Robotic surgery in Orthopedics

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The term "robot" describes a machine that carries out a variety of tasks either automatically or with a minimum of external impulse[1]. It is derived from a Polish word meaning "Forced labor". The use of robotics in the operation theatre is probably one of the major technological breakthroughs of the 20th century [2,3]. It was wayback in 1950s that the robot Unimate was discovered[4]. Robotic surgery systems are of two types: haptic and autonomous. Haptic also known as tactile systems is surgeon dependent and requires constant inputs from the surgeon to complete the procedure. Contrary to this, autonomous robotic systems require surgeon to set up the machine first, but once engaged, there is no need of surgeon's help and the robot itself completes the surgery[5]. It was in the early 1990s that the robotic surgery first came into Orthopedic use, where it was used for planning of total hip replacements and optimal positioning of final implants[6]. Recently the use of robotics in Orthopedics has been extensive.

USES IN ORTHOPAEDICS

• KNEE:
Robotic surgery has the ability to reduce complications like malalignment, wear/fracture of the implant, aseptic loosening and increase the survivorship of the implants[7]. Various authors have compared the robotic knee replacement with the conventional techniques and have reported that though the alignment is better in the robotic group the functional outcomes are similar in both the group of patients [8-12]. Cobb et al, 2006 studied the role of robotics in unicompartent knee arthroplasty. 23 patients were operated using Acrobot System (The Acrobot Co Ltd, London, UK) as the robot and 14 patients were operated by the conventional technique. They found that robotic alignment was better than the conventional technique however the functional outcome was similar in both the group of patients, and there were no major complications in either of them [8]. Bell et al used MAKO Robotic Interactive Orthopedic (RIO) Arm (Stryker, Mahwah, NJ, USA as the robot and reported that the alignment was better achieved by the robot[9]. Various studies have emphasised that the accuracy of robot-assisted Unicondylar knee arthroplasty (UKA) is better with regard to the tibial slope and alignment of varus and valgus [13-16]. Robot-assisted UKA allows accurate soft-tissue balancing and helps restore biomechanics of knee, with positive implications for implant survival and functional outcomes[17]. Robot-assisted TKA is believed to improve position of the implant, preserving bone protecting the soft tissues[18]

HIP:
Robots have been used for total hip arthroplasty (THA) for the past 20 years. Bargar et al studied total hip arthroplasty using ROBODOC; Integrated Surgical Systems, Davis, CA. 69 cases were operated with the help of robots and 65 were conventional cases with a mean follow up of 24 months. The authors observed a statistically significant improvement in the placement of femoral component. The limb length discrepancy and varus–valgus stem orientation were also improved with robotic THA[19]. Bargar et al followed up the patients for a mean of 14 years and stated that the functional outcome and alignment is better in Robot group with no major complications[20]. In a matched-pair controlled study, it was observed that the size of the robotically implanted acetabular cups were significantly smaller than the manual THAs. Thus robotic THAs could preserve bone stock and could be of immense benefit in revision cases preserving the remaining acetabulum[21].

SPINE:
The use of robots is widespread in spine surgery especially for pedicle screw placement. Kim et al in 2017 studied placement of pedicle screw in the spine using SpineAssist (Mazor Surgical Technologies Ltd, Caesarea, Israel) as the robot.
There were 41 patients in both the robotic and conventional groups. The authors stated that there is similar accuracy (99.4%) in both the groups however there were 13 (15.9%) violations with the freehand technique and none with the robots[22]. Minimally invasive spinal fusions can be performed with less radiation exposure in robotic surgery as compared with freehand technique [23].

TRAUMA AND GENERAL ORTHOPAEDICS:
Trauma Pod which is a semi-automated telerobotic surgical system is used to save the lives of critically injured patients on the battlefield[24]. Robots have a role in percutaneous reduction of fractures[25-27]. Wang et al conducted a randomised study on 30 patients who required posterior pelvic ring stabilisation. Of the 4s sacro-iliac joint (S1 and S2) screws, 22 were done freehand and 23 robot-assisted (TiRobot™ [TINAVI Medical Technologies Co, Ltd, Beijing, China]). Though there was no significant difference between the operation time; the robot-assisted group had less radiation exposure. The accuracy of screw placement was excellent and good in 100% of robot-assisted group and 95% in the freehand group [28].

LIMITATIONS:
Financial constraints are a major factor limiting the widespread use of robotics in orthopaedic surgery. Though robotic surgery has demonstrated definite benefits but there have been reports of increased incidence of nerve damage and infection with increase in the rate of litigation[29]. The use of ROBODOC has been associated with increased operating times and blood loss[30-32] since its introduction in the last century today, the robotic technology is in the process of being state-of-the-art for orthopedic use [33]. Despite some minor issues, the benefits are clear. It is believed that, in time, robotic devices will be a routine addition to the armamentarium of orthopaedic operation theatres.

References
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