Precision Surgery: A white paper on groundbreaking research and discoveries in image-guided surgery from Brigham and Women’s Hospital

“Image-guided therapy is changing the way we treat a wide range of medical conditions. By enhancing precision and enabling new interventions, we are improving outcomes for patients worldwide.”

Ferenc Jolesz, MD
Co-director, Advanced Multimodality Image Guided Operating (AMIGO) Suite, Brigham and Women’s Hospital; Co-director, National Center for Image Guided Therapy, National Institutes of Health

Precision: At the Heart of Medical and Surgical Procedures

From X-rays to magnetic resonance imaging (MRI), medical imaging has long played an important role in guiding diagnosis and follow-up. In more recent years, however, it also has increasingly taken on a highly valuable function during surgery and other procedures – enhancing precision for improved patient outcomes.

Precision is at the very heart of these procedures. When removing or ablating tumors, for example, achieving clear margins is critical to avoid additional surgeries and prevent recurrence. Preserving as much normal tissue as possible is imperative to preserve organ function. During procedures involving the brain, neurosurgeons must navigate critical structures related to speech, movement, and other essential functions. Catheter-based, robotic-assisted, and other minimally-invasive procedures that make surgery less invasive and provide treatment for patients who are unable to undergo traditional surgical procedures require highly-specialized and precise skills and techniques.

Image-guided Therapy: The Beginning

With almost 30 years of innovation in the field of image-guided therapy (IGT), Brigham and Women’s Hospital (BWH) is recognized as the leader in introducing these novel techniques into the treatment of complex cases.

BWH radiologist and Co-director of the Advanced Multimodality Image Guided Operating (AMIGO) suite Ferenc A. Jolesz, MD, established the Image-Guided Therapy Program at BWH in the early 1990s. With training
in both radiology and neurology, Dr. Jolesz envisioned ways that neurological conditions could benefit from the types of targeted, precise treatments that image-guidance provides. The challenge was to develop the imaging systems that could support these types of techniques.

Dr. Jolesz began collaborating with a team of engineers from GE Healthcare in 1988 to build the first MRI scanner for use during surgical procedures. The system had two magnets on each side of a patient table, giving surgeons access to the patient who remained situated in the MRI scanner. In 1994, the world's first magnetic resonance image-guided craniotomy to remove a brain tumor was performed at BWH.

Dr. Jolesz and Clare Tempany, MD, Co-director of the AMIGO suite, along with the Brigham and Women’s IGT team, soon followed the successful development of intraoperative MRI with another landmark achievement. In 2004, the U.S. Food and Drug Administration approved the first image-guided procedure: MRI-guided focused ultrasound treatment of uterine fibroids. Developed by BWH’s IGT team, this non-invasive interventional procedure uses MRI to monitor and control high-intensity ultrasound waves that are beamed onto a fibroid and destroy it with heat. Specialists have since used the technique to treat breast and brain tumors and relieve pain from bone metastasis.

BWH’s image-guided therapy program continued to lead the advancement of the field into the 21st century, accumulating vast knowledge on best practices in designing and implementing image-guidance systems, establishing clinical programs, and designing IGT research studies. This cumulative body of work drew the attention of the National Institutes of Health, which selected Brigham and Women’s Hospital to become the National Center for Image-Guided Therapy (NCIGT) in 2005.

**Introduction of the AMIGO Suite**

In 2011, the Advanced Multimodality Image Guided Operating (AMIGO) Suite at BWH was introduced. A state-of-the-art medical and surgical research environment, the AMIGO suite is the only suite of its type in the world. The suite’s 5,700-square-foot space is divided into three interconnected procedure rooms that house real-time anatomic, functional, and molecular imaging modalities, including MRI, CT, PET, x-ray fluoroscopy, and ultrasound.

Multidisciplinary teams of specialists use this equipment array and the unique design of the suite to efficiently and precisely guide treatment – before, during, and after surgery – without the patient or medical team ever leaving the operating room. This innovative operating and imaging research suite encourages collaboration among multidisciplinary teams of surgeons, interventional radiologists, imaging physicists, computer scientists, biomedical engineers, nurses, and technologists.
“We set out to create a groundbreaking operating/procedural environment where doctors could access many imaging modalities, rather than being limited to just one imaging type,” says Dr. Tempany. “Being able to use these modalities together provides tremendous flexibility, enabling the imaging to be tailored for each procedure.”

To date, more than 600 procedures have been performed in the AMIGO Suite, spanning MR-guided interventions, such as MR/PET/CT guided biopsies and tumor ablations, surgery for breast tumors, laser ablation for brain lesions, video-assisted thoracoscopic surgeries for lung nodules and lesions, brachytherapy for gynecologic tumors, and many other applications. In the future, new image-guided treatments for cardiac conditions will be introduced.

Each of these procedures is part of a specific research study protocol, where researchers track and assess a wide variety of aspects. These studies also are helping physicians develop new uses for imaging in the traditional operating room.

“We really have just begun to realize the potential of this rapidly-evolving field,” says Steven Seltzer, MD, Chairman of the Department of Radiology at BWH.

Visit us online at www.brighamandwomens.org/amigoprecisionsurgery to learn more about the AMIGO suite and image-guided surgery.