39th IACDE National Conference

TINY TECH BIG IMPACT

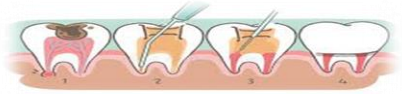
MICROROBOTICS PIONEERING NEW FRONTIERS IN ENDODONTICS

Problem?

Improper and inadequate disinfection is one of the major causes of root canal failures.

Current Technologies

- Mechanically- Files
- Chemically- Irrigating agents
- Lasers-PIPS, SWEEPS



Solution

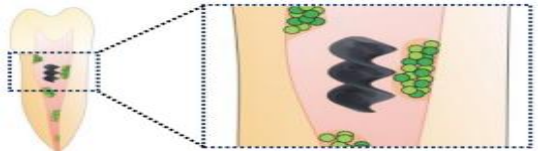
MICROROBOTICS utilizes microscopic robotic devices to improve the precision and effectiveness of RCT, which are actuated by extrinsically powered magnetic fields.

Features

- Reconfigurability
- Remote-control & Physical Intelligence
- Untethered
- Adaptability
- Multi-functionality - Biofilm disruption, targeted drug delivery, microorganism retrieval for analysis

Types of Microrobots

Intrinsically Powered	Ions
	Chemicals
Extrinsically Powered	Acoustic
	Electric
	Optical
	Magnetic Field



Advantages & Disadvantages

Precision Targeting	Lack of controlled directionality OR speed of self-propulsion
Access to narrow and curved canals	
Real-time feedback	
Minimally invasive	Expensive
Automated navigation	Steep learning curve

Application

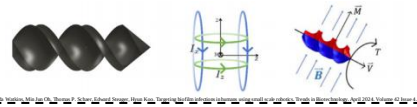
Microrobots are used to optimize root canal disinfection by the 'kill-degrade-and-remove' approach.

3D-Moulded robots

IONPs embedded in biocompatible hydrogel
MOA: Generation of ROS

Alaa Babeer, Sarah Bukhari, Rayan Alrehaili, Bekir Karabucak, Hyun Koo Microrobotics in endodontics- A perspective. International Endodontic Journal. May 2024. Volume 57, Issue 7, p. 861-871

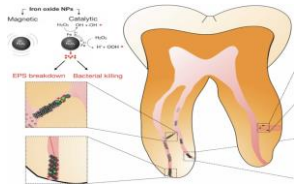
Time series images showing 3D- moulded robots propelling inside the root canal



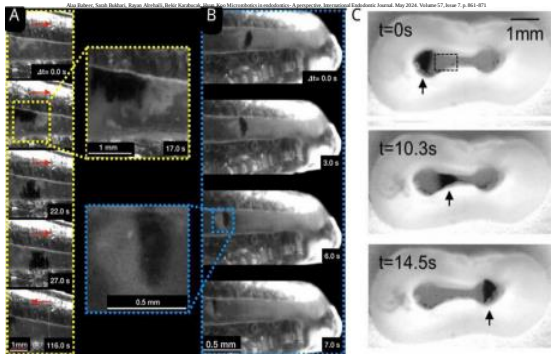
Hong Hai Tran, Amanda Watkins, Min Jun Oh, Thomas P. Schen, Edward Steager, Hyun Koo, Targeting biofilm infections in human urine using small-scale robotics, Trends in Biotechnology, April 2024, Volume 42 Issue 4, P479-495

Aggregated Microswarms

MOA: Use IONPs as building blocks that possess an inherent catalytic activity.



Alaa Babeer, Sarah Bukhari, Rayan Alrehaili, Bekir Karabucak, Hyun Koo Microrobotics in endodontics- A perspective. International Endodontic Journal. May 2024. Volume 57, Issue 7, p. 861-871



Time-lapse showing A) Biofilm disruption B) Sample retrieval C) Navigation through isthmus space

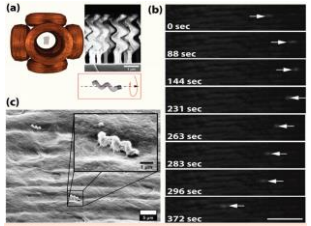
Helical Silica Nanorobots

These silica helices contain a silica blob head with pure iron deposited at its core to facilitate their tetherless control.

1

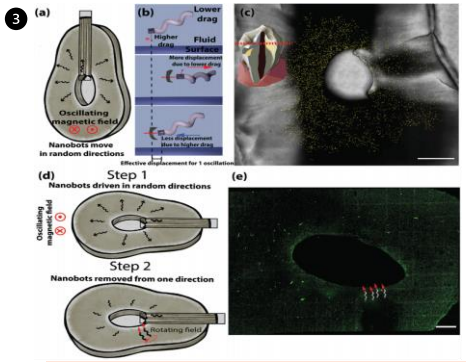
Cross section of a tooth showing single dentinal tubule with bacteria

2



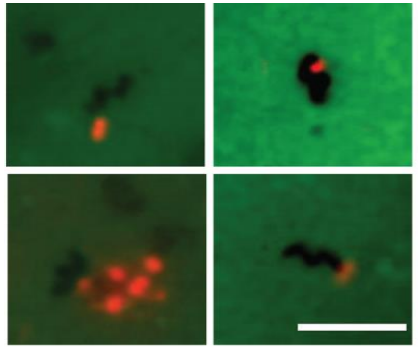
A triaxial Helmholtz coil was used to generate the magnetic field

3

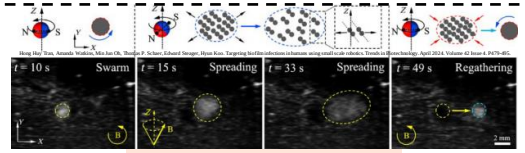


A,B,C - Motion of microbots inside tubules
D,E- Retrieval of nanobots

4



The dead bacteria(red) acts as a heat source when subjected to magnetic hyperthermia



Real time tracking using ultrasound

Technology	NaOCl flushing	Ultrasoud agitation	Laser-PIPS	Laser-SWEEPS	Magnetic nanobots reported here
Depth of Penetration	<20 µm	160-330 µm	800 µm	650-800 µm	2000 µm

References

1. Alaa Babeer, Sarah Bukhari, Rayan Alrehaili, Bekir Karabucak, Hyun Koo Microrobotics in endodontics- A perspective. International Endodontic Journal. May 2024. Volume 57, Issue 7. p. 861-871
2. Debayan Dasgupta, Shanmukh Peddi, Deepak Kumar Saini, Ambarish Ghosh Mobile Nanobots for Prevention of Root Canal Treatment Failure. Advanced Healthcare Materials. April 2022. Volume 11 Issue 14. 2200232