Brace yourself

Robotic precision in dental implants

- Dentistry and dental implants are being transformed by technology, with robotics at the forefront.
- Robots, acting as a surgical GPS, alleviate some of the traditional complications and challenges associated with dental implant procedures.
- Dr. Jeffrey Ganeles and fellow researchers at the South Florida Center for Periodontics & Implant Dentistry, USA, explore what we can expect from the future of robotics in dental surgery and beyond.
- Revolutionary technological breakthroughs promise faster, safer, and more accurate dental procedures.

Have you ever wondered how amazing it is to regain a lost smile with the help of precisely designed artificial teeth? The dental field is constantly changing and developing, driven by advancements in technology and not solely focused on tooth replacement. Picture dentistry at the intersection of robotics and digital technology. One area where robotics has shown great promise is the implant reconstruction of the upper jaw in patients with edentulous maxilla (absence of teeth), which is recognised as a particularly challenging problem in many people.

It is at this point that our attention is drawn to the groundbreaking efforts of Dr. Jeffrey Ganeles and his team at the South Florida Center for Periodontics & Implant Dentistry in the USA. Ganeles has dedicated his illustrious career to spearheading dental innovation, continuously striving to improve and streamline the implant procedure. His philosophy is to deliver exceptional, long-lasting results with minimal discomfort to patients. He co-founded TeethToday™, a national network of dental specialists, with Dr. Frederic Norkin. Throughout his professional journey, Ganeles has implemented cutting-edge technology, developed pioneering practice styles, and created novel procedures and tools. Ganeles and his team aim to refine the impact of dental robotics in the field of implant dentistry, one smile at a time.

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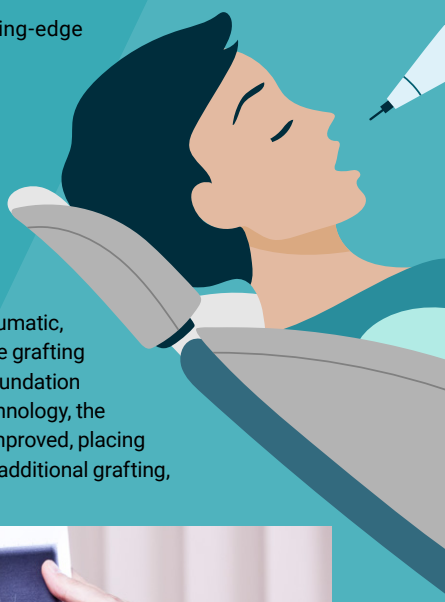
Robots to the rescue

Dental implants have evolved beyond being just fixtures anchored into your jaw; they are now a secure and sophisticated solution for missing teeth. At the forefront of a technological revolution, they often rely on robots. Think of these robots as the world's finest dental assistants, armed with a precise GPS-like system for surgery. A digital blueprint of the jaw is given to them, helping dentists place implants accurately for a perfect result. Indeed, robots are becoming a crucial element in cutting-edge dental care.

Technology is playing a significant role in the bright future of implant dentistry, especially for the upper jaw. To illustrate, many patients have small upper jaws after losing teeth and the accompanying jawbone atrophy (bone loss). In the past, dental surgeons performed traumatic, unreliable, and time-consuming bone grafting procedures to create an adequate foundation for dental implants. With robotic technology, the precision of this procedure can be improved, placing dental implants into the jaw without additional grafting,



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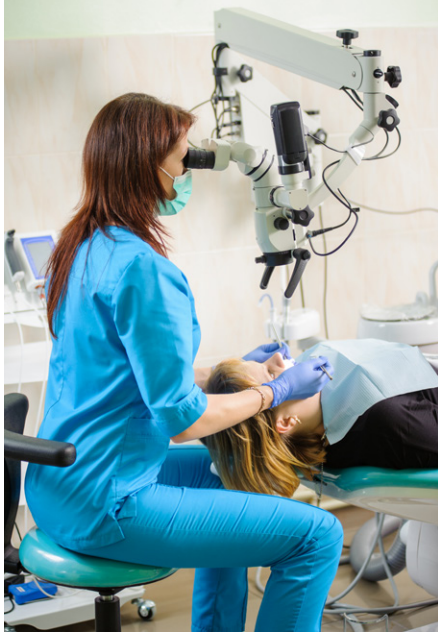
leading to increased safety and effectiveness. The precision of the machine combined with the artistry of a master craftsman – that is the dentist – ensures promising end results with much less healing time, expenses, and fewer complications.

Breaking the da Vinci code

Dentistry isn't the only field experiencing this robotic revolution. The da Vinci Surgical System is a prime example of how technology has transformed surgery. Complex procedures can be executed by surgeons with greater precision and control, thanks to this minimally invasive marvel. Prostatectomies, hysterectomies, and cardiac operations are some surgeries in which the system has been utilised so far. The system is composed of a surgeon's console, a patient-side cart with robotic arms, and a high-definition 3D vision system.

The accuracy of implant placement in upper jaw implant reconstructions has been improved with the help of robotic technology. The application of robotic technology allows for precise implant placement planning, resulting in improved patient outcomes. Programming the robotic arm ensures that the implant is placed precisely where planned. Achieving this level of precision with traditional implant placement techniques is a challenging task.



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Same day, new smile

Guided surgery technology for dental implants has advanced, resulting in shorter healing times and the ability to use new teeth right after surgery. The revolution started more than 25 years ago with Ganeles' team and the innovative concept of TeethToday™. It meant that patients walked out with a transformed smile on the same day, regardless of the condition of their teeth when they arrived. Computer-aided design (CAD) and computer-aided manufacturing (CAM) are leading the digital transformation in dentistry. Consider them the leading wingmen for dental surgeons, aiding in the flawless fit of dental implants, collaborating closely with robotics, 3D diagnostics, precision intraoral scanning, and cutting-edge innovations like Smile Design and 3D printing.

The question is – what does this mean for us? The capabilities of digital technology may extend beyond what we currently know. Instead of selecting a generic implant from a shelf, picture an AI-enhanced printer creating a custom-made implant just for you at the dentist. Traditional implants are limited to standard sizes and shapes, but printing technology has the potential to produce implants that are tailored to individual needs. Furthermore, there are other advantages to consider. Thanks to robotic technology, surgeries can be completed much faster, resulting in quicker recoveries. With robotic technology, the risk of errors is significantly reduced, which means that additional corrective surgeries are typically unnecessary.

The future of dental implants

This future is all about using technology to take the human touch to the next level, providing precision and personalisation in surgeries and dental implants, but it still requires a skilled surgeon to manually and intellectually power the robot. Ganeles and his team at TeethToday™ are striving to make this envisioned future a reality. When considering dental implants, patients are not simply visiting a dental clinic anymore, but instead entering a world of cutting-edge technology and personalised care that produces stunning, safe, and efficient results. Ganeles wants to ensure that a person's smile is no longer just a simple cosmetic concern; it's an intricate work of art that is crafted with scientific precision in this new era of dental care.

Personal response

How will the swiftly evolving landscape of AI be incorporated into future digital dentistry?

The swiftly evolving landscape of AI is now being incorporated into digital dentistry in many ways. It is not a future consideration. It is currently in our practice in three areas. First, AI reviews all our dental x-rays to highlight suspicious areas looking for cavities in teeth, sites of periodontal bone loss, and root canal infections. We consider this a screening function where a computer compares our radiographs using the algorithms created from hundreds of thousands of other x-rays in its memory. The result of implementing AI is that our dentists and hygienists are becoming more accurate in picking up problems earlier, rather than waiting for problems to become more severe and recognisable. Implementing AI in reading dental x-rays also reduces human error, which is known to happen when a dentist is busy, distracted, or image quality is not optimal.

AI is also used in various software to analyse 3D scans for dental implant planning. In the past, the dentist would have to align the scan, filter it, and manage different settings to be able to properly view and use planning software. With AI, these functions are done instantly, with the push of a digital button. This not only saves time but also does a better job displaying information and scans, so accurate plans are done seamlessly.

Currently, digital impressions are also being verified by AI. In many procedures, messy impression-taking, using a tray full of gel that sets into a hard, rubbery cast has been replaced with optical scanners. This leap in technology is cleaner, faster, and eliminates the possibility of patients gagging on gooey paste for dental impressions. Typically, these optical impressions are considered accurate for small areas of the mouth, but not for large views, like a full upper or lower jaw, as would be required when replacing a full arch of teeth with implants. Secondary impressions and try-in procedures are often done to confirm or improve accuracy, called verifications. AI allows us to perform instant digital verification on these large impressions by precisely calculating the amount of error present in a digital impression. If the scan passes, production of the prosthesis continues. If it fails, a new scan can be taken immediately and instantly checked again, saving many appointments.

Prevention is better than cure. How can we use this research to better educate children from an earlier age about dental hygiene and practices?

Digital technology can be used as a great learning tool to educate kids about dental hygiene and practices. Kids often learn better from devices than they do from traditional lectures. Devices can display personalised education. Imagine a personalised augmented reality video produced using the child's own mouth or smile to show the effectiveness of homecare and biofilm (plaque) removal. This could become a contest with themself or others to get the cleanest mouth. Or imagine this same technology being used with simulation software to demonstrate how tooth malposition could be treated with orthodontics to create a beaming smile. Elements of these applications are already available but have not been put together into a single tool yet. The only limitation in designing these applications is the imagination.

Will this be accessible and affordable to those of lower socio-economic backgrounds?

People at the lower socio-economic scale of the spectrum have always been disadvantaged with respect to oral health and treatment options. As digital tools and applications become more common, their costs drop and providers become more efficient. It is likely that as the implementation of digital tools for diagnosis, management, and treatment of dental pathology like caries (cavities), periodontitis (gum disease), malocclusion (poor bite), and implant dentistry (tooth replacement with dental implants) become more prevalent in practice, these services will become more recognised and available to all. The medical healthcare community, policy makers, and insurers beyond dentistry have to appreciate and value the systemic health, social, and economic benefits of good oral health.

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Bio

Dr. Jeffrey Ganeles is board certified in periodontics and dental implant surgery by the American Board of Periodontology and is credited with performing the first robotic dental implant surgical procedure worldwide. He is on the faculty of several dental schools and is a frequent speaker at professional meetings. He conducts his practice in Boca Raton, Florida, USA along with his partners.

Competing interest statement

Dr. Ganeles was a consultant with the developers of the robotic system, Neocis, Inc and participated in clinical trials and FDA evaluation to gain approval for the system.

Collaborators

- Dr. Frederic Norkin
- Dr. Liliana Aranguren
- Dr. Andre DeSouza

Further reading

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