Intraoperative image guidance

The more commonly available and routinely used tool for intraoperative image guidance is neuronavigation (NN), which are based on preoperative imaging. NN is an excellent tool for surgical planning and identification of the lesion and the surrounding vital structures but suffers from major limitations.

The evidence supporting the use of image guidance systems in surgery remains limited. New augmented reality systems offer the possibility of enhanced operating room workflow compared with existing triplanar image displays, but recent studies have highlighted several concerns, particularly the risk of inattentional blindness and impaired depth perception.

New augmented reality platforms incorporating always-on wire mesh and on-demand inverse realism might improve surgical performance, at least in novice surgeons. All image display modalities, including existing triplanar display, carry a risk of inattentional blindness [1].

As minimally invasive surgery becomes the standard of care in neurosurgery, it is imperative that surgeons become skilled in the use of image-guided techniques. The development of image-guided neurosurgery represents a substantial improvement in the microsurgical treatment of tumors, vascular malformations, and other intracranial lesions.

Neuronavigation systems and intraoperative imaging should improve success in cranial neurosurgery. Additional functional imaging modalities such as PET, SPECT, DTI (for fiber tracking), and fMRI can now be used in order to reduce neurological deficits resulting from surgery; however the positive long-term effect remains questionable for many indications.

To date significant data amount show advantages in intraoperative accuracy influencing the perioperative morbidity and long-term outcome only for cerebral glioma surgery [2].

Despite its widespread availability and success in open cranial neurosurgery, image-guidance technology remains more limited in use in open spinal procedures, in large part because of patient registration challenges.

In a study, Ji et al. evaluated the feasibility of using intraoperative stereovision (iSV) for accurate, efficient and robust patient registration in open spinal fusion surgery. Geometrical surfaces of exposed vertebrae were first reconstructed from iSV. A classical multi-start registration was then executed between point clouds generated from iSV and preoperative CT (pCT) images of the spine. With two pairs of feature points manually identified to facilitate the registration, an average registration accuracy of 1.43 mm in terms of surface-to-surface distance error was achieved in 8 patient cases using a single iSV image pair sampling 2-3 vertebral segments. The iSV registration error was consistently smaller than the conventional landmark approach for every case (average of 2.02 mm with the same error metric). The large capture ranges (average of 23.8 mm in translation and 46.0 deg in rotation) found in the iSV patient registration suggest the technique may offer sufficient robustness for practical application in the operating room. Although some manual effort was still necessary, the manually-derived inputs for iSV registration only needed to be approximate as opposed to be precise and accurate for the manual efforts required in landmark registration. The total computational cost of the iSV registration was 1.5 min on average, significantly less than the typical ~30 min required for the landmark approach. These findings support the clinical feasibility of iSV to offer accurate, efficient and robust patient registration in open spinal surgery, and therefore, its potential to further increase the adoption of image-guidance in this surgical specialty [3].

1)
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