Section II: Basic Science Issues in Advanced Musculoskeletal Imaging and Computer-Assisted Surgery

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Computer-assisted orthopaedic surgery as a technological tool has to be understood as an integrative process, incorporating the elements of clinical diagnosis, surgical planning, operative execution, and postoperative outcomes assessment. The overall goal of the application of computer-assisted orthopaedic surgery in the operating room is to improve the accuracy and precision of the surgical procedure. However, specific goals of each clinical procedure still need to be better defined so that the evaluation methodology can be universally shared and the results uniquely interpreted. It is also crucial to analyze different combinations of computer-assisted orthopaedic surgery elements for their combined accuracy and precision. With recent advances in tracking and registration, these goals gain additional importance. Active or passive optical tracking devices have proven to be accurate and efficient. Newer, electromagnetic devices provide the ability to track the distal end of the instrument, making flexible instruments possible. In the past, registration relied on fiducial markers, landmarks, or shapes. Some recent approaches eliminate the need for preoperative imaging by relying on direct collection of anatomic landmarks in an anatomic atlas. This statistical description of anatomic structures can be integrated with intraoperative imaging (fluoroscopy or ultrasound) and allow for the creation of patient-specific three-dimensional models. Innovative approaches in computer-assisted orthopaedic surgery include the concept of semi-active robots that add virtual safety barriers during minimally invasive surgery, revival of patient-specific templates for alignment of cutters and drills, and customized patient-specific implants. Most importantly, however, there is a critical need for improved outcome measures following the use of this technology.

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