

THE ROBOT THAT MAY ONE DAY DO YOUR ROOT CANAL SURGERY

DENTAL AND FLUID MECHANICS SCIENTISTS are developing an automated approach to root canal therapy.

Many of us will at some point suffer an endodontic condition,

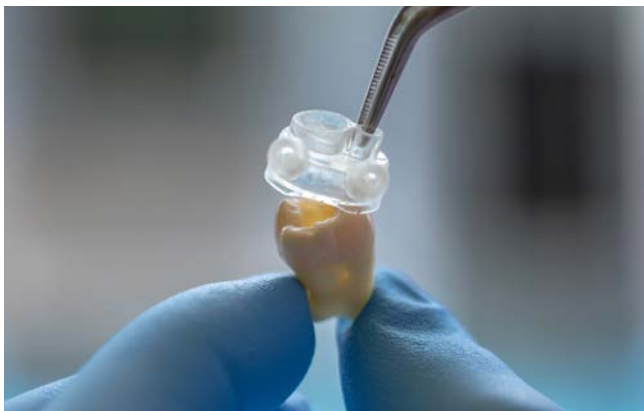
such as an inflammation in the pulp inside a tooth. This is manageable if you have access to an experienced endodontist, but a potential catastrophe if you do not. Untreated endodontic conditions can lead to severe pain, infections spreading to the jaw or bloodstream, and loss of teeth.

"In China, the shortage of endodontists poses a critical problem," says Jizhi Zhao, dean of dentistry at Peking Union Medical College Hospital in Beijing.

To address this, Zhao's team has developed a new treatment called PUMCH therapy, short for 'Photoacoustic-steaming Unite Minimal-invasive Chemomechanical-preparation Hydramatic-obturation'. Zhao is also collaborating with fluid mechanics expert, Chong Pan, from nearby Beihang University, to develop a prototype endodontic robot to help deliver PUMCH therapy. The robot, which is not yet approved for use, could lead to more comfortable and precise treatment, that could be performed by most dental practitioners, says Zhao.

EXPLOSIVE CLEANING

Endodontic treatment typically involves eradicating debris and microorganisms within a tooth to clean up infection as much as possible, followed by filling the root canal to prevent reinfection. Teeth are cleaned via a combination of topical antimicrobials and mechanical tools, such as hand files, drills, ultrasonic devices, and — increasingly — laser tools.



▲ Researchers in China are working to help provide universal access to quality dental care (top). Dental robots, such as this prototype (bottom), could one day make treatment safer and more widely available.

But the whole process is delicate and occasionally more damage is done. "The complexity and variability of root canal anatomy demands precision, which largely relies on endodontists' nuanced skills and experience, especially in the mechanical preparation process," Zhao explains.

The prototype endodontic robot uses a type of laser called Er:YAG laser, which vaporizes water in the pulp chamber, causing micro-explosions that destroy organic and inorganic particles, reducing the need for mechanical preparation.

Zhao's team tested the Er:YAG laser at different settings on tooth models of different shapes and sizes¹. The results, together with a series of further trials, were used to optimize Er:YAG laser parameters to a range that would help ensure safer treatment for different tooth shapes.

The endodontic robot is intended to ensure thorough disinfection "and also to preserve the integrity of the tooth structure, significantly reducing the risk of postoperative tooth weakening," says Zhao.

The team then gave the robot prototype the capability to perform automated root canal fillings, using vacuum filling technology with the aim of producing a more uniform distribution of the filler. This could avoid excessive drilling, explains Zhao. The endodontic robot's precision is intended to reduce the risk of overfilling which can also cause damage.

SEALED AND DELIVERED

The development of the endodontic robot is being supported by the Chinese government National High Level Hospital Clinical Research Funding initiative, which supports translation of research into practical uses, says Zhao. Since last year, a medical robotics company in Beijing, has been refining the technology to enhance patient comfort and usability for dental practitioners.

"Our objective is to broaden the root canal therapy application to general dental practices, not only specialised endodontists, for a wider patient demographic," he says. "The automation of dental procedures is pivotal in transforming quality dental care into a universal standard, not a privilege." ■

REFERENCE

1. He, X. *et al. Lasers Med. Sci.* **38**, 123 (2023).



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