Robotic facilitation of ceramic implants in compromised alveolar ridges

Demonstrating the benefit of haptic guidance in ridge-splits and lateral sinus lifts

Clinicians are frequently presented with less-than-ideal bony or soft-tissue anatomy in patients desiring oral rehabilitation with dental implants. This presents challenges to implantologists who perform ridge or sinus augmentation techniques for their patients, or those who only do minor grafting at the time of placement and refer to colleagues or specialists. It can be harder for the placing surgeon to make the most of another practitioners' surgical outcomes. This report highlights how comprehensive dental therapy, and the use of robotic assistance and haptic guidance can maximise the bone and soft-tissue present, even in challenging ceramic implant cases.

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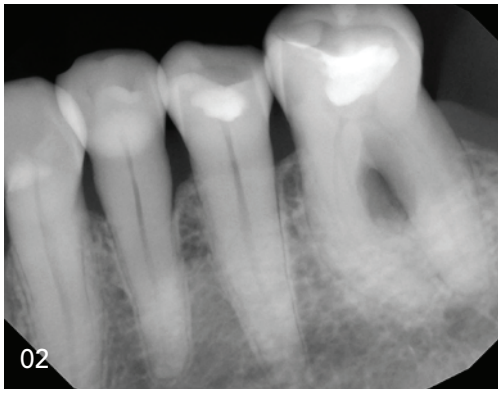
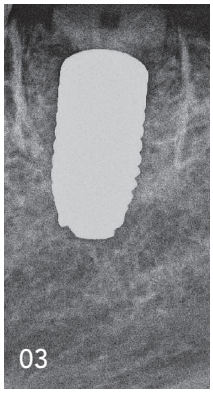




01
Pre-op photo.

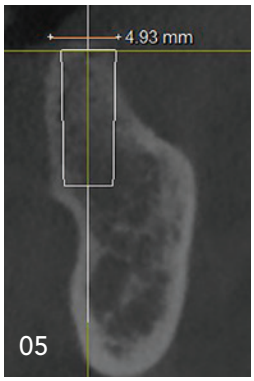
02
Tooth #36 periodontal infection and bone loss.

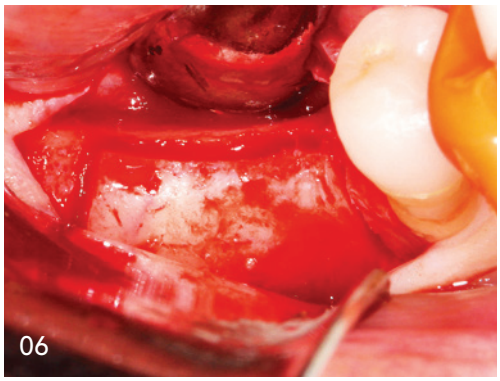
03
Site #36 post-op radiograph.

Case #1

A 79-year-old female patient with an unremarkable health history presented to Lotus Dental Wellness in Portland, OR, USA desiring a complete oral rehabilitation. She had numerous failing teeth and advanced periodontal disease in her lower molars and throughout the maxilla. She underwent extraction of all hopeless teeth and LANAP to re-establish health on a reduced periodontium. Her upper jaw is currently planned for an All-on-X type prosthesis supported by six or more ceramic implants which will be placed with haptic guidance. The lower dentition became stable after the periodontal treatment. Tooth #36 was the only tooth that had remaining advanced disease and was planned for extraction. Sites #46 and #47 had previously been extracted and grafted with 50/50 cortico-cancellous allograft. When the patient presented for placement at these sites each presented their own unique challenge.

Advanced bone loss and infection had to be mitigated on patient's left, while a very thin alveolar ridge was present on the right. Z5–BL (Z-SYSTEMS) were chosen for their proven clinical history and the ability to place them at bone level, either buried or loaded with a healing abutment. Local anaesthesia was administered, and an anterior Yomi-link was placed so that the robotic device could assist bilaterally in the posterior mandible without hindrance. A CBCT scan was exposed on the Axeos (Dentsply Sirona) with the link and fiducial array, to allow for digital implant planning. Tooth #36 was extracted without





04
Sites #46, 47.

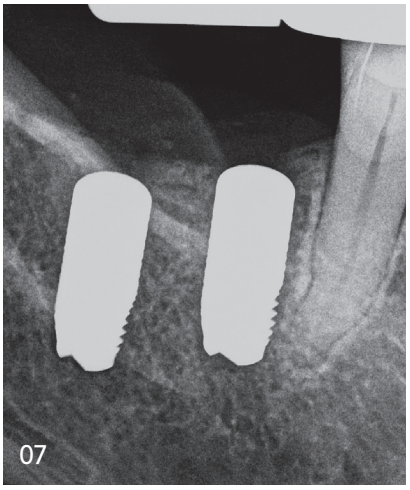
05
CBCT slice showing narrow alveolar ridge sites 46, 47.

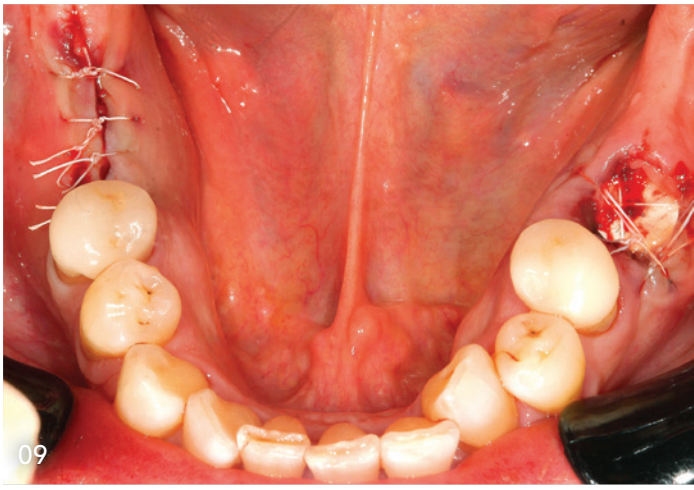
06
Ridge split.

07
Sites #46, 47 post-op radiograph.

08
Ridge split post-op photo.

09
Full-arch post-op photo.





trauma to adjacent soft tissue. The bone was thoroughly debrided of all infected tissue and there was no major dehiscence or fenestration. The site was irrigated with ozonated water and fumigated with ozone gas. A 5.0 x 10 mm implant was planned in Yomi-plan and the procedure on the left was completed with haptic guidance. The concentric osteotomy allowed for precision and the implant successfully engaged buccal, lingual, and apical bone. A large diameter healing cap was placed, and the site was grafted and closed with PRF, cortico-cancellous allograft and PTFE suture.

A full-thickness flap was laid on the right and the dimensions of the narrow ridge were exposed. A piezosurgery unit with a narrow diamond osteotomy tip was used. The crestal corticotomy was punctuated with pilot drill osteotomies in both the anterior and posterior positions. Vertical cuts were also made. Versah® drills were used sequentially to spread the cortices and accurately followed the initial drill path. The final drill was the 0.325 mm diameter ceramic drill from Z-SYSTEMS. Two 4.0 x 10 mm bone level ceramic implants were placed with cover screws. Additional grafting on the buccal and crestal with allograft and PRF was performed before the site was closed with PTFE suture. This case took approximately two hours to complete, and the patient remarked on the overall ease with which it was completed. This case has integrated successfully and is now ready to restore.

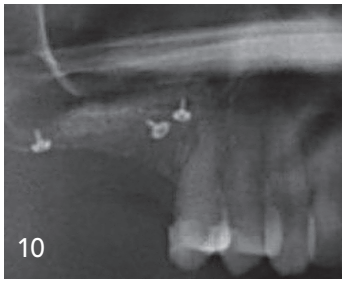
Case #2

A long-time patient of the clinic returned desiring an implant in the upper-right quadrant, tooth #16. She was fifty-five years old and in good health. She had been treated by an oral surgeon in her hometown for extraction and a lateral sinus lift which had to be revised due to postoperative infection. Upon initial CBCT the site was minimally viable with the planned placement of a 4.0 x 10 mm Zeramex XT (Ceramtec) likely still requiring additional grafting. The risk of failure or complication was discussed, and the patient consented to the following procedure.

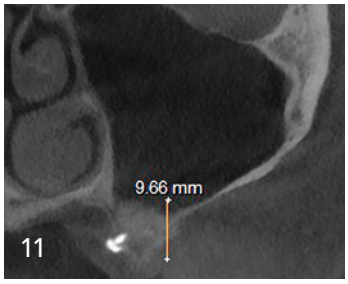
She was sedated with oral triazolam and locally anaesthetised. A Yomi-link, CT scan, and intraoperative digital planning was completed. The site was opened and extended posteriorly for retrieval of surgical screws. The osteotomy was performed, and plan executed precisely following both the prompts in the Yomi software and the manufacturer's drilling sequence. The implant was placed with good torque and a 3 mm healing abutment. A similar grafting protocol was followed. Five months of healing time elapsed and the case was restored with a screw-retained crown composed of LiSi (GC) and a stock 1mm straight abutment from Zeramex. Occlusion was verified with shimstock and articulating paper. The patient was pleased with the result.

Discussion

Ceramic implants of various shapes, sizes and concepts have been used since the 1960s.[1] Zirconia has emerged as a promising biomaterial for many orthopaedic devices including dental implants.[2] There is recently published evidence that its use in the surgical and prosthetic replacement of infected natural teeth may reduce inflammation and reduce chromosomal degradation in humans.[3]



10
Post lateral sinus lift radiograph.



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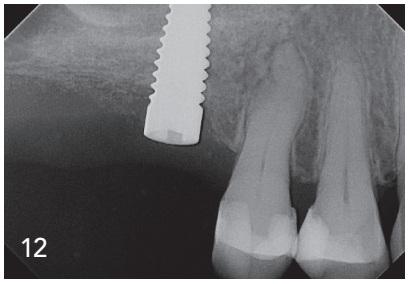
Post lateral sinus lift CBCT slice.

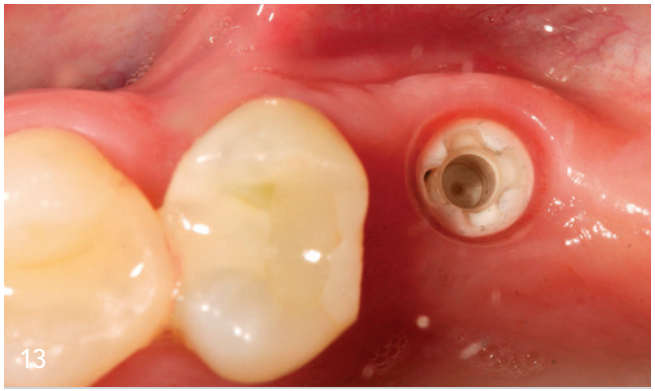


12
Post-op radiograph #16.

Robotics have had a major impact on modern surgical procedures beginning with the use of the DaVinci robot, Intuitive Surgical, for general surgery.[4] This is the first robot to have been used intra-orally for oral surgical procedures including cancer resection.[5] The Yomi robot from Neocis is the first robotic device designed for oral surgery. The X-guide from X-NAV Technologies, and Navident from ClaroNav, are both classified as semi-robotic systems of dynamic navigation. The distinction lies in the "active" arm which provides physical assistance, haptic guidance, to the hand of the surgeon. These devices provide accuracy comparable to static guides and significantly better than freehand surgery.[6,7] They also allow for the modification of surgical plans in real-time, improved ergonomics, and the separation, or connection between doctor and patient by an intelligent machine.

Conclusion

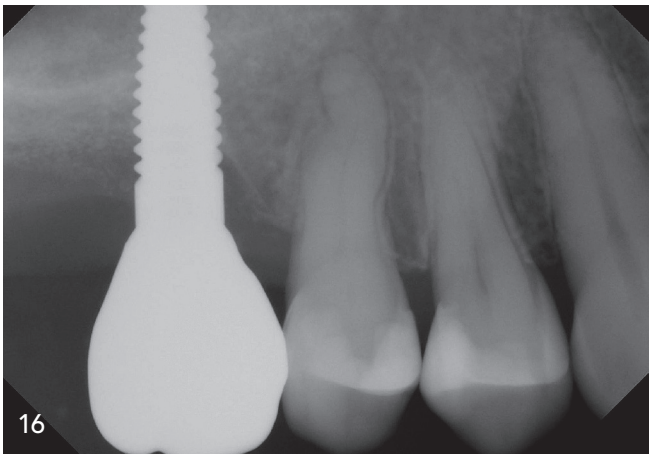
This case report showcases the advantages of robotically assisted guided implant surgery for the placement of ceramic dental implants in difficult surgical scenarios. Surgeons from all specialties benefit from the advancement of both material and technological means for performing procedures that lead to better patient health outcomes. Compromise, challenge, and ideals, are all concepts that define healthcare providers' daily and life-long work. As evidenced by the concepts presented here, doctors and medical industry professionals will not leave well enough alone but will continue the evolution of their methods to provide modern patients the best health outcomes possible.



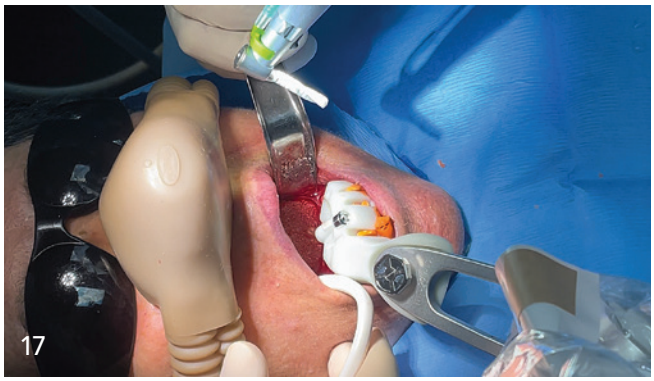
13
Post placement healed site.

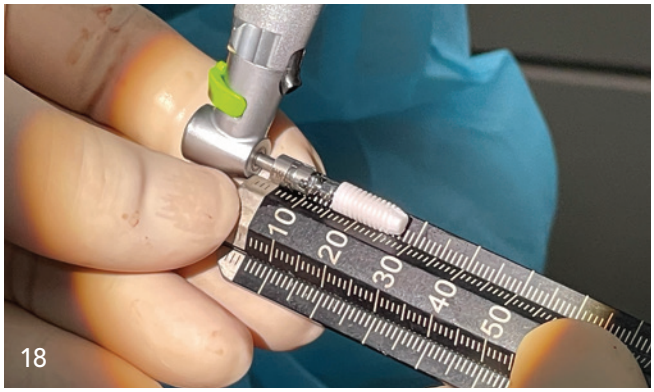
14
Final restoration occlusal photo.

15
Final restoration buccal photo.



16
Final restoration radiograph.





17
Measuring ceramic drill for robotic osteotomy.

18
Z-SYSTEMS implant mounted on robotic handpiece ready for insertion.

19
Robotic situational photo.

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About the author

Shepard DeLong is a 3rd generation dentist in Portland, Oregon, USA. He holds a BS from Portland State University, DMD from Oregon Health and Sciences University and completed a General Practice Residency at The Queen's Medical Center in Honolulu, Hawaii. He is a member of AMED, IAOCI, EACim, IAOMT, and has served as a mentor for CEREC-doctors. He was formerly an associate at the first LEED certified, hi-tech, eco-friendly practice in the US. He is on the forefront of digital evolution, and development of novel technological workflows in dentistry. He has a part-time position at Pure Health Dentistry on the island of Maui, Hawaii and owns Lotus Dental Wellness, in Lake Oswego, Oregon. He is a residency site director for the MSc Implantology programme at the University of Jacksonville, and lectures on ceramic implantology, robotics, lasers, and digital dentistry. His latest project has been sharing the profound advantages of combinational technologies for the health of both doctor and patient. He can be reached at drdelong@lotusdentalwellness.com.

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