J Oral Res
oral and craniofacial sciences

Perspective

Autonomous Robotics: A fresh Era of Implant Dentistry… is a reality!

Ziyad S. Haidar.[1,2]

Affiliations: [1]BioMAT'X, Facultad de Odontología, Universidad de los Andes. Santiago de Chile, Chile. [2]Centro de Investigación e Innovación Biomédica, Facultad de Medicina, Universidad de los Andes. Santiago de Chile, Chile.

Corresponding author: Ziyad S. Haidar. Facultad de Odontología, Universidad de los Andes, Mons. Álvaro del Portillo 12.455. Las Condes, Santiago, Chile. Phone: (56-2) 26181372. Ext. (56-2) 22149468. E-mail: zhaidar@uandes.cl

Conflict of interests: None.

Acknowledgements: This work was supported by operating grants provided to BioMAT'X (Laboratorio de Biomateriales, Farmacéuticos y Bioingeniería de Tejidos Cráneo Máxilo-Facial) through the Faculty of Dentistry and PMI (Plan de Mejoramiento Institucional I+D+i), Dirección de Innovación, Universidad de los Andes, Santiago de Chile. It recognizes the gigantic contributions to dental implant education and celebrates the 45th anniversary of the International Congress of Oral Implantologists (ICOI): 1975-2017. The author is an active member of the Implant Dentistry Study Consortium (ID-SC), an ICOI-affiliated Center, in Dubai – UAE.

Cite as: Haidar ZS. Autonomous Robotics: A fresh Era of Implant Dentistry… is a reality! J Oral Res 2017; 6(9):230-231. doi:10.17126/joralres.2017.072

Per-Ingvar Brånemark's virtuoso encounter of "osseointegration" in 1952 and George A. Zarb's outstanding long-term evidence-based efforts, presented in 1982 via the renowned "Toronto Conference on Osseointegration in Clinical Dentistry" revived the realm of dental implantology.[1-3] The last decades witnessed a hungry integration of computerized tomographic scans, computer-aided design/computer-assisted manufacturing (CAD/CAM) and three-dimensional (3-D) surgical planning software, in practices and academic/training programs. With such oro-dental appliances that transfer the computerized planning into the surgical field, the oro-dental implantology field has been undergoing a remarkable and fast-paced trend towards minimally-invasive surgical procedures.[4,5]

Today, 35 years later, the World's first *autonomous* dental implant robot was used on September 16th in China. This news comes only 6 months after the first robotically-assisted dental surgical system/software, labelled "YOMI", received clearance by the U.S. Food and Drug Administration (FDA). YOMI (Available at https://www.neocis.com) is a robotic guidance or navigational computerized system for dental implant procedures, performed by the "human" surgeon and "human" team. It aids us in the pre-op planning and intra-op surgical phases, via complimenting and providing accurate and reliable physical and visual guidance throughout the procedure, alleviating the need for preparing a custom guide. Henceforth, it is designed to enhance confidence, view of surgical site, and the precise control of the surgeon's operative hand in terms of position, orientation and depth via delivering vibrational feedback, in real-time.

Yet, the Chinese created an "autonomous" robot to do the job! Well, anesthesia on you!

An autonomous robot is basically an intelligent robot that performs behaviors or tasks with a high degree of autonomy, in other words, possesses the capacity of individual rationalization to make an informed and un-coerced decision, him/her/it-self and without any apparent control from us, humans.

Innovating robotic technologies for surgical intervention is not a "new" concept or quest. Exciting and emerging, certainly though. The widely-spread da Vinci robot was approved for use by the US-FDA in 1997. Equipped with a magnified 3-D high-definition visualization system and miniature arms that bend and rotate far greater than the

ISSN Online 0719-2479 - www.joralres.com © 2017

human hand, facilitating minimal-invasiveness, the da Vinci robot empowers the medical (General, Head and Neck, Thoracic, Cardiac, Colorectal, etc…) surgeon to operate with enhanced vision, control and precision.[6] However, reports indicate that much development remains, technically, before the full potential of robotic medical surgery can be apprehended.

Likewise, in Dentistry, I recall a Polish *robot* made the stage at the IADR (International Association for Dental Research, 79th General Session in Japan, if memory serves well). Combining intra- and extra-oral cameras, remote/wireless transmission of captured images, an artificial oral cavity with simulated mandibular movements was reproduced. The dentist, extant in another location, wearing virtual reality glasses, can then freely and smoothly navigate intra-orally using a joy-stick and transmit operative commands. Applications included cariology, endodontics and occlusion. At the time, it was presented as an innovative solution for dentists with disabilities or those with spinal and neck problems. Distant manoeuvre can also shield the team thru foiling disease transmission.

The just announced and 100% Made-in-China robot, combines accurate mechanical positioning with 3-D printing, for the robotic "arm" to perform with high-precision, the dental implant surgical procedure, in ~30 minutes, per implant (Demonstration video available at: https://www.youtube.com/watch?v=6bXnBto0NNo). A collaborative project between the robot institute at Beihang University in Beijing and the Fourth Military Medical University Hospital in Xi'an, the robot aims to avoid human surgical errors and address the shortage of qualified dentists in China. It was reported that the robot performed with higher precision than manual of a "human", with an error of 0.2-0.3mm. Relaying sensory input/feedback (touch sensation) from the robotic instruments back to the operating surgeon, concurrently, is a very attractive achievement.

Now, *!tranquilo!*, it is not expected that such cutting-edge (and evolving) robotic systems will replace the need for oro-dental implantologists anytime soon. Rather, will skulk; driven by market needs and strategies, into your clinical and surgical armamentarium, over time.

Researchers will continue the quest to create optimal natural-looking dentition replacement, with predictability, shorter healing times and advances in developing bio-active implant materials and surfaces *-photo-functionalization of titanium?* Despite striking developments, robot-related faults and safety issues require numerous series of well-documented cases and perhaps, randomized controlled trials comparing robotic-assisted and autonomous robotic procedures with traditional techniques; unquestionably lacking/in-existent to date.[6-8] Finally, besides implant insertion matters, we still need to be able to overcome or avert unsuccessful or destructive changes in osseointegration, a topic of ongoing investigation.

REFERENCES.

1. Brånemark PI, Zarb GA, Albrektsson T. Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry. Hanover Park, IL. 1st Ed. Chicago: Quintessence; 1985.
2. Adell R, Lekholm U, Rockler B, Brånemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg. 1981;10(6):387–416.
3. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants. 1986;1(1):11–25.
4. Mozzo P, Procacci C, Tacconi A, Martini PT, Andreis AI. A new volumetric CT machine for dental imaging based on the cone-beam technique: preliminary results. Eur Radiol. 1998;8(9):1558–64.
5. Closmann JJ, Schmidt BL. The use of cone beam computed tomography as an aid in evaluating and treatment planning for mandibular cancer. J Oral Maxillofac Surg. 2007;65(4):766–71.
6. Lanfranco AR, Castellanos AE, Desai JP, Meyers WC. Robotic surgery: a current perspective. Ann Surg. 2004;239(1):14–21.
7. Dutreuil J, Goulette F, Laurgeau C, Clavero Zoreda J, Lundgren S. Computer Assisted Dental Implantology: A New Method and a Clinical Validation. Medical Image Computing and Computer-Assisted Intervention – MICCAI 2001. Lecture Notes in Computer Science. 4th Ed. Springer, Berlin: Heidelberg; 2001.
8. Zhang Y, Jiang JX. Trajectory planning of robotic orthodontic wires bending based on finite point extension method. Adv Mat Res. 2011;201–203:1873–7.