Da Vinci robot

The introduction of robot-assisted surgery, and specifically the da Vinci robot Surgical System, is one of the biggest breakthroughs in surgery since the introduction of anaesthesia, and represents the most significant advancement in minimally invasive surgery of this decade. One of the first surgical uses of the robot was in orthopaedics, neurosurgery, and cardiac surgery. However, it was the use in urology, and particularly in prostate surgery, that led to its widespread popularity.

Because da Vinci® Surgical System at present is developed for laparoscopic procedures, most neurosurgeons are not familiar with this robotic surgical system.

Integration of robotic surgical technology into skull base surgery is limited due to minimum angle requirements between robotic tools (narrow funnel effect), steep angle of approach, and instrumentation size [1].

Spinal surgery

In the field of spinal surgery, a few laboratory results or clinical cases about robotic spinal surgery have been reported. In vivo trials and development of related surgical instruments for spinal surgery are required before its clinical application [2].

see Transoral robotic surgery

See robotic forceps

Endonasal surgery

Novel robots have recently been developed specifically for endonasal surgery. They can deliver several thin, tentacle-like surgical instruments through a single nostril. Among the many potential advantages of such a robotic system is the prospect of telesurgery over long distances.

To describe a phantom pituitary tumor removal done by a surgeon in Nashville, Tennessee, controlling a robot located approximately 800 km away in Chapel Hill, North Carolina, the first remote telesurgery experiment involving tentacle-like concentric tube manipulators.

A phantom pituitary tumor removal experiment was conducted twice, once locally and once remotely, with the robotic system. Robot commands and video were transmitted across the Internet. The latency of the system was evaluated quantitatively in both local and remote cases to determine the effect of the 800-km distance between the surgeon and robot.

Wirz et al. measured a control and video latency of < 100 milliseconds in the remote case. Qualitatively, the surgeon was able to carry out the experiment easily and observed no discernable difference between the remote and local cases.

Telesurgery over long distances is feasible with this robotic system. In the longer term, this may enable expert skull base surgeons to help many more patients by performing surgeries remotely over long distances [3].

The da Vinci® Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) is the most common system used for robotic surgery today.

The da Vinci® Surgical System offers three-dimensional visualization, tremor filtration, and an increased freedom of instrument movement within a limited space.

This system is widely used in urology, gynecology and other surgical disciplines, and recently there have been initial reports of its use in spine surgery, for transoral access and anterior approaches for lumbar inter-body fusion interventions. SpineAssist, which is widely used in spine surgery, and Renaissance Robotic Systems, which are considered the next generation of robotic systems, are now FDA approved. These robotic systems are designed for use as guidance systems in spine instrumentation, cement augmentations and biopsies. The aim is to increase surgical accuracy while reducing the intra-operative exposure to harmful radiation to the patient and operating team personnel during the intervention [4].

The da Vinci surgical system was used to perform arachnoid dissection towards the deep-seated intracranial cisterns. It was not possible to simultaneously pass the 12-mm endoscope and instruments through the keyhole craniotomy in any of the approaches performed, limiting visualization. The articulated instruments provided greater dexterity than existing tools, but the instrument arms could not be placed in parallel through the keyhole craniotomy and, therefore, could not be advanced to the deep cisterns without significant clashing. The da Vinci console offered considerable ergonomic advantages over the existing operating room arrangement, allowing the operating surgeon to remain non-sterile and seated comfortably throughout the procedure. However, the lack of haptic feedback was a notable limitation. In conclusion, while robotic platforms have the potential to greatly enhance the performance of transcranial approaches, there is strong justification for research into next-generation robots, better suited to keyhole neurosurgery [5].

A surgical robot (Da Vinci S™ system, Intuitive Surgical(®), Sunnyvale, CA) was installed with three ports on the pig's left chest. The phrenic nerve was transected distally where it enters the diaphragm. The phrenic nerve harvest was successfully performed in 45 minutes without major complications. The advantages of robotic microsurgery for phrenic nerve harvest are the motion scaling up to 5 times, elimination of physiological tremor, and free movement of joint-equipped robotic arms. Robot-assisted neurolysis may be clinically useful for harvesting the phrenic nerve for brachial plexus reconstruction [6]

Transoral transpalatal approach

A transoral transpalatal approach to the nasopharynx and medial skull base was performed on 4 cryopreserved cadaver heads. Fernandez-Nogueras Jimenez et al. used the da Vinci robot, a 30° standard endoscope 12mm thick, dual camera and dual illumination, Maryland forceps on the left terminal and curved scissors on the right, both 8mm thick. Bone drilling was performed manually. For the anatomical study of this region, they used 0.5cm axial slices from a plastinated cadaver head.

Various skull base structures at different depths were reached with relative ease with the robot terminals

Transoral robotic surgery with the da Vinci system provides potential advantages over conventional endoscopic transnasal surgery in the surgical approach to this region [7].

1)

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5)

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7)

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