Robotic Microsurgery Innovations: Pioneering Precision in Delicate Surgical Procedures

Article *in* International Journal of Surgery Open · October 2024

DOI: 10.1097/IO9.0000000000000223

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Robotic microsurgery innovations: pioneering precision in delicate surgical procedures

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Robotic microsurgery is changing the way surgeons repair fragile tissues like nerves and blood arteries, where accuracy is vital. The conventional manner of microsurgery is restricted by the surgeon's ability to handle precise motions, since little tremors in control may quickly lead to blunders in suturing or reattaching tiny vessels[1]. Robotic technologies address the issues by improving a surgeon's accuracy and reducing human error. Among the important advances in this discipline, the use of increasingly modern robotic platforms now enables them to achieve sub-millimeter precision[2]. These devices employ motion scaling to transform the surgeon's actions into very accurate, much smaller motions. Furthermore, they have greatly decreased hand tremors, allowing for solid and controlled motions even during the most sensitive treatments[3].

The development of robotic systems, such as the Da Vinci Surgical System, which were first used for broad purposes, including operations, is projected to be employed for microsurgical applications and more precisely in fields such as urology and reconstructive surgery[4]. Platforms designed for microsurgery, such as the MUSA robot and the Symani Surgical System, give surgeons instruments for working on microscopic veins and nerves[5]. In such systems, 3D high-definition visualization plays a key role since it allows for the viewing of detailed pictures of the operational field with depth awareness, which improves accuracy even more[6]. Integrating new haptic feedback in robotic systems improves the surgeon's ability to do difficult tasks by giving a sense of touch, which is required for fragile tissues to be gently manipulated[7].

AI and machine learning capabilities enhance these robotic systems. AI-powered devices may analyze real-time data during surgery and provide recommendations or alterations depending on variations in tissue tension, blood flow, and other factors that will change[8]. In addition to improving decision-making during surgery, these technologies lower the overall incidence of problems. The influence of robotic microsurgery is significant. It also allows surgeons to execute more difficult surgeries with higher precision, which improves patient outcomes by lowering complications and recovery times[9]. Other microsurgical treatments, such as nerve repair and vascular reconnections, are now safer and more dependable on this robotic equipment[10]. Despite such advances, the cost or availability of these technologies restricts their application. These technologies are currently pricey, making them only accessible to high-income countries and bigger hospitals[11]. Robotic microsurgery should be extensively distributed once the technology is affordable and portable, allowing more patients throughout the globe to benefit[12]. The ongoing growth of these technologies, together with advances in AI and haptic feedback, promises to increase the precision and skill of surgeons performing even the most minute and intricate surgeries[13].

Ethical approval

Not applicable.

Consent

Not applicable.

Sources of funding

None declared.

Author contribution

A.S.V., study concept, data collection, writing original draft; M.C.M.C., writing original draft; T.B.E., supervision and writing – review & editing.

Conflicts of interest disclosure

None declared.

Research registration unique identifying number (UIN)

Not required.

Guarantor

Talha Bin Emran.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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International Journal of Surgery Open (2024) 62:845–846

Received 9 October 2024; Accepted 12 October 2024

Published online 24 October 2024

http://dx.doi.org/10.1097/IO9.0000000000000223

Data availability statement

Not required.

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