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DENTAL TECHNIQUE

Computer-assisted autogenous shell technique and simultaneous implantation for reconstruction of an atrophic alveolar ridge in the esthetic zone

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ABSTRACT

The autogenous shell technique offers strong biological performance by combining the mechanical stability of cortical bone with the rapid revascularization of particulate autograft. However, the method is highly technique-dependent, particularly when performed concurrently with implant placement, as both the bone shell and implant require spatially accurate positioning. A technique involving a fully digital protocol delivering controlled, predictable, and prosthetically guided shell grafting with simultaneous implant placement is described. (J Prosthet Dent 2026;136:e28-e32)

Autogenous bone grafting continues to be regarded as the standard for rebuilding alveolar defects.[1] Khoury et al refined this approach with the cortical shell technique, in which a block graft is sectioned into thin plates, which are fixed to the defect site, and the intervening space is filled with particulate bone.[2,3] This design merges the rigidity of cortical bone with the biological advantages of particulate grafts, creating a favorable environment for regeneration.[4–7]

Although effective, the technique requires high expertise and meticulous control. The bone shell must be positioned to support the intended implant trajectory while avoiding excessive graft volume to minimize the risk of soft-tissue dehiscence. Additionally, the harvesting of a donor block of appropriate size and shape must be performed safely and efficiently.[8–10] When shell grafting is combined with simultaneous implant placement, the procedure becomes even more demanding, as the implant positioning must respect prosthetic requirements,[11] and fixation screws must be placed securely without encroaching upon the implant or adjacent roots. These constraints contribute to high technical sensitivity and unpredictable outcomes when performed freehand.

Digital planning with guided surgery has been determined to improve autogenous block grafting and delayed implant placement accuracy.[12,13] However, the authors are unaware of reports of a fully integrated digital workflow that coordinates mandibular ramus harvesting, shell preparation, grafting, and immediate implantation.

This technique article introduces a novel digital system that incorporates graft-implant, harvesting, and trimming guides into a unified protocol. This technique has been used successfully for autogenous shell grafting with simultaneous implant placement in a patient, with the results being monitored over a 3-year period.

TECHNIQUE

The technique described was used to treat a 32-year-old man who presented with the loss of the maxillary left central incisor following trauma and a history of 2 unsuccessful augmentation and implant procedures performed elsewhere (Fig. 1). Examination revealed severe horizontal ridge deficiency, and a treatment plan was developed for simultaneous autogenous shell grafting

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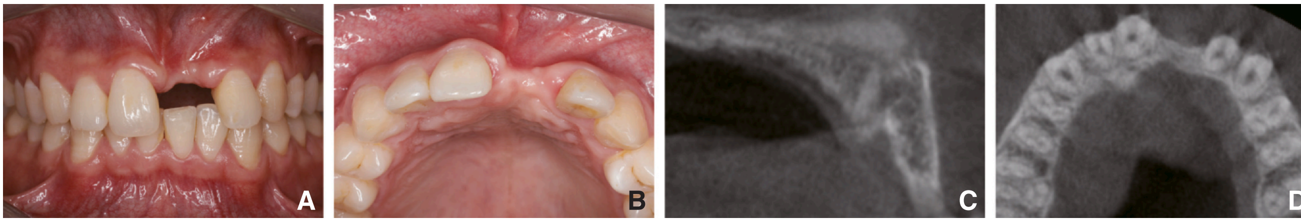

Figure 1. Pretreatment examination. A, Frontal view. B, Occlusal view. C, D, Cone beam computed tomography images indicating severe horizontal ridge deficiency.

and implant placement. The procedure was conducted with institutional ethics approval and informed patient consent.

1. Acquire an intraoral scan (TRIOS; 3Shape A/S) and import the dataset into a dental CAD software program (Dental System; 3Shape A/S) to design the definitive prosthesis. Import cone beam computed tomography (CBCT) data into a medical imaging software program (Mimics Medical 23.0; Materialise) to reconstruct the jaw model. Align the reconstructed jaw, prosthetic design, and dentition model within a reverse engineering software program (Geomagic Wrap 2021; 3D Systems).
2. Establish the intended boundaries for bone augmentation. Position the implant virtually according to the prosthetic plan (Fig. 2A). Create the required augmentation morphology to maintain a 2-mm labial bone envelope, ensure seamless transitions to adjacent cortical walls, and apply an additional 1-mm overaugmentation (Fig. 2B-E).
3. Determine locations for 2 fixation screws (HAZ04 1.5×10mm; Xianzhongbang) that avoid both the implant and neighboring tooth roots (Fig. 2F). Generate guide sleeves for the fixation screws and the implant and design a tooth-supported graft-implant guide (Fig. 2G).
4. Define a safe harvesting region with a 3-mm buffer from anatomic structures. Relocate the planned graft shape into this zone, aligning its contour to the cortical surface. Plan osteotomy planes while accounting for kerf loss and produce the harvesting guide accordingly (Fig. 2H).
5. Position the virtually harvested graft at the recipient site, evaluate its fit, and generate a trimming guide. Create retention pinholes by performing a Boolean subtraction between the trimming guide and fixation screws (Fig. 2I). Print the graft-implant

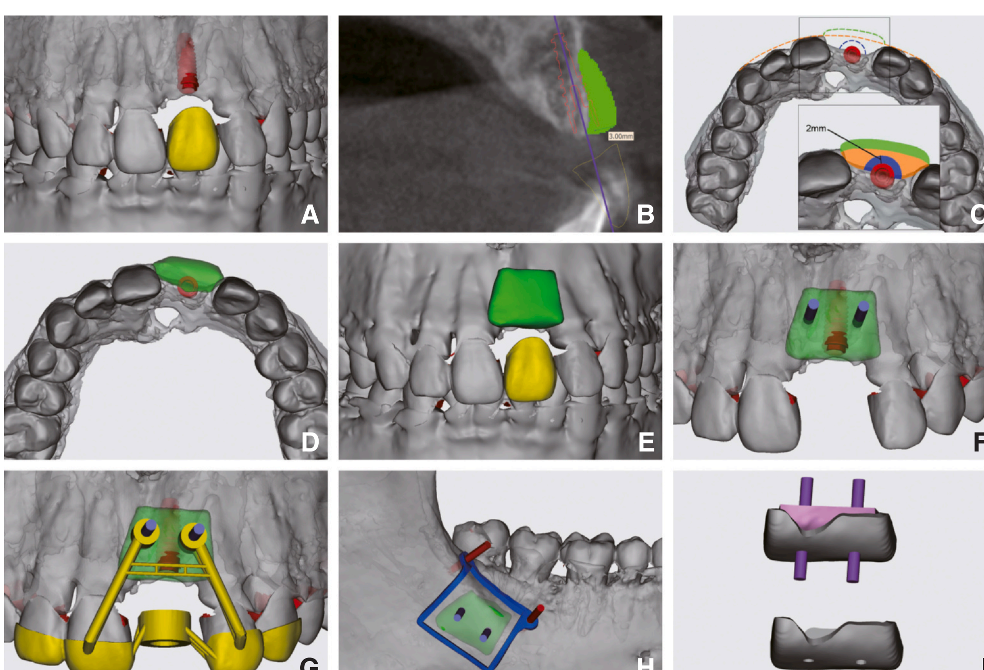

Figure 2. Digital prosthesis, implant, graft morphology, and guiding system planning. A, Intraoral scan integration with reconstructed jaw model, displaying the definitive prosthesis (*yellow*) and planned implant trajectory (*red*). B-E, Virtual bone graft plan (*green*). F, Bone fixation screws placement (*purple*). G, Designed graft-implant guide (*yellow*). H, Bone harvesting guide (*blue*). I, Trimming guide (*gray*).

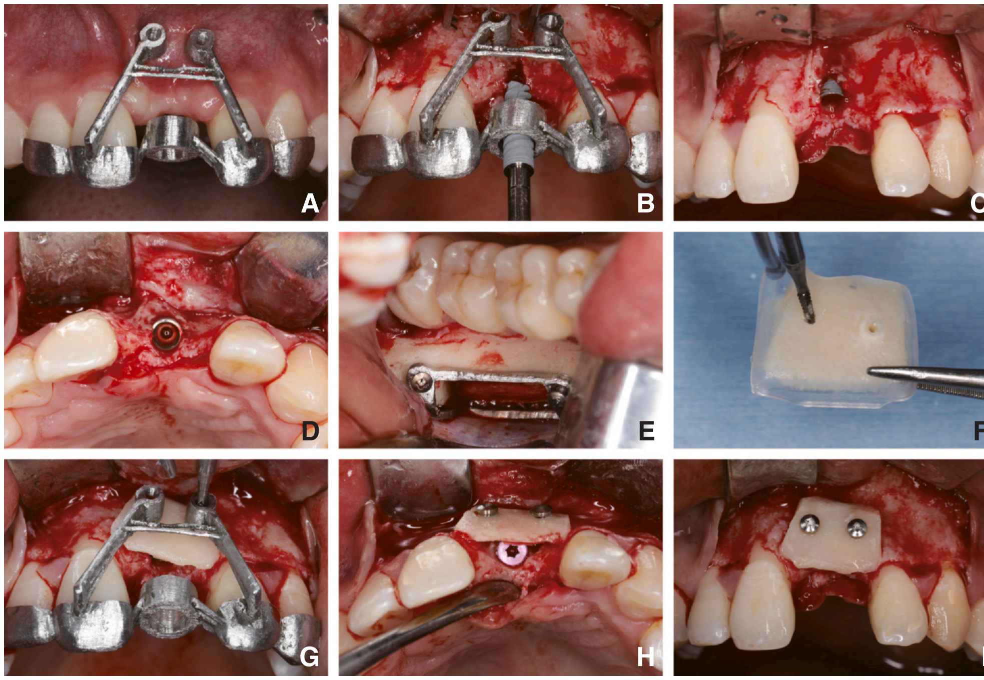

Figure 3. Guided simultaneous shell grafting and implant placement. A, Verification of graft-implant guide on recipient site prior to procedure. B, Guided osteotomy preparation and implant insertion. C and D, Labial aspect of placed implant exposed. E, Harvested donor-site bone block. F, Harvested bone shell-shaped and perforated with trimming guide. G, Shell positioned and secured. H, Space between shell and native ridge prepared for autogenous particulate filling. I, Trimmed graft secured to recipient area.

and harvesting guides in cobalt chromium alloy using a 3D printer (Mlab; Concept Laser) and the trimming guide in photopolymer resin using a 3D printer (Objet500 Connex3; Stratasys).

6. Confirm the fit of the graft-implant guide preoperatively (Fig. 3A). Insert the implant (NobelActive; Nobel Biocare) through its guide sleeve and prepare pilot holes for the fixation screws using the designated sleeves (Fig. 3B-D). Secure the harvesting guide to the external oblique ridge. Execute the osteotomy with an ultrasonic saw (Piezosurgery; Mectron) to the predetermined depth (Fig. 3E). Retrieve the bone block, refine its edges, and drill through the retention pinholes (Fig. 3F). Thin the block into a shell and collect autogenous bone particles. Seat the shell at the recipient site using the guide sleeves (Fig. 3G) and stabilize it with fixation screws (HAZ04 1.5×10mm; Xianzhongbang) (Fig. 3H, I). Pack the particulate autograft into the gap, place the abutment, and complete soft-tissue closure.
7. Perform second-stage surgery at 4 months. Locate the fixation screws using the guide sleeves and then remove them minimally invasively. Scan the implant intraorally and fabricate the definitive screw-retained prosthesis based on the original prosthetic design.

DISCUSSION

The technique presented involves a fully digital workflow for prosthetically driven shell grafting with simultaneous implant placement in a horizontally

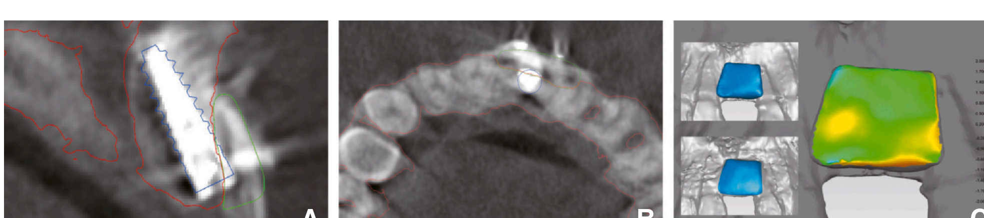

Figure 4. Immediate postoperative assessment. A, B, Superimposition of preoperative ridge contour (*red*), planned implant (*blue*), and virtual bone graft (*green*) onto immediate postoperative cone beam computed tomography imaging. C, Immediate postoperative graft contour accuracy. Left: comparison between designed graft and graft placed clinically (*blue*). Right: chromatic deviation map.

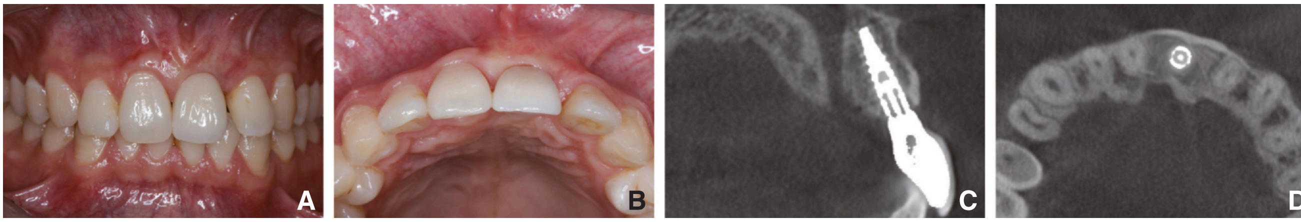

Figure 5. Three-year postoperative follow-up. A, Frontal image. B, Occlusal view. C, D, Sagittal and axial cone beam computed tomography images.

deficient maxillary anterior ridge. The results showed high implant accuracy (coronal/apical deviation: 0.298/0.186 mm; angular deviation: 2.02 degrees) and excellent reproduction of the preoperative contour (immediate postoperative RMSE: 0.254 mm) (Fig. 4). The graft remained stable throughout the 3-year follow-up (contour RMSE change: 0.347 mm), marginal bone levels were preserved, and the prosthesis conformed closely to the digital design. Patient-reported satisfaction was high (VAS: 95.3/100) (Fig. 5).

The autogenous shell method provided a rigid scaffold and an environment conducive to osteogenesis.[4,5] The cortical plates resisted collapse from soft-tissue pressure, while the particulate autograft promoted rapid angiogenesis and new bone formation.[6] Unlike block grafts, this construct can support simultaneous implantation.[7] However, this requires a self-tapping implant and precise 3-dimensional alignment to avoid conflict with fixation screws, which increases technical difficulty. Virtual planning ensured that the implant and screw trajectories did not interfere and that both were positioned within their optimal prosthetic and anatomic zones. Compared with freehand execution, this coordinated guide system minimized geometric errors, reduced the risk of over- or underaugmentation, and enhanced procedural safety by enabling simulation before surgery.

Unlike resin guides that require bonded metal sleeves, the cobalt chromium design eliminated sleeve-bonding inaccuracies and maintained dimensional stability. Its slimmer profile also improved access, visibility, and irrigation. The trimming guide featured integrated retention pinholes, which reduced the complexity associated with limited mouth opening and awkward drill angulation at the donor site.

Overall, this technique allowed simultaneous grafting and implantation, shortening the duration of treatment and decreasing surgical variability. Good 3-year reliability has been found in appropriately selected indications. However, a limitation of this technique is that the digital surgical workflows still require operator familiarity with specific software programs and incur design and fabrication costs.

SUMMARY

This technique article introduces a fully digital, prosthetically driven autogenous shell workflow. It helps reduce technique sensitivity, enhance surgical precision, and increase the predictability of simultaneous shell grafting and implant placement.

PATIENT CONSENT

Informed consent was obtained.

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