



## Editorial: The Transformative Role of Robotic Surgery in Orthopedics

**Melissa Olguín Rodríguez\* and Juan Francisco Javier Valles Figueroa**

*Department of Orthopedic Surgery, Hospital Español de México*

**\*Corresponding Author:** Melissa Olguín Rodríguez, Department of Orthopedic Surgery, Hospital Español de México.

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In the last two decades, orthopedic surgery has undergone a quiet yet profound revolution. From the adoption of minimally invasive techniques to the integration of data-driven diagnostics, the field has consistently evolved to improve patient outcomes and surgical precision. Today, robotic-assisted surgery stands at the forefront of this transformation, offering unparalleled accuracy, reproducibility, and potential for personalization in orthopedic procedures.

Robotic surgery in orthopedics is no longer confined to experimental or elite institutions. Systems such as the MAKO for joint arthroplasty, ROSA for knee and spine interventions, and others have transitioned from novel technologies to practical tools in high-volume centers worldwide. These platforms integrate preoperative imaging, real-time feedback, and haptic-guided execution, allowing surgeons to plan and perform procedures with sub-millimeter precision.

### Enhancing surgical accuracy and outcomes

One of the clearest benefits of robotic systems is the improved alignment and component positioning in total joint arthroplasty. Numerous studies have now shown that robotic-assisted total knee and hip replacements can reduce outliers in implant positioning, potentially lowering the risk of early failure and revision surgery. While the long-term data is still maturing, early and mid-term outcomes suggest reduced variability in component alignment and improved functional scores.

In spine surgery, robotic systems assist in pedicle screw placement with greater accuracy than conventional freehand or fluoroscopy-guided techniques, minimizing radiation exposure for both patient and surgical team. Similarly, robotic guidance in trauma and complex reconstructions is beginning to show prom-

ise, particularly where anatomy is distorted, or surgical corridors are narrow.

### Challenges in cost, training, and integration

Despite its advantages, robotic surgery comes with inherent challenges. High upfront costs, steep learning curves, and the need for institutional support in training and workflow integration remain significant barriers to widespread adoption. Moreover, evidence-based scrutiny is essential to ensure that technology truly adds value—both clinically and economically.

Robotic platforms should not be viewed as replacements for surgical skill, but rather as enhancements—extending the capabilities of experienced hands. This requires a cultural shift in how we approach technology in the operating room, with emphasis on continuous education, data collection, and transparent outcome reporting.

### A Future guided by data and precision

The future of orthopedic surgery will likely be defined not just by robotic tools, but by how we integrate them with artificial intelligence, intraoperative navigation, and patient-specific analytics. Personalized surgical planning, predictive modeling, and augmented reality interfaces are on the horizon, promising a more tailored, efficient, and safer surgical experience.

As we move forward, it is our responsibility as orthopedic surgeons, educators, and scientists to rigorously evaluate these technologies, advocate for equitable access, and train the next generation to use them wisely. Robotic surgery is not a distant future, it is a present reality shaping the next chapter of our field.

Let us ensure that we lead this transformation with the same principles that have always guided great surgery: precision, compassion, and an unwavering commitment to patient care.