Facially driven and digitally guided surgical crown lengthening in the contemporary management of amelogenesis imperfecta

From digital planning to clinical reality with precise and predictable results.

Introduction

Amelogenesis imperfecta (AI) is frequently associated with other developmental dentofacial defects, such as orthognathic malformation.[1] This may give rise to clinically significant discrepancies in the smile, such as excessive or uneven gingival display. When considering significant changes to a dentition, it is critical that due consideration is given to all foundational discrepancies at an early stage of diagnosis and treatment, as this period is the principal window of opportunity to prevent their propagation into the definitive reconstruction. Although it is theoretically possible to address foundational discrepancies post reconstruction, such an approach is effectively ruled out, as doing so would necessitate costly re-treatment of a segment. Therefore, it is important that the nature of such discrepancies is communicated to the patient and the option to engage in their management is considered seriously at this stage.

This clinical tip guide aims to illustrate how contemporary digital tools may be used to plan and implement facially driven and digitally guided surgical crown lengthening with a view to addressing an uneven gingival display within a smile, with a high degree of clinical control.

Clinical tips

- A three-dimensional (3D) virtual patient is created through the merging of an intra-oral scan (3Shape TRIOS, Copenhagen, Denmark), a facial triangulation scan (Face Hunter 3D facial scanner, Zirkonzahn Srl, Gais, Italy) and patient-specific occlusal data (PlaneSystem, Zirkonzahn Srl, Gais, Italy) on Zirkonzahn.Modifier software (Zirkonzahn Srl, Gais, Italy) (**Figure 1A**) as previously published in this *Journal*.[2] The 3D facial scanner and the PlaneSystem are seamlessly integrated into a workflow that aligns perfectly with the design software in use. This integration ensures that all acquired data is transferred into the software with 1:1 accuracy, preserving every detail and enabling the creation of a precise 3D virtual reproduction of the patient's physiognomy and oral condition. The design software, on the other hand, places special emphasis on aesthetics. The two diagnostic tools, in combination with the design software, support the entire restorative team with a comprehensive planning and communication solution, with patient-centred outcomes in mind.

- A treatment rehearsal or treatment feasibility study may be simulated, to include a virtual diagnostic wax-up of the dentition, including repositioning of the gingival margin locations, where required. A digital sphere, based on the occlusal theory of the sphere of Monson, was applied in a novel approach to guide the harmonious positioning of a proposed gingival margin in this case (**Figures 1B** and **1C**).[3] The outcome of proposed changes may be assessed in the context of the virtual smile display (**Figure 1D**).

- Pending approval of the proposed gingival margin locations, a digital

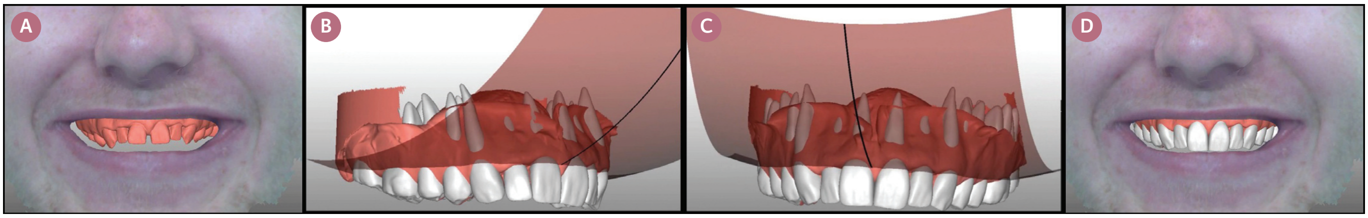

FIGURE 1: A 3D virtual patient feasibility study may be rehearsed through the merging of a 3D facial tessellation scan, achieved with Face Hunter, and an intra-oral scan, using Zirkonzahn.Modifier software. From this, a dimensionally accurate 3D virtual wax-up may be created to include modelling of proposed crown lengthening. A digital sphere, based on occlusal compensation curves (such as the sphere of Monson) was applied in this case as a novel reference guide for the harmonious and aesthetically pleasing positioning of proposed gingival zeniths, which integrate well into facial balance as determined through the smile display. Readers should note that root anatomy depicted in the digital wax-up is imported from a library for illustrative purposes and is not representative of the patient's true root anatomy in this particular case.

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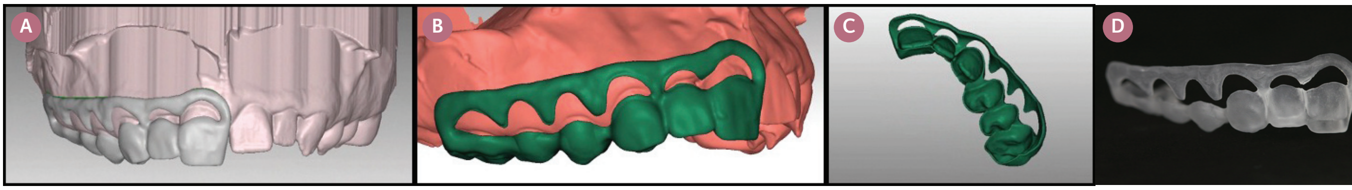

FIGURE 2: Based on the diagnostic findings of the 3D virtual feasibility study, a fully tooth-supported and fully digitally fabricated surgical guide may be developed via a process of computer-aided design and computer-aided manufacturing (CAD/CAM). The guide indicates the proposed gingival margin location as well as the proposed incisal edge and cusp height locations.

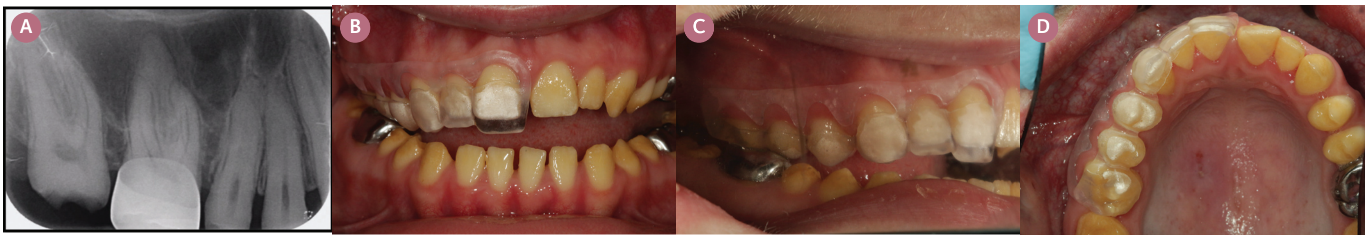

FIGURE 3: A pre-operative radiographic assessment and clinical try-in of the surgical guide gives the clinician an indication of the extent of crown lengthening surgery required. The clinician may confirm that sufficient crown–root ratio, distance from furcation anatomy, keratinised tissue, and attached gingivae will remain post surgery, and ensure the complete and comfortable seating of the guide at this stage. It is of note that the stainless steel crown on tooth UR6 was lost to retention failure between the radiographic assessment and the clinical assessment in this case.

FIGURE 4: During the surgical procedure, the upper, inner edge of the window within the guide provides the surgeon with the exact site of the proposed definitive gingival margin location and in doing so, indicates the precise location of the internal bevel incision. Following a sulcular incision and curettage of the excess gingival tissue, a full-thickness mucoperiosteal flap is raised. Osteotomy, followed by osteoplasty, is performed using a variety of round end cutting burs and/or Piezo tips with a view to re-establishing a tailored biological width from the alveolar osseous crest to the proposed free gingival margin crest.

crown lengthening guide may be designed, 3D-printed in Temp Premium Flexible transparent resin (Zirkonzahn Srl, Gais, Italy), post-processed (**Figure 2**) and subsequently tried in the patient's mouth.

- Following clinical and radiographic assessment of the width of the keratinised mucosa, the positioning of the gingival margin in relation to the cemento-enamel junction (CEJ) and the distance of the CEJ from the bone crest, the surgical guide is tested for stability and the proposed gingival margins are approved (**Figure 3**). To achieve an optimised outcome, the operator should envisage that at least 2mm of keratinised tissue, including at least 1mm of attached gingivae, remain intact post surgery.[4] A favourable crown–root ratio and integrity of furcation anatomy must remain intact post surgery.

- During the surgery, the upper, inner edge of the window within the guide provides the surgeon with the exact site of the proposed definitive gingival margin location and in doing so, indicates the precise location of the initial internal bevel incision (**Figures 4A-4C**).[5]

- The incisions are usually made with a 15C or SM67 surgical blade (Swann-Morton, Sheffield, England). After removal of the excess tissue and revealing of the new crown length, a full-thickness mucoperiosteal flap is raised for direct visualisation of the surrounding bone and the CEJ anatomy. The area for supra-crestal tissue attachment is recreated by osteotomy followed by osteoplasty, using a variety of round end cutting burs and/or Piezo tips. The operator must tailor the distance between the new alveolar osseous crest and the free gingival margin to create a stable

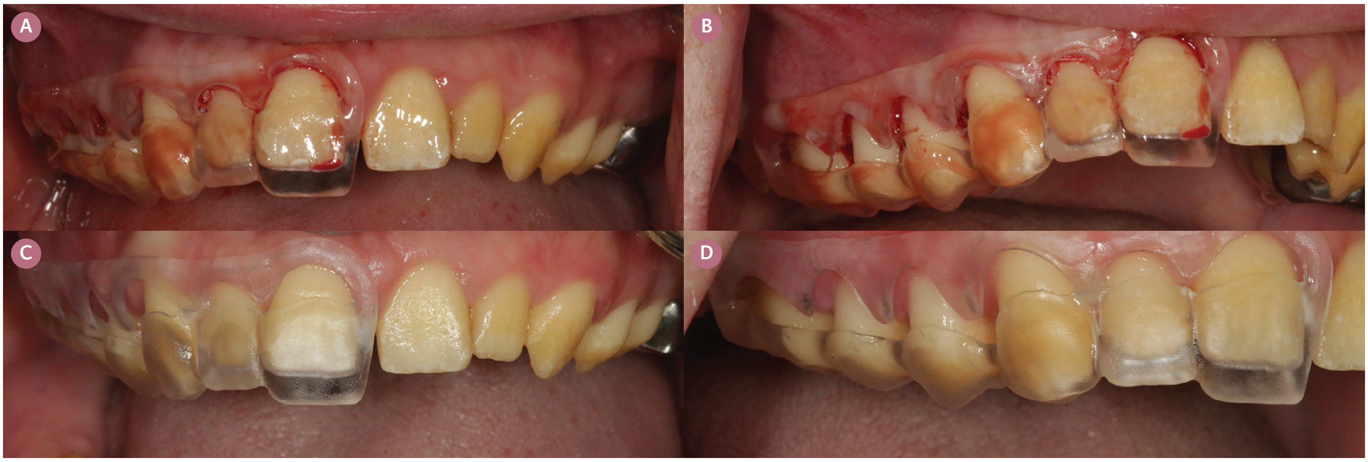

FIGURE 5: Following closure of the mucoperiosteal flap and again following 12 weeks of healing, the clinician may confirm that there is alignment between the planned and the actual location of the new proposed gingival margin. In doing so, the clinician ensures they remain in control of the treatment plan.

biological width, with average appropriate distances being approximately 2-3mm.[6,7] The flap is then repositioned and sutured using internal vertical mattress sutures (**Figures 4D-4F**).[8]

- Immediately post surgery and once again following healing and gingival remodelling at 12 weeks, the alignment between the planned outcome and the actual outcome of surgery may be assessed to ensure that the goals of treatment have been met, and that a high degree of control is maintained over the treatment plan (**Figure 5**).

Conclusions

Innovations in the digital workflow are providing clinicians with indispensable tools for accurately manifesting planned surgical outcomes into clinical realities, with precise and predictable results beyond what free-hand techniques can offer.[9] Such outcomes are becoming increasingly focused on patient-centred outcomes, such as the creation of a facially driven and aesthetically pleasing smile display.

CRediT author statement

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References

1. Crawford PJM, Aldred M, Bloch-Zupan A. Amelogenesis imperfecta. *Orphanet J Rare Dis.* 2007;2:17.
2. McReynolds D, Lichtmannegger A, Steger E. Digital planning in the contemporary management of amelogenesis imperfecta. *J Ir Dent Assoc.* 2025;71(2):81-84.
3. Nam SE, Park YS, Lee W, Ahn SJ, Lee SP. Making three-dimensional Monson's sphere using virtual dental models. *J Dent.* 2013;41(4):336-344.
4. Scheyer ET, Sanz M, Dibart S, *et al.* Periodontal soft tissue non-root coverage procedures: a consensus report from the AAP Regeneration Workshop. *J Periodontol.* 2015;86(2 Suppl):S73-S76.
5. Coachman C, Valavanis K, Silveira FC, *et al*. The crown lengthening double guide and the digital perio analysis. *J Esthet Restor Dent.* 2023;35(1):215-221.
6. Gargiulo A, Krajewski J, Gargiulo M. Defining biologic width in crown lengthening. *CDS Rev.* 1995;88(5):20-23.
7. Lanning SK, Waldrop TC, Gunsolley JC, Maynard JG. Surgical crown lengthening: evaluation of the biological width. *J Periodontol*. 2003;74(4):468-474.
8. Lee EA. Aesthetic crown lengthening: classification, biologic rationale, and treatment planning considerations. *Pract Proced Aesthet Dent.* 2004;16(10):769-780; quiz 80.
9. Li Y, Liu M, Zhou T, Lyu J, Tan J, Liu X. Accuracy of three types of digital guides for crown lengthening surgery: an *in vitro* study. *J Dent Sci.* 2024;19(1):39-45.