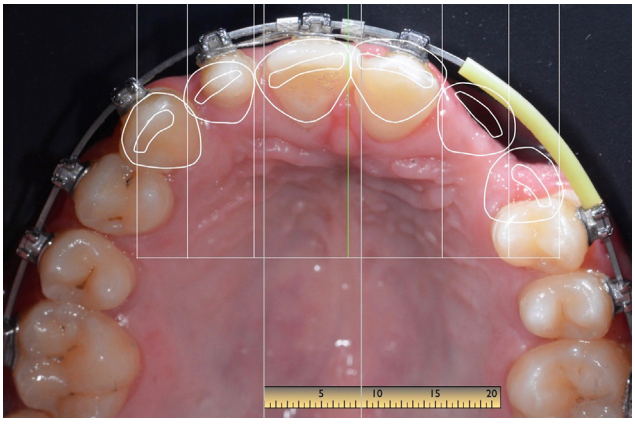

FIGURE 5
DSD result–occlusal view

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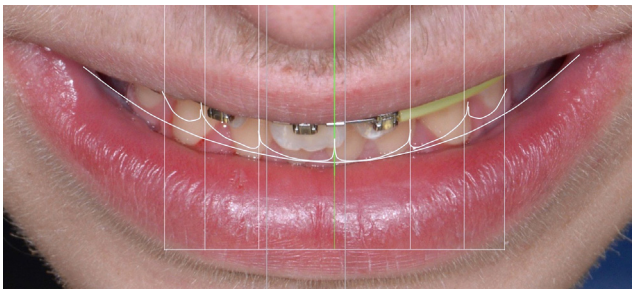

FIGURE 6
DSD result–12 o'clock view

Discussion

Orthodontic treatment planning, and especially a multidisciplinary aesthetic approach, is still considered to be a challenge for orthodontists [14–16]. Conventional orthodontic examinations — which are comprised of clinical information, study models, RX and photographs — provide relevant information for diagnosis. However, the dynamic between the face, the lips and the teeth cannot be studied. This proof of concept explored for the first time the benefits of the Digital Smile Design protocol as an additional tool in the conception of a complex orthodontic treatment plan.

First of all, the simultaneous analysis of the 3 result sheets provided us with additional values compared to the classic orthodontic examination procedure. The facial proportions, the patient smile, the teeth and the dynamics between them were recorded and analysed to obtain a final harmonious pattern of treatment. Secondly, the shape and lines of the DSD system seem to be a relevant guide for the orthodontist. The position of the maxilla median line, as well as the correct position and dimension of the anterior upper teeth, can be obtained with the DSD procedure, which seems to be difficult with only a classic orthodontic examination. The orthodontic mechanics can therefore be considered according to this. It appears appropriate to perform an intermediary DSD procedure to check if the progress of the treatment matches the final result sheets of the DSD. Therefore, the diagnosis but also the predictability of the final result seems to be improved.

By sharing the DSD result, team members can work by common accord, which improves communication among the dental team and with the patient, according to some authors [11,17]. The DSD protocol therefore seems to be a tool that facilitates communication, especially in multidisciplinary orthodontic treatment.

Concerning practicability, the DSD system seems to be easy to use. A single clinical appointment with a minimal dental photo protocol without specific equipment is all that is necessary. The utility of DSD is significant in complex orthodontic case, especially when a multidisciplinary approach is mandatory. However, the use of DSD in routine practice seems not to be relevant, the classic orthodontic examination alone is sufficient.

Limitations: however, DSD is not able to record some relevant orthodontic parameters (dental class,. . .). This digital workflow must therefore always be used in addition to the classic orthodontic exam. Moreover, DSD analysis can be applied only in the maxilla, especially from #13 to #23. It would also be relevant to develop a specific DSD tool for orthodontic cases. Digital Smile Design is still in evolution. A "new dynamic approach" based on videos taken by smartphones has been published [8]. This approach seems to be promising.

Conclusion

Digital Smile Design is a new tool for complex orthodontic treatment planning, especially in multidisciplinary treatment. It strengthens diagnosis, guides teeth displacement, enhances the predictability of treatment and improves communication between multidisciplinary team members. This new tool has completed the classic orthodontic examination procedure. Further investigations should be considerate in order to define a specific DSD protocol for orthodontic treatment.

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Disclosure of interest: Cyril Gaillard is an official instructor of Digital Smile Design France.

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