The Use of Artificial Intelligence in Implant Digital Workflows

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Abstract

Objective: Artificial intelligence (AI) has increased its presence in dentistry, including implantology. Digital workflows for implant planning and rehabilitation have gained popularity over the years due to improved accuracy, reduced surgical time, better communication, and improved prosthetic outcomes. There are multiple software for implant planning and static guide design, however, there are different steps that the clinician needs to complete. This case report will demonstrate how AI is incorporated in implant planning and static guide design as it mimics the intelligence of humans to complete the steps that were traditionally completed by the clinician.

Case History: A 44-year-old healthy female patient presented to the East Carolina University School of Dental Medicine clinic for implant treatment. A mandibular CBCT was exposed, and an intraoral scan was obtained with Cerec Omnicam®. Data was imported into CoDiagnostix® software for planning and guide design. Image segmentation, panoramic curve, nerve tracing, patient position and image superimposition were completed using the artificial intelligence features. The implant position was planned, and the guide was designed and printed. Implant placement was completed using a fully guided protocol.

Results: AI tools in the implant digital workflows were successfully used to fabricate an accurate static surgical guide in less time while obtaining the planned implant position.

Conclusion: The use of AI in the implant digital workflows allows the clinician to significantly reduce time while increasing accuracy. The described AI features allow for a precise guide design and implant placement.

Figure 1. CBCT segmentation of mandible for implant planning.

Figure 2. AI-detected patient coordinate system from sagittal, coronal, and axial views.

Figure 3. Detected panoramic curve.

Figure 4. Nerve tracing.

Figure 5. 3D superimposition of CBCT with intraoral scan.

Figure 6. Surgical guide design created with CoDiagnostix® (Dental Wings).

Figure 7. Implant plan for #19 and #30.

The implants were placed using a 1-stage approach after full thickness flap elevation. The 3D printed tooth-supported surgical stent with verification windows was seated, and the implant sites were prepared to 8.0 mm using the proposed guided drilling sequence. 4.8 x 8.0 mm Straumann BLT implants were placed with adequate stability followed by the placement of a healing abutment (Figure 8). The patient healed uneventfully and was satisfied with the treatment. The placed implants were in accordance with the planned restoratively driven position. The prosthetic treatment significantly decreased time spent during the planning phase and guide design and provided an accurate guide and implant placement.

Discussion

Artificial intelligence is likely going to play a major role in the dental field in years to come, but its potential applications are still being explored and developed. AI has been successfully compared to clinical references for tooth segmentation of CBCT radiographs and was implicated a potential fast and accurate replacement for clinician performed tooth segmentation. AI has also been studied in the medical field for its usefulness in planning total hip arthroplasty, and it produced reliability in prediction of components for use in the surgery. This could potentially be extended to implantology within the dental field, as implant size selection and positioning is a key facet of implant planning performed by clinicians. As shown in the present case report, AI software can be used to greatly accelerate dental implant planning while still maintaining a high degree of accuracy, as demonstrated by the successful placement of endosteal implants.

Beyond saving time, AI technology may be implemented to overcome limited accessibility for the clinician due to limited mouth opening by the patient. An exciting prospect to overcome this is robot-guided dental implantology, which is already in development. A limited study on robotic osteotomies showed promising results with less angular and placement deviations and yields itself to further and broader investigation. Future studies should focus on assessing the reliability and accuracy of implant placement in surgeries fully planned by clinicians as compared to surgeries planned using AI. Once significant breadth and depth of research has been achieved, these types of workflows should be regularly incorporated in clinical settings. Additionally, AI technology can continue to be developed and implemented to further streamline the implant planning and placement process.

Conclusions

AI technology can be integrated into the implant workflow to decrease time that the clinician would normally spend during the planning process. Creating a guide design can become more efficient, and the result is a precise implant placement.

References