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Commentary

To Be Trustworthy, the Robot Assisted Cervical Spine Surgery Needs More Than Accuracy Beyond Technological Limitations: Commentary on "Robotics in Cervical Spine Surgery: Feasibility and Safety of Posterior Screw Placement"

Corresponding Author
Seong Yi
https://orcid.org/0000-0003-0700-4744

Department of Neurosurgery, Spine and Spinal Cord Institute, Severance Hospital, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea
Email: yiseong@yuhs.ac

See the article "Robotics in Cervical Spine Surgery: Feasibility and Safety of Posterior Screw Placement" via https://doi.org/10.14245/ns.2244952.476.

Seong Yi

Department of Neurosurgery, Spine and Spinal Cord Institute, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

Robotic-assisted (RA) surgery is becoming increasingly common in spine surgery, many literatures have been accumulated and showed the advantage of accuracy, radiation reduction, efficiency, future applications over traditional open surgery or even conventional minimally invasive surgery.[1-3] By using advanced imaging techniques and computer-assisted navigation, the surgeon can plan and execute the procedure with a high degree of precision, which can help reduce the risk of complications and improve outcomes. The potential advantage of RA cervical spine surgery is greater accuracy and precision. Recently the robot assisted cervical spine surgery has been studied, some studies have suggested that RA cervical spine surgery may offer several advantages over traditional surgery.

The paper "Robotics in Cervical Spine Surgery: Feasibility and Safety of Posterior Screw Placement"[4] proved this line of research using meta-analyses, to evaluate the feasibility and safety of RA screw placement on cervical spine surgery. This paper reviewed systematically total 7 studies; 1 randomized controlled trial,[5] 3 comparative cohort studies, and 3 case series.[5-9] This paper concluded that the RA cervical pedicle screw fixation is safe and feasible on the result of optimal and clinically acceptable cervical screw placement accuracy under robotic guidance were 88.0% and 98.4% respectively.

Though the accuracy is highly enough reported in recent reports, there is several reasons why the RA cervical pedicle screw placement is still challenging procedures to be cautious in the practice.

Current status of U.S. Food and Drug Administration (FDA) regulation for the RA cervical pedicle screw placement reflect the current status of the clinical acceptable accuracy of several kind of robotic systems.[10] Several robotic systems have had FDA clearance for use in the cervical spine; the ExcelsiusGPS (Globus Medical, Audubon, Pennsylvania, PA, USA), the Cirq Robotic Alignment Module (Brainlab, Munich, Germany) but such use requires simultaneous intraoperative fluoroscopic confirmation or imaging workflow for real-time

visualization including intraoperative computed tomography (CT) and fluoroscopy.[10] The Mazor X Stealth (Medtronic, Inc., Minneapolis, MN, USA) robotic system, the ROSA ONE Spine (Zimmer Biomet) are cleared for thoracolumbar spine, the Ti-Robot system (Tinavi Medical Technologies, Ltd, Beijing, China) was approved in China for pedicle screw placement from T1 to L5 with a posterior approach only.[10,11]

The unique features of cervical spine are complex anatomy encasing vertebral artery and larger spinal cord, skiving on the bony surface, more mobile segments highly affected by patient's position and surgical manipulation, smaller dimension, more convergent trajectory for pedicle screw and musculature than the other spine, which has more potential risk than thoraco-lumbar-sacral spine if the robotic errors exceed some extent of limit. The neurovascular complication by misplacement of cervical screws would be more catastrophic than the other spine. The main advantage of minimally invasive RA thoracolumbar surgery is the percutaneous screw insertion without using fluoroscope or navigation, avoiding radiation hazards and restriction of unnecessary hand movement along the axis of screw insertion, minimizing destructive procedures. But the cervical pedicle screw placement is usually performed in open procedures, cannot be easily done by percutaneous technique at this moment due to the difficulty in localizing optimal anatomical landmark, few available percutaneous cervical screws system, except posterior C1–2 transarticular screw placement which can be done by percutaneously in skin entry, but not be done in bone entry actually.

RA cervical spine surgery is controversial though recent articles showed favorable results. The accuracy of surgical robot itself is reliable enough in submillimeter level. But the current technical limitations, which cannot visualize virtual image over cervical anatomy in real time, resulted in unwillingness of RA cervical surgery. Surgeons should understand the possible errors and consequences beyond robotic system.[12,13] To be confident for the RA cervical spine surgery, real-time visualization or tracking system for real anatomical landmark to be coordinated by robotic system should be achieved, which is not introduced yet in current technologies.

In the current state, the robotic system has benefit clearly on identifying the ideal entry point and trajectory for accurate screw insertion based on the 3-dimensional CT reconstructions in cervical spine, especially in the patient of complex deformity. The preoperative planning leads to higher efficiency saving surgical time. Ultimately, the decision to undergo RA cervical spine surgery should be based on a careful evaluation of the patient's individual anatomy and circumstances, as well as the skillful experience of the surgeon performing the procedure.

While this paper concluded a promising result, we look forward to a larger series before conclusions can be made about the safety and accuracy of its use with instrumentation in the cervical spine.[14] The RA cervical spine will become essential, reliable and standard procedures when the accuracy supported by real-time anatomical information, the cost effectiveness,[15] efficiency, special surgical instruments allowing RA percutaneous procedures are realized in the near future.

• **Conflict of Interest:** The author has nothing to disclose.

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