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Letter

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Robotic Applications in Neurosurgery

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Introduction

Recent advances in neuro-imaging and stereotactic and computer technology gave birth to minimally invasive keyhole surgery to the extent that the scale of neurosurgical procedures, demanded by patients, will soon be so small that it will not be within the capability of the most gifted and skilled neurosurgeons of today. Neurosurgical robotics is the natural progression in this field. Furthermore, the economic advantages, increased precision and improved quality in industrial applications of robotics have stimulated robotic applications in neurosurgery [1]. These neurosurgical robots have significant manipulative advantages over neurosurgeons; neuro-robots are reliable to perform the same procedure over and over, again and again without tiresomeness, variation or boredom. They possess near absolute geometric accuracy and are impervious to biohazards and hostile environments and can work through very narrow and long surgical corridors most suited for surgery on the brain, which is an organ uniquely suited for robotic applications; it is symmetrically confined within a rigid container, the skull, and the brain can be easily damaged by even the smallest excursions of surgical instruments. Robots can also see around corners that are beyond the line of sight of the neurosurgeons during operations and in a way, robots extend the visual and manual dexterity of neurosurgeons beyond their limits. Several ergometric studies during surgery were reported that have demonstrated substantial muscle fatigue occurring during procedures related to procedure duration and the angle of surgical instruments [2]. Over the last two decades several systems were developed for use in neurosurgery; some of these neuro-robots have been used in clinical practice while others have not been near a patient because of safety and ethical concerns. Among those robots which were used included the PUMA 200, the Minerva robot from the University of Lausanne in Swtizerland the NeuroMate from Integrated Surgical Systems, the MRI compatible robot developed in Japan, the Evolution 1 (Universal Robotics Systems, Schwerin, Germany), the CyberKnife (Accuracy Inc, Sunnyvale, CA), the RoboSim neurosurgery simulator the neuroArm ,the PathFinder and lastly the SpineAssist .Robots were also integrated within current neurosurgical tools such as the microscope, the SurgiScope stereotactic system (Elkta AB, Stockholm, Sweeden) and the Open Access Database www.i-techonline.com MKM microscope system.

Neurosurgical robotics had a long gestation period spanning over two decades. The main reason for this long period of development is the stringent regulation of health and safety [3]. In contrast, industrial robots leaped into production very quickly because they can be isolated from human contact in a cage or a highly secure environment; neurosurgical robots on the other hand are designed to interact with surgeons and perform or assist the surgeon to perform complex surgical procedures on alive but anaesthetised patients.

A standard industrial robot (PUMA 200) was used to hold a stereotactic biopsy needle in a 52-year-old man on a CT scanner table, the target was identified on the CT images and the robot was used to orient a guide tube through which a needle was inserted Localization of the target was achieved by using the Brown-Roberts-Wells (BRW) stereotactic frame localization plates and the head was secured to the CT scanner table using the stereotactic frame reference ring. It is a programmable, computer-controlled, versatile robot that was designed to perform highly accurate, delicate work, yet it was rigid enough to provide stable trajectory. It was a safe robot, designed to work with humans and its joints were equipped with spring-applied, solenoid-released brakes that automatically clamped should any mechanical or electrical defect occur. It has 6 degrees of freedom; movements are executed by DC servomotors; tracking is achieved by optical encoders and it can be used in passive or active programmable modes [4, 5]. It has an accuracy of 2 mm and repeatability of 0.05 mm. It uses the Brown-Roberts-Wells stereotactic frame for registration and CT scan for imaging. The use of the cumbersome stereotactic frame is a constraint and as such its accuracy and performance are similar to the frame, it has an advantage over the frame in those tedious calculations and manual adjustments were automatically executed by the robot. It was used as a retractor during resection of thalamic astrocytomas.

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Conflict of Interest

The authors declare that they are no conflict of interest.

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