Robotic facilitation of ceramic implants in compromised alveolar ridges

Digital restorative workflow and one-year follow-up

Shepard DeLong DMD, USA

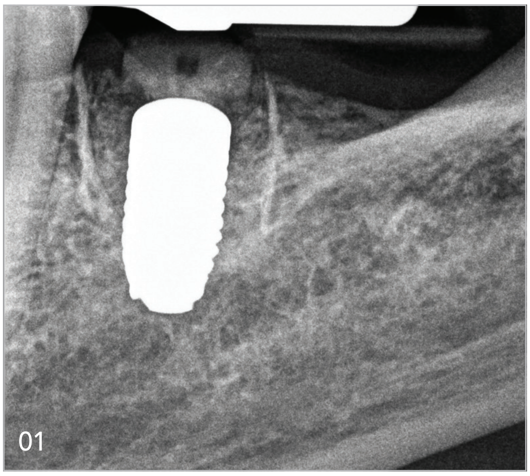
Introduction

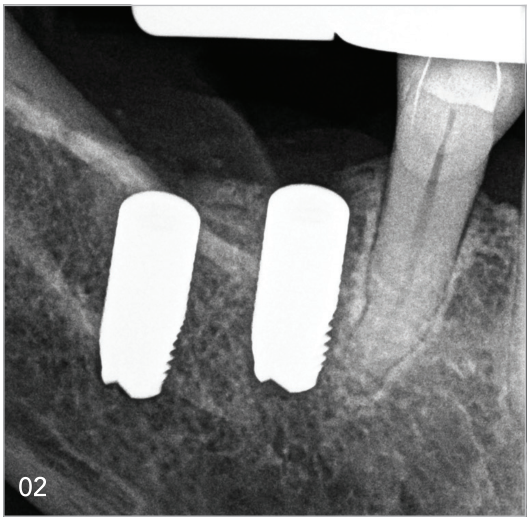
This case report follows the previously described surgical placement of ceramic implants in a 79-year-old healthy female patient with severely atrophic posterior mandibular ridges. The initial procedure utilised the Yomi robotic system by Neocis to facilitate precise, minimally invasive ridge splitting and placement of two implants on the right and immediate implant insertion on the left using bone-level zirconia implants by Z-Systems[1] (Figs. 1+2). Five months post-surgery, the patient returned for restoration with a fully digital workflow. To the author's knowledge, this represents the first documented digital restorative workflow for robotically placed ceramic implants.

Z-Systems was the first commercially available ceramic implant system in the United States and remains the only truly bone-level ceramic implant.[2] This design positions the implant-abutment junction at the bone crest, facilitating surgical and restorative protocols familiar to clinicians experienced with titanium bone-level implants.

Various approaches to implant placement include freehand surgery, static surgical guides, dynamic navigation, and robotic assistance. Static guides offer predefined trajectories but lack intraoperative adaptability. Dynamic navigation allows realtime tracking and adjustments but requires optical registration. Robotic systems, such as the Yomi, provide pre-programmed haptic boundaries that constrain drill motion within a planned volume, combining the precision of static guidance with the flexibility of freehand surgery. All three methods for accurate implant placement can facilitate good patient outcomes.[3]

This report details the restorative phase and one-year follow-up of robotically placed ceramic implants; emphasising the integration of a digital restorative workflow with scan bodies for bone level ceramic implants, intra-oral scanning and CAD/CAM fabrication of all ceramic screw retained restorations.





01
Periapical radiographs day of placement and ridge split #30, #31.

02
Periapical radiograph at time of immediate placement #19.

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ZIRCONIA IMPLANT
TISSUE LINE

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03
Minimal full-thickness flap reflection uncovery, preserving keratinised mucosa, and placement of digital scan bodies at sites #30 and #31.

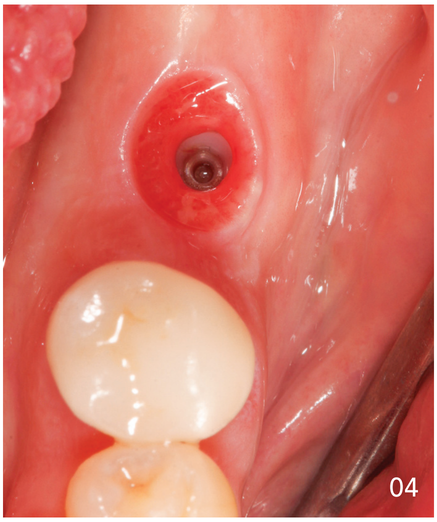
04
Removal of healing abutment at site #19 and view of peri-implant soft tissue health.

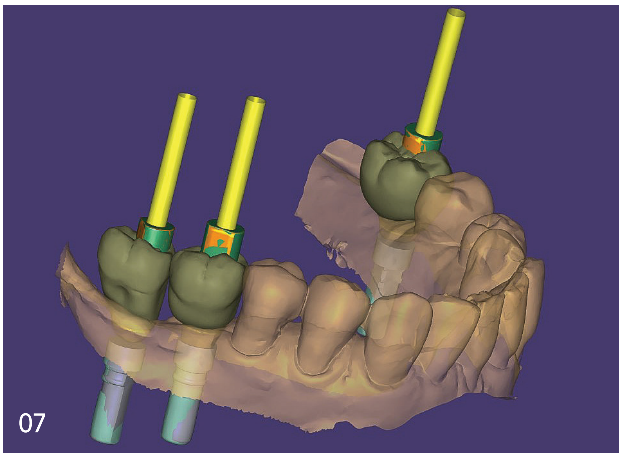
05
Shade selection using a VITA Shade guide (A3.5) adjacent to implant site for accurate crown fabrication.

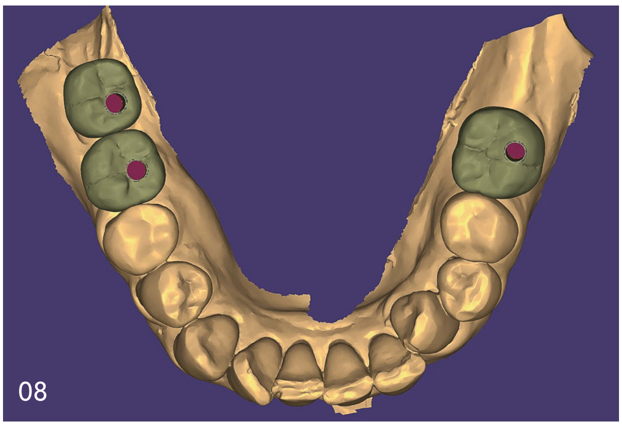
06
Intra-oral photograph with PEEK healing abutments in place, exhibiting healthy soft-tissue contours.

07
Prosthetic design using exocad software, note the scan bodies, digital implant analogs, abutments, crowns, and planned screw access channels.

08
Digitally designed, screw retained, zirconia crowns on Z-Systems' zirconia abutments.







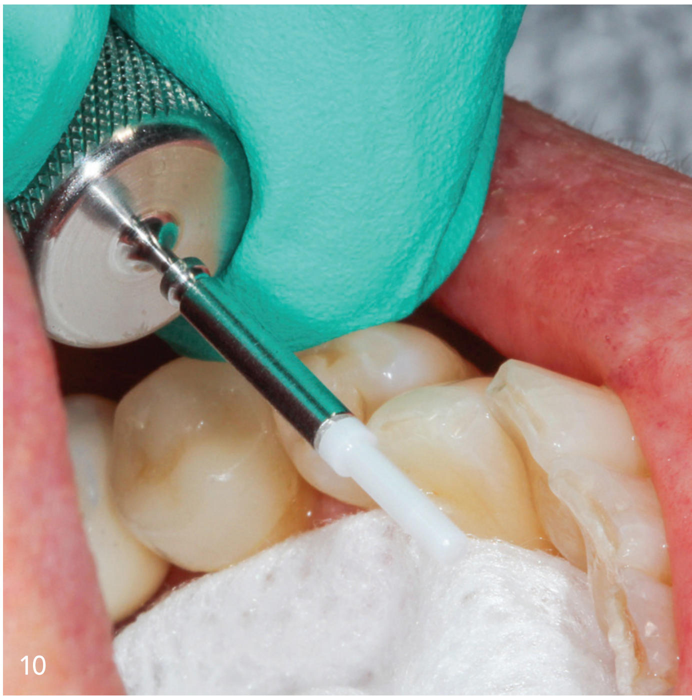
Clinical report

At five months post-placement, periapical radiographs demonstrated excellent bone–implant contact and bone density around all implants. Soft-tissue healing was uneventful: the implant at site #19, which had a PEEK healing abutment placed at extraction and immediate implantation, was surrounded by healthy, non-inflamed mucosa with adequate keratinised gingiva. Implants #30 and #31, which were buried following a ridge split, exhibited complete soft-tissue coverage.

Local anaesthesia with 4% articaine (Septodont) containing 1:100,000 epinephrine, was administered and a full-thickness crestal incision was made at sites #30 and #31. The flap was positioned to ensure at least 2 mm of keratinised mucosa remained buccal to the implants. Cover screws were removed, and Z-Systems bone-level digital scan bodies were inserted and hand-tightened. (Fig. 3) At site #19, the healing abutment was removed, (Fig. 4) and a scan body placed similarly.

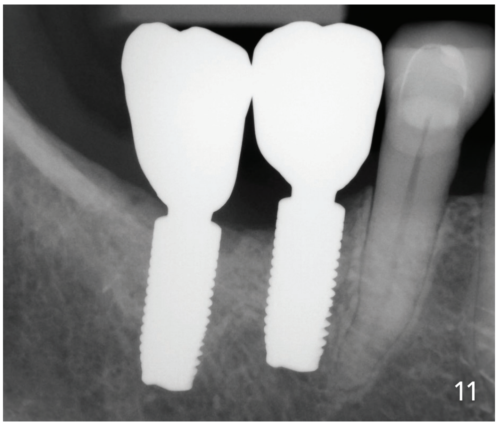
09
CAD/CAM fabricated full-contour, screw-retained, zirconia crowns on Z-Systems proprietary abutments, ready for delivery.

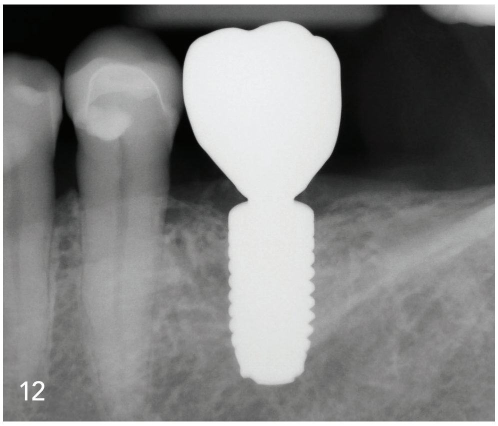
10
Use of the Z-Systems fracture controlled torque driver and final zirconia prosthetic screw.



11
Periapical radiograph #30, #31 showing final implant crown seats.

12
Postoperative periapical radiograph confirming proper seating of the crown #19 with no interface gaps.





An intra-oral scan was captured using the Primescan 2 (Dentsply Sirona), including complete scan-body data, adjacent teeth, opposing arch, and bite registration. Digital files and photos were forwarded to the laboratory with a prescription for full-contour, screw-retained zirconia crowns in VITA Shade A3 (Vita North America; Fig. 5) with unglazed gingival contact areas and Z-Systems proprietary zirconia abutments.

Healing abutments were placed, and the flap at sites #30 and #31 was closed with 4/0 PTFE sutures. Four weeks later, the patient was ready for delivery of the final restorations (Fig. 6). The restorations were designed and fabricated using exocad and milled from Noritake STML A3 zirconia (Kuraray North America; Figs. 7+8).

Healing abutments were removed, and the crowns were seated following verification of interproximal contacts and occlusal harmony (Fig. 9). The restorations were torqued into place using the Z-Systems torque-control hand driver, which fractures at 10 Ncm to prevent over-tightening and potential damage to the ceramic screw or implan. (Fig. 10). Complete seating of all prosthetics was confirmed with radiographs (Figs. 11+12). Final buccal photographs demonstrate appropriate contour and aesthetics in a patient with a reduced periodontium (Figs. 13+14), and the restorations blend well with the patient's remaining natural dentition (Fig. 15).

Discussion

The combination of robotic surgical precision and a fully digital restorative workflow offer distinct clinical advantages. Robotic placement is now known to be highly accurate. It can ensure high-fidelity reproduction of the planned implant position, with haptic guidance.[4] This provides an optimal foundation for subsequent digital restorations. Scan bodies enable accurate capture of implant angulation and spatial relationships without the inaccuracies inherent in conventional impression materials. A digital approach eliminates physical impressions, reduces patient discomfort, laboratory processing errors, and potential distortion.[5,6]

The bone-level design of Z-Systems implants facilitates restorative protocols analogous to those used with titanium systems, including straightforward scan body placement, scanning and digital restoration. Zirconia's biocompatibility further supports favourable soft-tissue responses, with reduced bacterial ad-

hesion and plaque accumulation compared to titanium.[7] In the evolution of general medicine and surgical technology, both the method for accurate surgical outcomes and the optimisation of implanted biomaterials should be advanced; Zirconia dental implants, robotic/haptic guidance, and digitally fabricated all-ceramic restorations combined, stand at the forefront of oral implantology and prosthetic rehabilitation today.

One-year post-loading, the restorations remain fully functional without complications, including no implant mobility, screw loosening, or peri-implant inflammation. Probing depths are stable at 2–3 mm with no bleeding on probing, and radiographs show maintenance of crestal bone levels. These outcomes align with clinical data demonstrating high survival rates and low peri-implantitis prevalence with zirconia implants.[8] This approach leverages the accuracy of robotic placement to support subsequent digital protocols, potentially improving overall treatment predictability.

Conclusion

This case demonstrates the successful restoration of robotically placed bone-level ceramic implants using a fully digital workflow, resulting in stable, complication-free outcomes. By combining the precision of Yomi robotic assistance with the efficiency and accuracy of intra-oral scanning and scan bodies, this treatment sequence provides a streamlined, metal-free solution for posterior implant rehabilitation in compromised ridges. The familiarity of bone-level implant protocols, coupled with the advantages of digital workflows, supports the broader adoption of robotics and ceramic implants in multiple clinical scenarios.

Acknowledgement: I would like to thank Kyle Kuhns, CDT at Ceramica, for designing and fabricating the restorations.

13
Final buccal view of restored #30, #31.

14
Final buccal view of restored #19

15
Occlusal view of the restored implants at sites #19, #30, and #31, showing ideal aesthetic and functional prosthetics.

In vitro and *in vivo* studies demonstrate superior implant positional accuracy with robotic assistance compared to freehand placement, static guides, and dynamic navigation.

References

Shepard DeLong

Shepard DeLong, DMD
Lotus Dental Wellness,
Private Practice
Five Centerpointe Dr., Suite 260
OR 97035 Lake Oswego, USA
+1 503 6844174
drdelong@lotusdentalwellness.com

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