How Advances In the Technology Transforming the Surgical Practices?

Abdul Qadeer Memon,[1*] Jamshed Akhtar [2]

In the present century, science and technology have progressed at a great pace. Medical fields, including surgical specialties are equally benefiting from this as number of innovations are added into the surgical practices. However, during the 20th century a remarkable leap was also made. It included organ transplantation, the use of heart-lung bypass machine to facilitate open heart surgeries, minimal-invasive surgery, robot-aided surgeries, and many other procedures in different surgical specialties like orthopedics, ophthalmology, to name a few.[1]

It is pertinent to note that parallel advancements in the diagnostic fields like radiology, the imaging techniques like MRI, CT scan and other modalities helped surgeons in diagnosing different diseases and planning operative procedures before and during the surgery with great accuracy and precision. With the availability of three-dimensional (3-D) reconstruction technology, a visuospatial vision can be created. The 3-D printing is now in use because of which accurate reconstruction is done from the available imaging data.[2] This helps in precisely identifying the morphology of the injury as in complex orthopedic cases, unusual anomalies like conjoint twins, mapping extent of the tumors and others. The surgical procedures are thus tailored accordingly.

With the availability of fast internet services, the robotic surgery can now be performed with enhanced accuracy and precision from a remote site, the telesurgery, thus overcoming the geographical barriers. The newer robots including Da Vinci and SSI Mantra have developed highly advanced system that provide immersive interfaces with remote control. The 5G and other high-speed-internet facilities made it possible to provide controlled, real-time data transmission. This facilitates video sharing and other controlled signals transmission in microseconds or single-digit milliseconds referred to as ultra-low latency data transmission. The incorporation of artificial intelligence helps surgeons in decision making quickly and accurately with the help of soft-wares. Advanced imagery like 3-D integration enhances visualization and facilitates surgery. In a recent conference of WHO with the Society of Robotic Surgery a health innovation initiative was launched to expand access to virtual care and telesurgery. They have signed a Memorandum of Understanding the purpose of which is to ensure an equitable access to virtual care and telesurgery across the globe.[3]

It is pertinent to mention that a parallel improvement in the designs of operation rooms, availability of newer gadgets and the surgeons' desire to think out of box, implementing new ideas and working with the industry to invest in the technology and equipment development also made a huge change. The availability of high-quality and ergonomically efficient equipment made a significant change in performing surgical procedures. Surgeons face less stress and safety of patients is also enhanced. With the availability of miniaturized sized equipment minimal invasive procedures are more frequently performed. In the field of urology, a remarkable change is witnessed over the years.[4] This is due to the combination of advanced engineering technology and demand of the operating surgeons who guide the industry.

The future of surgery is expected to improve further with the use of artificial intelligence. The newer algorithms based upon the huge data available can guide surgeons in making diagnosis, identifying patients at risk before operation, the suitable surgical approach for a patient, postoperative care and follow up. Patient care is thus improved with better outcome.

[2] Department of Paediatric Surgery, National Institute of Child Health Karachi Pakistan
ORCID: 0000-0002-3967-7241

Correspondence:
Dr. Abdul Qadeer Memon [1*]
Department of Surgery
King Faisal University College of Medicine
Al Ahsa, Kingdom of Saudi Arabia
E mail: amuhammad@kfu.edu.sa
ORCID: 0000-0002-7071-9489

Similarly, it is used in teaching and training of surgical residents as well as surgeons themselves.[5] It has a global application which is flexible too as models may be modified according to the particular geographical region and demography of the population.

The augmented reality and virtual reality is expected to bring a huge change when freely available by providing training not only for the budding surgeons but also for experienced surgeons in the field. It is not ethical to learn the surgical procedures on the patients. A simulation center can be a place where surgical education and training can be provided.[6,7] A huge investment is required to achieve such a goal. The simulations are quite expensive and require a complete new set up for its construction and maintenance. Virtual reality simulators are more realistic. Those who were trained on box-trainers can appreciate the difference. The American Board of Surgery incorporated few basic courses as a requirement of qualifying examination. This includes the Fundamentals of Laparoscopic Surgery (FLS) and Fundamentals of Endoscopic Surgery (FES). These are not available in many low and middle income countries though they are important benchmarks for residents and surgeons in training.

Till now the focus was on goods related to the innovations in the surgical field. However, there are number of issues that must be kept upfront when a new technology is adopted. Firstly, a need must be defined and reasons as to why the older approach may be abandoned be presented with evidence. A standard scientific approach must be followed for the development of newer devices and equipment. Then comes the process of testing on models and human subjects. There are not many randomized controlled trial in the field of surgery where new devices and equipment pass through a rigorous research before being used on the patients. There is always a learning curve with a new technology. A potential harm may occur to the patients.[8] The industry involved in the manufacturing of new equipment can also have competing interests. The cost of equipment, its working and maintenance are other major barriers in limited resource settings. A balance is thus required.

REFERENCES:

1. Morrell ALG, Morrell-Junior AC, Morrell AG, Mendes JMF, Tustumi F, DE-Oliveira-E-Silva LG, et al. The history of robotic surgery and its evolution: when illusion becomes reality. Rev Col Bras Cir. 2021;48:e20202798. doi: 10.1590/0100-6991e-20202798.

2. Xie L, Chen C, Zhang Y, Zheng W, Chen H, Cai L. Three-dimensional printing assisted ORIF versus conventional ORIF for tibial plateau fractures: A systematic review and meta-analysis. Int J Surg. 2018;57:35-44. doi: 10.1016/j.ijsu.2018.07.012.

3. WHO and Society of Robotic surgery. [Internet] Available from URL https://www.who.int/news/item/08-08-2025-who-and-society-of-robotic-surgery-launch-health-innovation-initiative-to-expand-access-to-virtual-care-and-telesurgery. Accessed on December 15, 2025.

4. Bhatt NR, Davis NF, Dalton DM, McDermott T, Flynn RJ, Thomas AZ, et al. Quantitative analysis of technological innovation in urology. Urology. 2018;111:230-7. doi: 10.1016/j.urology.2017.07.068.

5. Chiu SV, Liu CF, Liao KM, Chiu CC. Artificial intelligence-driven surgical innovation: A catalyst for medical equity. Ann Gastroenterol Surg. 2024;8(5):952-3. doi: 10.1002/ags3.12827.

6. Riddle EW, Kewalramani D, Narayan M, Jones DB. Surgical simulation: Virtual reality to artificial intelligence. Curr Probl Surg. 2024;61(11): 101625. doi: 10.1016/j.cpsurg.2024.101625.

7. Shen Y, Wang S, Shen Y, Hu J. The Application of augmented reality technology in perioperative visual guidance: Technological advances and innovation challenges. Sensors (Basel). 2024;24(22):7363. doi: 10.3390/s24227363.

8. Wilson CB. Adoption of new surgical technology. BMJ. 2006;332(7533):112-4. doi: 10.1136/bmj.332.7533.112.

Authors' contributions:
Abdul Qadeer Memon: Concept, initial draft and final approval.
Jamshed Akhtar: Concept, manuscript writing and final approval.

How to cite this article?
Memon AQ, Akhtar J. How advances in the technology transforming the surgical practices? J Surg Pakistan. 2025;30 (4):95-96.