

## PRECISION SMILE DESIGN: A CASE REPORT ON 3D PRINTED GUIDES FOR PERFECT TOOTH PREPARATION

### Joshua Narde

Post graduate student, Department of Prosthodontics, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

Email- 152109002.sdc@saveetha.com

### Subhabrata Maiti

Associate professor, Department of Prosthodontics, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

Email- drsubhoprostho@gmail.com

Corresponding Author

### Subhabrata Maiti

Post graduate student, Department of Prosthodontics, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

Email- drsubhoprostho@gmail.com

## ABSTRACT

**Introduction:** Digital Smile Design (DSD) integrates art, science, and technology in dentistry, transforming cosmetic treatments with advanced digital tools. DSD involves gathering comprehensive data—photos, videos, 3D scans—to create personalized smile designs. Digital imaging software allows precise adjustments to tooth shape, size, and alignment, enhancing patient engagement through visual simulations. This collaborative process ensures successful, aesthetically pleasing outcomes. Additionally, guided approaches in dentistry, particularly in implant and oral surgeries, employ advanced imaging and 3D modeling for precise, minimally invasive procedures. Combining DSD with guided techniques in teeth preparation is a novel approach, emphasizing accuracy and aesthetics in dental care.

**Clinical findings:** The patient reported to the Department of Prosthodontics with a desire for the aesthetic makeover and change in his smile post orthodontic correction. The patient is a known case of unilateral right side cleft lip and palate. He had a missing tooth in relation to 12 and an

edentulous space in relation to 21. The 21 was moved to the position of the 11 and the 11 in the position of the 12. This was done to prevent any tooth root around the cleft region. He also presented with a microdont in relation to 22. To manage the space available for us and to give him a highly aesthetic outcome a fixed dental prosthesis was planned for 13 to 23.

**Treatment plan:** To manage the space available for us and to give him a highly aesthetic outcome a fixed dental prosthesis was planned for 13 to 23. The preparations were to be done using 3D printed tooth preparation guides based on a digital mock up. The smile designing tool on Exocad 3.0 (exocad DentalCAD; exocad GmbH ) was used as the designing software. 3 guides were fabricated; full coverage, labial and lingual. The preparations were completed and temporisation was done. A master impression was made followed by a framework trial and cementation of the fixed dental prosthesis.

**Conclusion:** Guided tooth preparation and minimally invasive dentistry exemplifies the integration of advanced technology to refine and improve dental practices. By combining digital planning with precise physical guides, this approach ensures optimal preservation of tooth structure, superior fit and aesthetics of restorations, and an overall enhanced patient experience.

Keywords : smile design , 3D printed guide , CAD-CAM , digital dentistry

## INTRODUCTION

Digital Smile Design (DSD) epitomizes the synergy of art, science, and technology in modern dentistry, revolutionizing how dental professionals approach cosmetic treatments. By employing advanced digital tools, DSD allows for meticulous planning and visualization, transforming abstract aesthetic concepts into tangible outcomes. The process begins with comprehensive data collection, encompassing digital photographs, videos, and 3D scans of the patient's dental and facial structures. This wealth of information serves as the foundation for creating a personalized and harmonious smile design.

Central to DSD is the integration of digital imaging software that facilitates the analysis and simulation of various aesthetic possibilities. Dentists can manipulate these digital representations to adjust tooth shape, size, and alignment, ensuring that the proposed changes complement the patient's facial features and personal preferences. The visual feedback provided by these simulations not only aids in precise planning but also enhances patient engagement and communication. Patients can actively participate in the design process, offering their input and gaining a clear understanding of the anticipated results, thereby fostering a collaborative and transparent treatment journey. This holistic approach ensures that all aspects of the patient's dental health and aesthetics are addressed, leading to more comprehensive and successful treatment outcomes. The convergence of diverse insights and skills within the DSD framework exemplifies the epitome of modern dental care.

The guided approach in dentistry epitomizes a blend of precision, technology, and expertise, revolutionizing both surgical and restorative procedures. Guides are most commonly used for

implant cases as well as various other oral surgeries that are planned. This method employs advanced imaging and radiographic techniques, such as intraoral scans, (Sindhu, Maiti, and Nallaswamy 2023) cone-beam computed tomography (CBCT) and sophisticated designing softwares to visualize and create detailed 3D representations of the patient's oral anatomy. The incorporation of guides is to keep up with the theme of minimally invasive dentistry which is considered to be the way forward. These digital blueprints facilitate meticulous planning and simulation of dental interventions, ensuring that each step of the procedure is executed with unparalleled accuracy.(Shenoy, Maiti, and Nallaswamy 2024; Singh, Maiti, and Shenoy 2024)

The use of a guide for teeth preparation is not commonly followed. This case is unique as we have combined the benefits of the digital smile designing and the use of a guided approach to achieve an aesthetic outcome.

## **CASE REPORT**

### **Patient Information**

A 22 year old male patient was referred to the Department of Prosthodontics for rehabilitation post orthodontic intervention. The patient was very particular about his smile and was seeking treatment for the same. He is a known case of right unilateral cleft lip and palate and had undergone surgical correction for the same. He had a rhinoplasty that was done too. Being a young man who is working at a multinational company, the patient was very concerned about his appearance and hence was very keen on seeking prosthetic rehabilitation to correct his smile. The patient was also very apprehensive throughout the treatment.

### **Past medical/dental history**

The patient had previously undergone unilateral cleft lip and palate repair. After the completion of his surgical procedures he underwent orthodontic treatment to treat the malocclusion and the alignment of his teeth. This led to an edentulous space being created in the maxillary arch.

### **Clinical Findings**

The clinical findings of relevance to our case were as follows:

- Edentulous space in relation to 21.
- Missing 12.
- Orthodontic movement leading to 11 in place of 12 and 21 in place of 11.
- Microdont in relation to 22.
- Gingival zenith mismatch and not at correct levels.

## Diagnostic tools

- Digital Impressions
- Intraoral and extraoral photographs
- CBCT( Cone beam computed tomography)

## Planning Phase

Maxillary and mandibular arch scans using the Trios 4 intraoral scanner ( 3Shape Trios, 3Shape, Copenhagen K, Denmark) were made of the patient. These scans were imported on a designing software Exocad 3.0 (exocad DentalCAD; exocad GmbH ) and an alignment of the scans and the preoperative intraoral photograph was done (Figure 1A, Figure 1B and Figure 1C). A digital diagnostic mock up was designed ( Figure 2). The diagnostic wax up was saved as a new file and the STL data was added to a new splint order form. Keeping in mind that gingival correction was needed, a crown lengthening guide was made first ( Figure 3A). Then an order form was created to design the preparation guide. A complete wrap-around splint was selected at first which gave us the first guide (Figure 3B). Windows were created on the labial surface of the splint to ascertain the amount of preparation and to verify the complete and passive seating of the guide. With the full splint used as the primary mesh, the labial (Figure 3C) and lingual guides (Figure 3D) were created. These guides were used to check for the amount of tooth reduction in their respective positions. Along with designing the guides for tooth preparation,

In total 4 guides were fabricated:

- a. Crown lengthening guide.
- b. Full coverage guide
- c. Labial guide.
- d. Lingual guide.



Figure 1: A- Digital intraoral scans in occlusion. B- Intraoral picture of maximum intercuspation. C- Alignment of the scans and images.

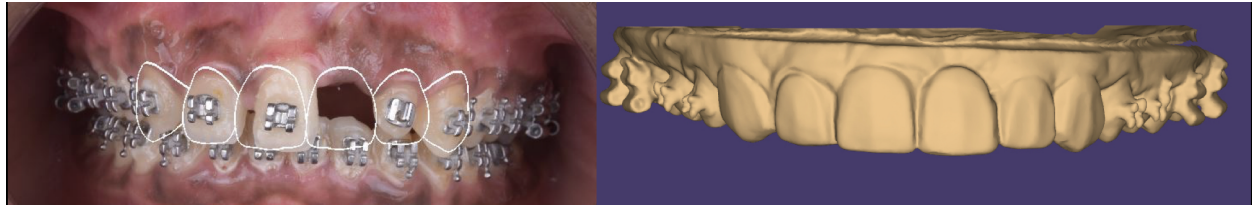


Figure 2: Creation of the diagnostic mock up.

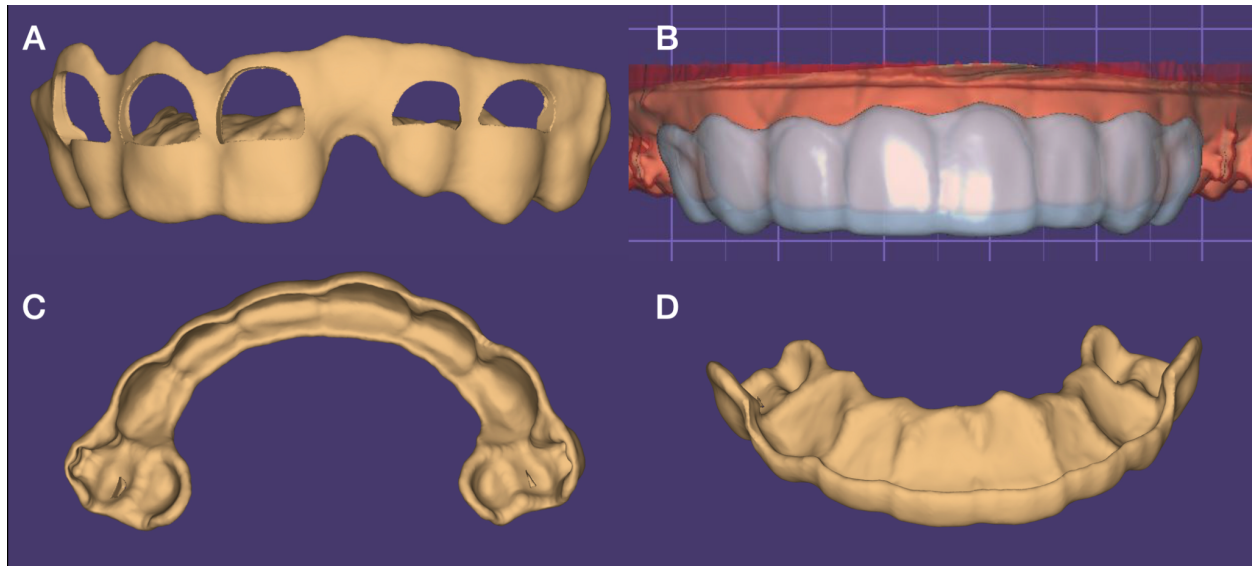


Figure 3: A- Crown lengthening guide, B- Full guide, C- Labial guide with windows, D- Lingual reduction guide.

### Therapeutic Intervention

The patient was administered local anesthesia (2% lignocaine, Xicaine, ICPA, India) at the start of the procedure. The guides were seated in place and the passive fit of the guides were checked. The digital mock up indicated the need for gingival zenith correction. A 3D printed guide was designed for this purpose to achieve the correct height of gingiva to do the crown lengthening. After completion, this guide was removed and then the tooth preparation guides were placed (Figure 4). The guides were designed depending on the amount of reduction that is required. The digital mock up plays a crucial role in deciding the amount of reduction required. Windows were created on guide labial surfaces to determine the amount of preparation. They determined the amount of interproximal and labial reduction (Figure 5).

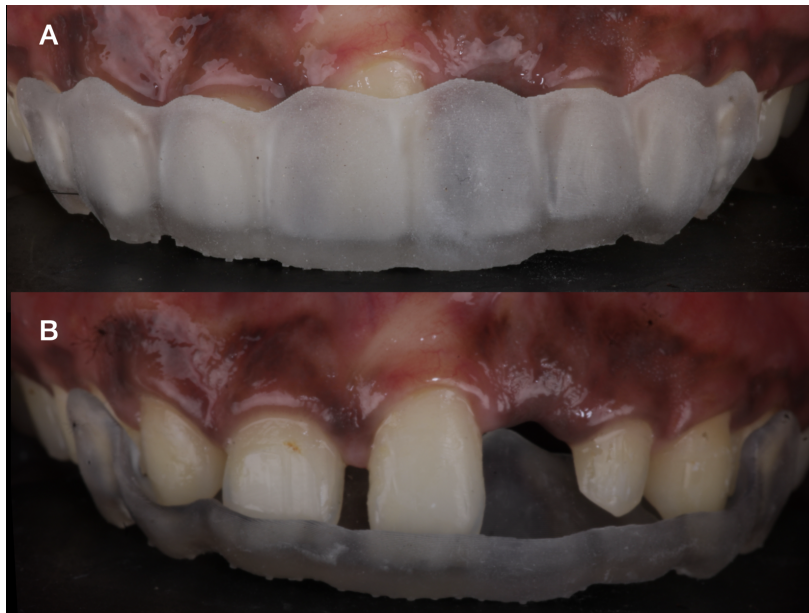


Figure 4: A-Seating of the full coverage guide, B- Lingual guide seated.



Figure 5: Labial preparation guide with windows indicating the amount of preparation needed. If the tooth lies within the window, correct amount of preparation is done.

The lingual guide was seated to determine the lingual reduction. Once completed the guides were removed and the preparations were evaluated. The teeth preparation was assessed to see if any further preparation or gingival correction was needed (Figure 6). Pulp vitality was checked to see if any of the pulps were exposed as a result of the preparation. Root canal treatment was initiated for two teeth which was expected as per the plan. Chairside temporisation was done using the designed template with 3 M™ Protemp™ 4(3M, ESPE) ( Figure 7) and that completed the first day of the treatment. After 15 days of soft tissue healing and completion of the root canal, the patient was recalled for the final impression. The impression was made in addition-silicon after

the double cord packing for gingival retraction (Figure 8A and 8B). A 360 degree flash was obtained and the cast pouring was done using Type IV stone( Zhermack).

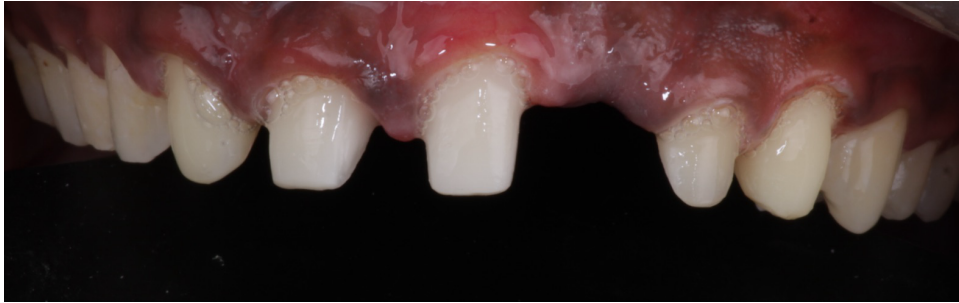


Figure 6: Preparation after the seating of the guide assessed for any further corrections.



Figure 7: Chairside temporisation done, areas which needed gingival ceramic addition were noted.

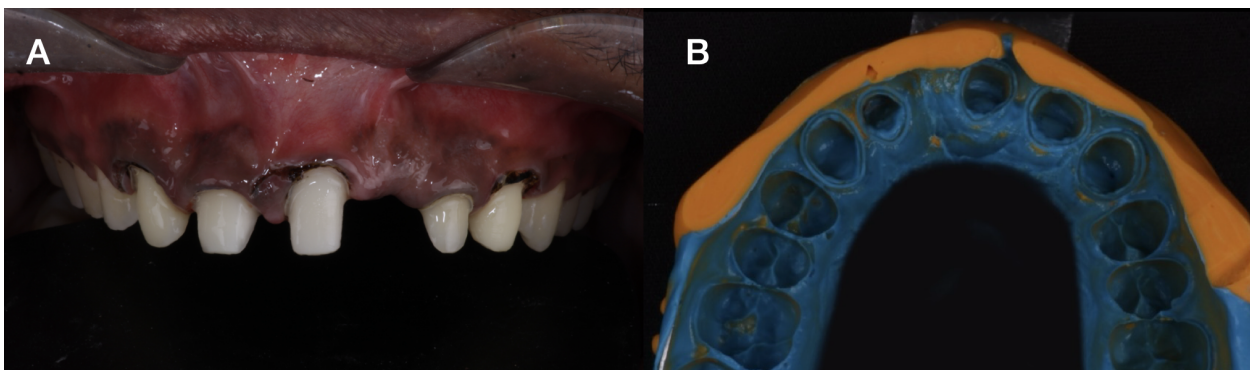


Figure 8: A- Gingival retraction performed, B- 2 stage putty wash impression.

The zirconia copings were designed according to the temporaries that were given. A framework verification trial was done and the fit was checked with the help of an x-ray. Layered zirconia crowns were delivered ( Figure 9).



Figure 9: Final outcome with hand layered all ceramic fixed dental prosthesis.

## DISCUSSION

Conventional preparation of teeth can lead to over or under preparation of teeth which makes it difficult to manage the available space in the best way possible. It can also lead to the iatrogenic pulpal exposure which then mandates the need for root canal treatment. Indirect restorations using crowns and bridges have higher short-term (5-year) and medium-term (10-year) survival (Shu et al. 2018). This guided preparation helps us to visualize the final restoration before we commence with the treatment. The benefit of the smile designing and guided procedures is that both the clinician and the dentist are well aware of the outcome. It reduces patient apprehension and additional procedures which could be decided during the course of the treatment. A recent randomized controlled trial also states how the digital smile designing displayed better patient satisfaction scores when compared to the conventional smile designing (Luniyal et al. 2024). The impact of DSD extends beyond the clinical realm, resonating deeply with patient satisfaction and confidence. The transformative power of a well-designed smile can significantly enhance an individual's self-esteem and quality of life. By harnessing the capabilities of digital technology, DSD not only elevates the standards of cosmetic dentistry but also empowers patients to envision and attain their ideal smiles with unparalleled clarity and confidence (Gao et al. 2020).

Guided teeth preparation is a technique that has been attempted but widespread or routine use of the same is not done. In such critical cases it is of paramount importance to be precise in every step of the procedure (Hu et al. 2023). The use of guides in implantology has revolutionized the accuracy of implant placements which translates to easier prosthetic rehabilitation of the patient (Putra et al. 2022) (Shenoy, Ganapathy, and Maiti 2024; Bhattacharya et al. 2024; Deshmukh et al. 2024). Higher accuracy and lesser faults during procedures is the need of the hour. A significant number of dental practitioners have adopted the use of these techniques to help optimize the surgical and prosthetic restorations.

Guided tooth preparation in dentistry represents a significant advancement in minimally invasive dentistry, integrating cutting-edge technology to enhance precision and outcomes in restorative

procedures(Taha et al. 2021). The use of guides helps in maximum preservation of sound tooth structure without hampering the This method leverages digital tools and customized guides to achieve meticulous accuracy in the preparation of teeth for restorations such as crowns, veneers, and bridges (Lo Russo et al. 2019). One of the primary benefits of guided tooth preparation is the ability to preserve healthy tooth structure. Traditional methods often rely on manual skill and visual estimation, which can lead to excessive removal of tooth material. In contrast, the guided approach uses pre-designed templates or digital guides that ensure only the necessary amount of tooth structure is removed(Winkelmeyer, Wolfart, and Marotti 2016). This not only conserves the natural tooth but also enhances the longevity and stability of the restoration(Silva, Stanley, and Gardee 2020). Furthermore, guided tooth preparation improves the fit and aesthetics of the final restoration. The precision of the digital guides allows for more consistent and uniform preparations, leading to restorations that fit more snugly and appear more natural. This reduces the need for adjustments and remakes, saving time for both the dentist and the patient.

## CONCLUSION

Guided tooth preparation in dentistry exemplifies the integration of advanced technology to refine and improve dental practices. By combining digital planning with precise physical guides, this approach ensures optimal preservation of tooth structure, superior fit and aesthetics of restorations, and an overall enhanced patient experience. The benefit of this method is that the clinician is already convinced of a promising outcome that can be delivered to the patient seeking treatment. This innovative technique is reshaping the landscape of restorative dentistry, setting new standards for precision and efficiency.

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