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Computer-Assisted Surgery of the Spine

Erich Sorantin

Faculty of Medicine, Minia University, Kuwait

Editorial

Across all surgical specialties, operative techniques have evolved as the knowledge and technology applicable to that field have continued to expand over time. Historically, the implementation of novel therapeutic strategies has occurred relatively slowly; for instance, posterior decompressive procedures of the spine were not routinely performed until several thousand years after they had been originally described. However, over the past few decades further advances in spine surgery have become increasingly common, largely due to the widespread use of spinal instrumentation as well as the advent of modern intraoperative imaging modalities and computer navigation systems.

The two primary options for intraoperative imaging of the spine are still plain radiography and fluoroscopy. Unfortunately, X-ray processing is time-consuming and these static images do not provide instantaneous positional information required for the tracking of instruments. While standard fluoroscopy delivers "real-time" images of spinal anatomy, the repeated use of the C-arm during the case may result in significant radiation exposure to both the patient and the surgical staff. Moreover, with both of these methods images may only be obtained in a single plane at a time. Image guidance technology (IGT) addresses many of these disadvantages by linking conventional imaging modalities such as fluoroscopy and computed tomography (CT) to a computer, which analyzes the imported data and generates an accurate representation of intraoperative anatomy in multiple planes that may immediately be used for surgical navigation, a process that serves to minimize the amount of ionizing radiation that is emitted in the operating room.

IGT has already been employed for a number of spinal applications, ranging from decompression of the neural elements to the placement of instrumentation for complex spinal reconstructions. For each of these indications, IGT has shown the potential to enhance the safety and accuracy of existing spinal procedures and stimulate the development of other innovative techniques. The purpose of this review is to discuss the variety of IGT systems already in existence and summarize the results of the *in vitro* and *in vivo* studies related to their use in the spine. IGT is currently available in a variety of formats which may be differentiated according to the manner in which these images are captured, processed, and presented to the surgeon. Nevertheless, all of these IGT approaches comprise the same principal components: (1) a system for image acquisition that allows for the tracking of specialized instruments in relation to a single or multiple reference points attached to suitable anatomic landmarks; (2) a computer workstation that reconfigures this data set into a series of multiplanar images that are displayed on a monitor along with the relative position of any instrumentation within the operative field.

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***Address for Correspondence:** Erich Sorantin, Faculty of Medicine, Minia University, Kuwait, Tel: 7457689712; E-mail: sorantin.erich@gmail.com*

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