Minimally Invasive Stereotactic Neurosurgery

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Classical craniotomy for biopsy or resection of brain tumors usually involved large skin flaps and cranial openings. This was necessary so that surgeons could be certain that they located the entire subcortical tumor. This localization method was very imprecise.

With the advent of computer aided tomography (CT scanning) and the MRI, surgeons began to rethink their approach to common resection of tumors. These computer based imaging techniques give precise information on the extent and localization of the tumor inside the cranial cavity. However, even though the computer imaging was very precise; the transfer from this three-dimensional information to the actual surgical field was very imprecise. With the use of this three-dimensional data, it is possible to transport this information to a stereotactically defined surgical field. Over the past 20 years impressive developments in computer hardware and software have made it possible for most any surgeon and hospital to obtain imaging software. This makes previously complex methods of surgery much more efficient, convenient and cost effective.

Volumetric stereotaxis is a method of gathering, storing and reformatting images in three dimensions to the surgical field. With this technique a surgeon can plan and simulate the surgical procedure beforehand. Most importantly, this technique allows the computer generated information to be displayed to the surgeon on computer monitors, and on a "heads up display" (similar to that used by a jet fighter aircraft) mounted on the operating microscope. This allows a scaled model of the surgical field to be made actual size and in the correct location. This will guide the surgeon in the correct boundaries of the brain tumor.

Before surgery a CT/MRI compatible stereotactic headframe is applied to the patient under local anesthesia using four carbon fiber pins inserted in the outer table of the skull. The surgical procedure involves a stereotactic frame, a heads up video display, a carbon dioxide laser, and various microsurgical instruments. The stereotactic frame is basically a Cartesian robotics system that is based on an X, Y, and Z space that is controlled by a stepper motor. During surgery, computer generated images that are scaled to exact size are superimposed onto the operating area through the operating microscope. This allows the surgeon to not only see the actual surgical field, but to also view what the field should look like based on the computer imaging. The carbon dioxide laser is useful in vaporizing tissue that is in a deep-seated cavity, into which there is limited access. Deep-seated lesions are resected by means of a stereotactically directed cylindrical retractor. This retractor is inserted through a small incision through the white matter of the brain made by the carbon dioxide laser. Once the lesion has been isolated from the surrounding brain tissue, it can be removed using biopsy forceps, laser, or suction.

Without volumetric sterotaxis three things are possible: 1. A surgeon can get lost attempting to find a tumor. 2. A surgeon cannot tell where a tumor ends and normal brain tissue begins. 3. A surgeon can perform a subtotal removal of the tumor, leaving much of the tumor behind.

Reference:

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