Artificial Intelligence (AI) in Orthopaedics - Decoded

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What is Artificial Intelligence?

"Artificial Intelligence" is a term coined by John McCarthy, a Professor Emeritus of Stanford, in 1955, defined as "the science and engineering of making intelligent machines". In simplest terms, it denotes computers that learn to perform tasks through pattern recognition with minimal human support. More specifically, it is a technology that adapts to humans. Within the umbrella term of artificial intelligence, we also have machine learning which denotes computers that are programmed to improve or 'self-correct' the algorithms by conducting trial-and-error experiments. Deep learning isa subfield of machine learning where layers of computer circuits interact to form artificial neuronal networks.

AI- where are we now?

AI has permeated every stream of life, both in the real and virtual world, making its mark not just in fundamental sciences to space technology but in something as small as making an online purchase recommendations. There is practically no technology immune from AI in the present world.

AI in Health Care

Artificial intelligence is revolutionising almost every sector and health care is no exception. It is reported that the global market for AI for the healthcare sector had reached $6 billion in 2021 and these figures are expected to rise much higher. The key categories of applications involve diagnosis and treatment recommendations, electronic health record systems, patient communication, to name a few. One of the major areas where AI has found practical application are in Oncology decision support

AI in Orthopaedics

Potential applications AI in Orthopaedics are immense. They may be categorised as pre operative, intra operative and post operative applications. The American Academy of Orthopedic Surgeons has developed best practise guidelines to standardise patient selection process for surgery based on medical history, symptoms severity etc. Another popular target of AI technologies is in orthopaedic imaging. Most of the researches used AI for image interpretation, image recognition and automatic segmentation of an area-of-interest or as a tool in clinical decision making. Spine, knee and hip are the joints most commonly studied. Researchers have also applied AI to trauma radiographs for diagnosing fracture, to predict limb salvage surgery, predicting models of complications and

mortality after surgery, and pattern identification. Immersive virtual reality is an AI-based surgical training tool that provides representations of many surgical techniques in a 360-degree viewing mode. Wearable and connected tools (IoT), remote monitoring systems to optimise patient management, to measure functional outcome etc., forms possible post operative applications.

AI in Joint Replacement

Perhaps the zenith of AI in orthopaedics can be identified as the application of Robotics in joint replacement surgery. Robotic arthroplasty is currently applicable for knee and hip joint.
Robotic-assisted total knee and total hip arthroplasty has been developed to recreate joint kinematics, for intelligent alignment, great functional outcomes, to expedite recovery, and improve implant survivorship. Robotic devices are classified into active/autonomous, semi active/haptic,and passive, based on their degree of freedom. With the active system, the surgeon does not need to directly manipulate the instruments, and the robot will independently perform the osteotomy. The semi-active system limits the range of movement of surgical instruments controlled by the robotic arm. The surgeon has more flexibility and can move the instruments freely within the defined boundaries. A passive system only provides a 3D virtual model for accurate preoperative planning but does not assist in the procedure. Among the above three, the semi-active system is most widely used and representative examples include MAKO Rio Robotic Arm System, VELYS™ Robotic-Assisted Solution by DePuy Synthes, CuvisJoint Robotic System by Meril Life etc.
Computer Assisted Navigation is another application of AI. It allows the surgeons to obtain real-time feedback during joint replacement and its advantages include a smaller physical footprint compared to the robotics system, a lower cost, the ability to have the intraoperative data in the same field of view, and an easier work flow.

How robotics makes a difference? What it means to patients?

The advantages of robotic-assisted Total Knee and Total Hip Replacement (TKA) are optimal kinematics, implant positioning and more soft tissue protection. Most controlled researches suggests a better short-term functional outcome with robotics compared to the conventional total joint replacement however mid- or long-term outcomes needs further evidence based research. The downside of robotic-assisted joint replacement includes a huge capital investment, long learning curve for surgeons and staff, longer operative time, and compromised cost-efficiency. Moreover, the incompatibility of a robotic system with different types of implants also pose a problem.
Despite so many promising applications, day-to-day clinical adaptation of AI in Orthopaedics remains limited. Ethical considerations regarding the ownership and the use of big data in health care are also a concern. But despite the above glitches, AI is here to stay. Generating awareness amongst the medical professionals is the key step towards laying the foundation for adoption of AI initiatives. Surgical skills cannot be substituted by artificial intelligence. 'Augmented' intelligence, to assist the health care providers, and not to replace them remains the ultimate aim.