TECHNOLOGY IN ORTHOPAEDIC SURGERY- A CONNUNDRUM OF HOPE AND HYPE

DR. VIKASH KAPOOR

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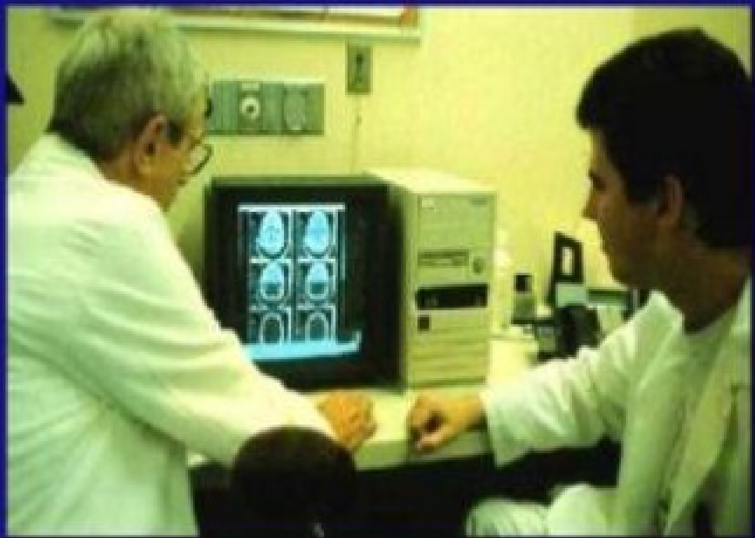
MEDICA SUPERSPECIALITY HOSPITAL

GROUP DIRECTOR ORTHOPAEDICS

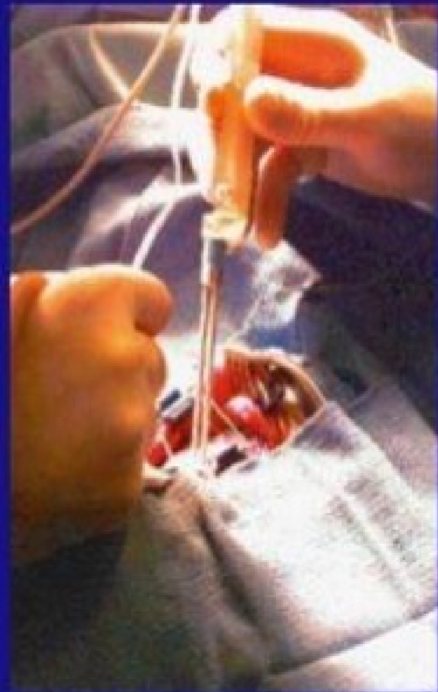
MEDICA GROUP OF HOSPITALS

PAST: Cut, then see

PRESENT: See, then cut



Preoperative Imaging



Intraoperative Execution

FUTURE: Combine, see, minimally cut

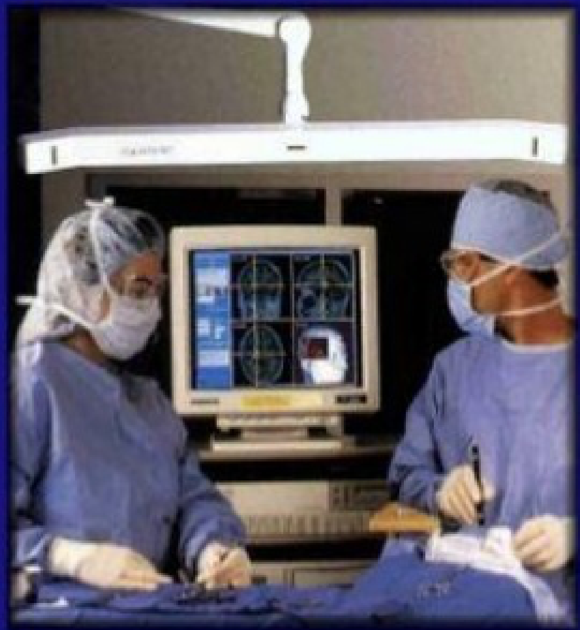
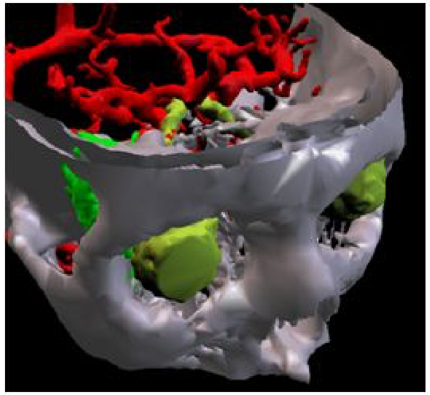


Image guidance

Augmented reality

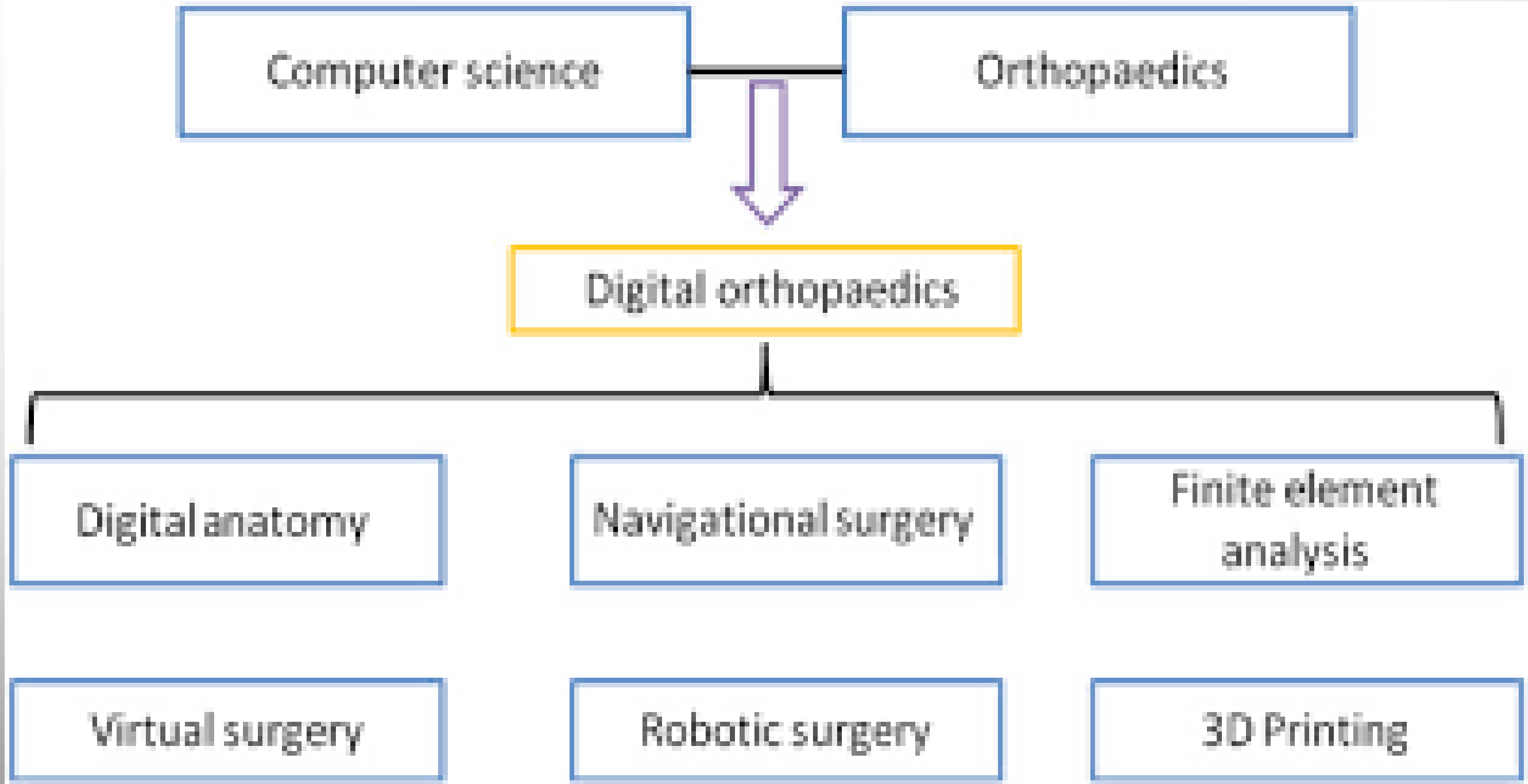
Medical Visualization

- Human body modeling
- 3D medical image visualization
  - Volume rendering
- Virtual surgery simulation
- Computer Assisted surgery
- Virtual Reality for patient care
  - E.g. Immersive Virtual Reality for pain control



Modeling human head
Images courtesy Stanford University

Volume Rendering
Images courtesy GE


Computer science
Orthopaedics
Digital orthopaedics
Digital anatomy
Navigational surgery
Finite element analysis
Virtual surgery
Robotic surgery
3D Printing

Computer Assisted Surgery

Do you want your body to be worked on by a computer?

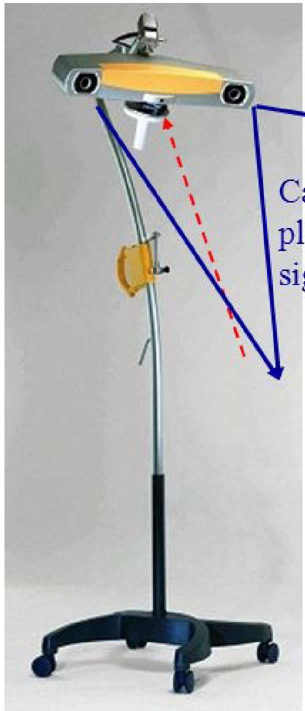
Da Vinci™ robotically-assisted surgery

Computer assisted surgery is a great way to have surgery done. Smaller incisions, as well as quicker recovery times are attracting many people. Do you really want a computer controlled instrument to operate on your body? Do you trust the code used to run this equipment working on your body?

Computer navigation

- Increasing use in orthopaedic surgery
- Accuracy and reliability
- Established in arthroplasty past 4 years
- Real time information on coronal & sagittal plane alignment
- Utilised in osteotomy past 4 years

How does the Ci System work?



Computer calculates the best position to place the components for accurate alignment.

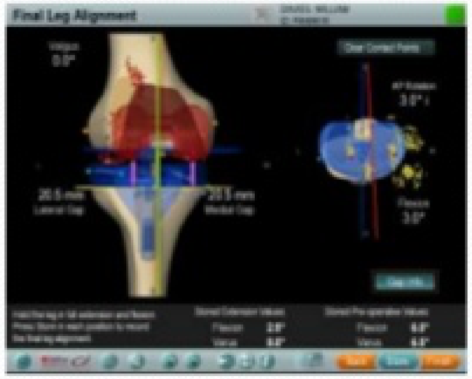
Camera searches for arrays placed on the patient via infrared signals.

Patient's anatomical information is entered into the computer through a process called registration.

Information is fed back to the camera and communicated to the computer

Navigation Assisted TKR

- A special pointer, also equipped with reflective marker spheres, is then used to register multiple points along your bone.
- The marker spheres reflect infrared light which is detected by the infrared cameras.
- This information is then supplied to the software which simulates a 3D model of your bone using an extensive CT database of healthy and arthritic knees.
- Adapters with reflective marker spheres are used with specially designed surgical instruments that enable the software to calculate the position of these instruments relative to your bone. This gives your surgeon real time information of your knee enabling very accurate placement of your knee replacement.

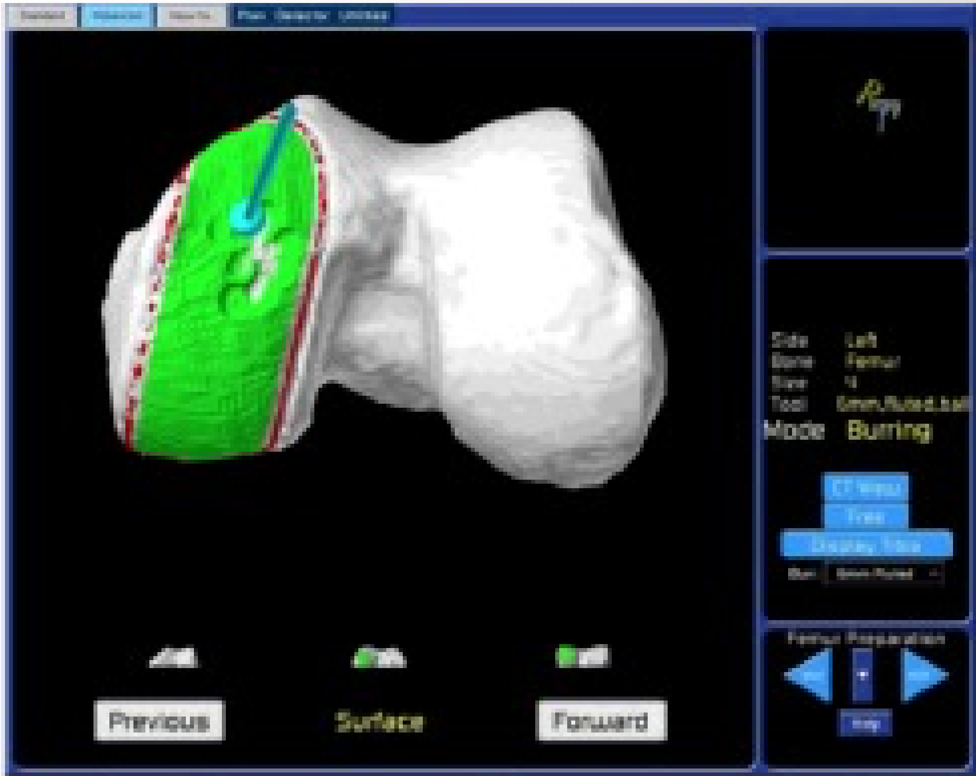


How Does Navigation Help ?

- Allow virtual planning of the implantation and control the orientation of bony resections during the operative procedure ,**HENCE LESS SOFT TISSUE DISSECTION AND LESS BONE LOSS**.
- Restoration of the tibiofemoral angle to within 3° of normal during total knee replacement (TKR) is associated with a better outcome which is accurately achieved with navigation. **HENCE MORE IMPLANT LIFE,LESS COMPLICATIONS AND BETTER FUNCTIONAL OUTCOMES.**

Navigation Assisted TKR

- The system is a touch screen-based planning computer with navigation software specially designed for use in knee replacement surgery.
- The system uses reflective marker spheres and infrared cameras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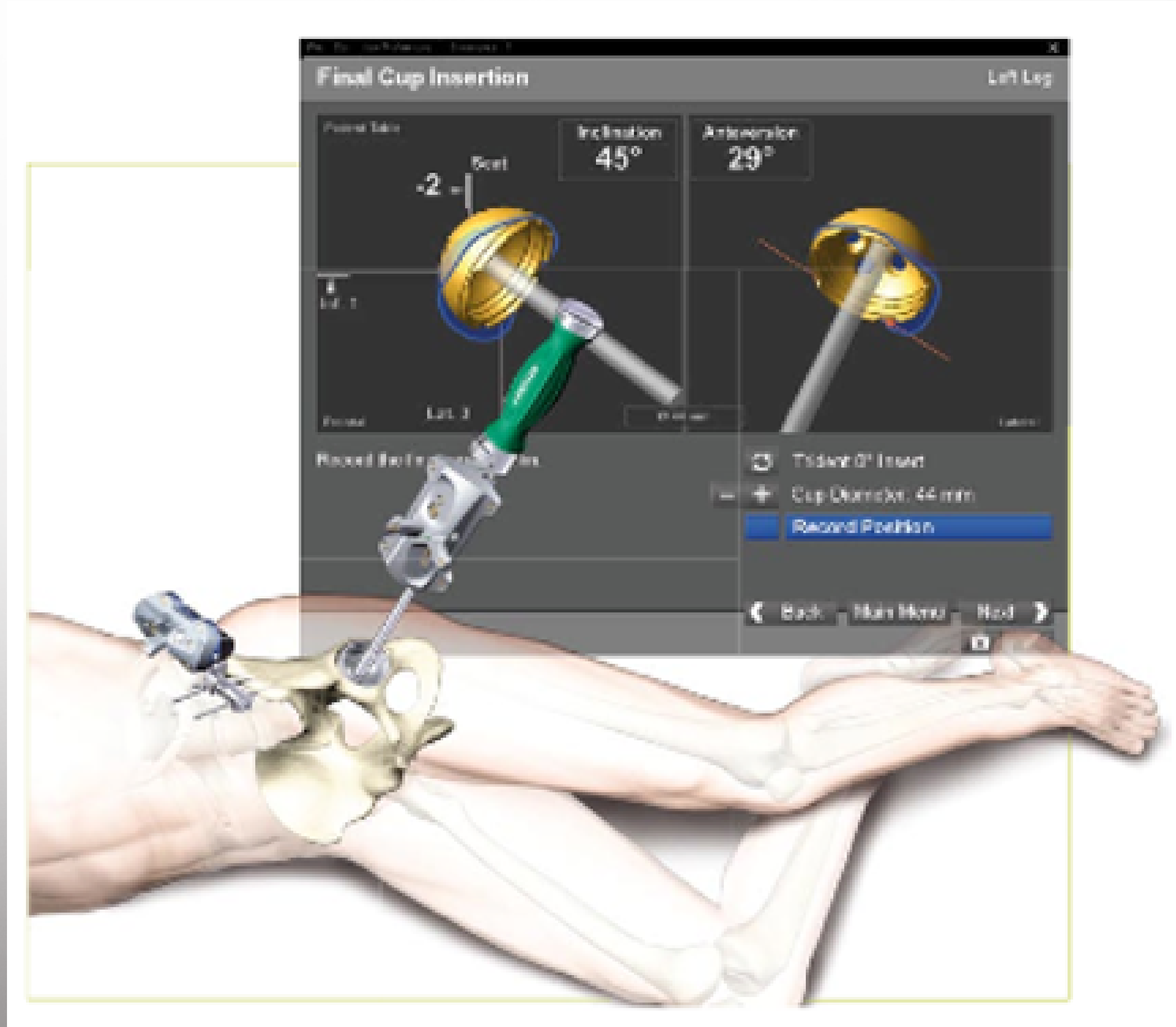
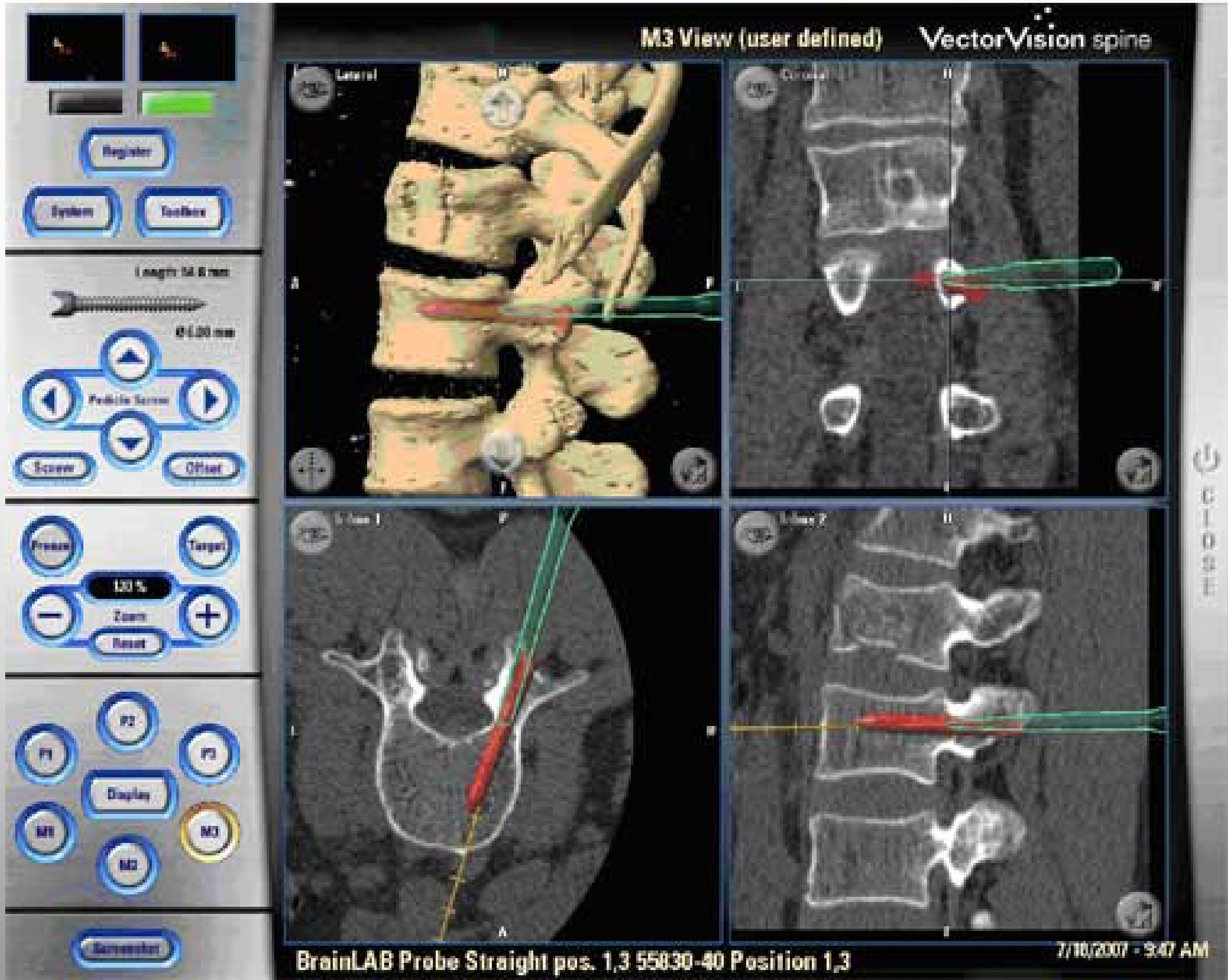
Surface
Forward


Final Cup Insertion
Left Leg
Inclination
45°
Anteversion
29°
Record Position
Back
Main Menu
Next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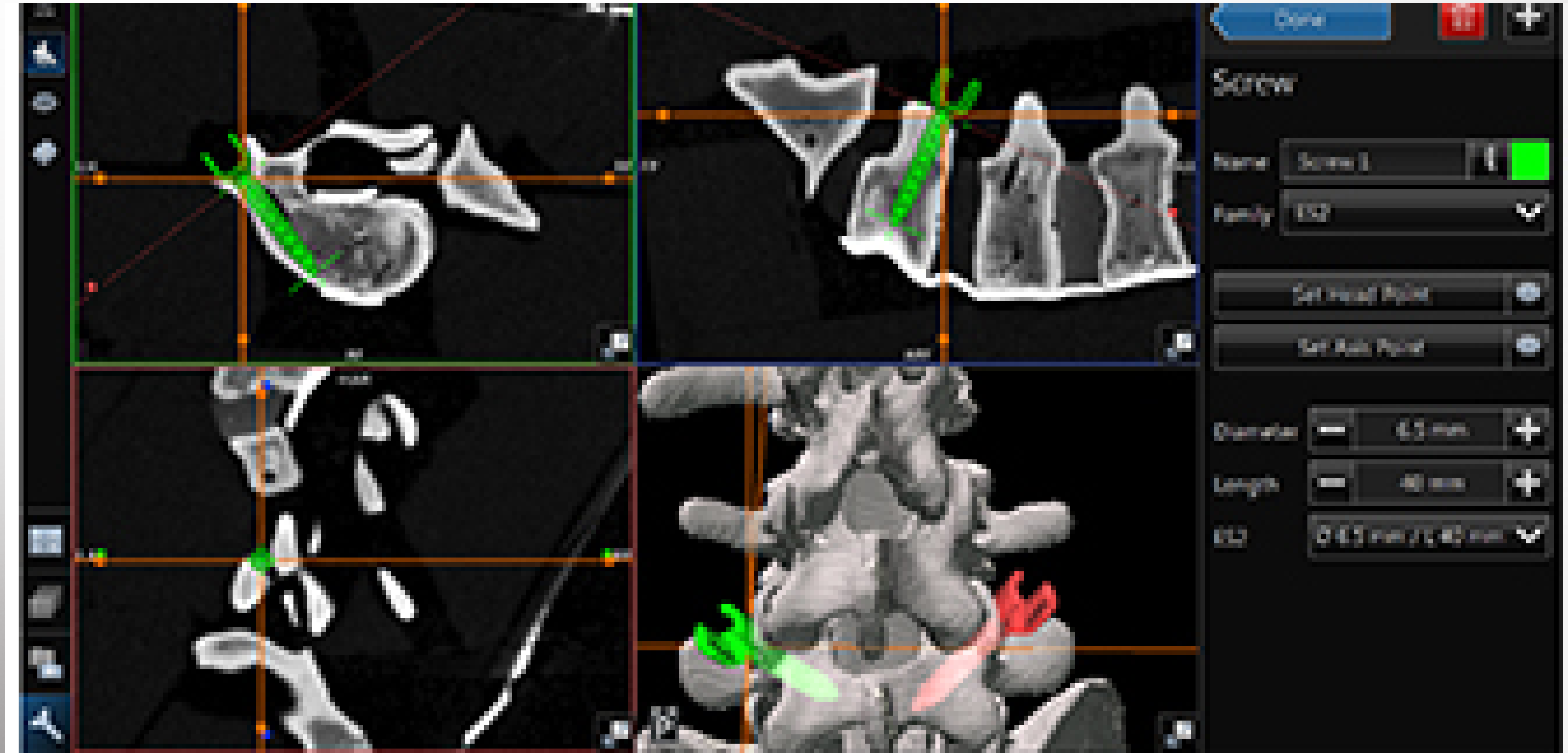
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Diameter
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Orthopedic Surgical Robots Market to Surpass $4.1 Billion by 2029

Robots are associated with such advantages as better visualization of the operating field and lessened tremor.

emphasis on value-based outcomes and reducing costs associated with hospital stays, the benefits offered to patients by procedures carried out using orthopedic surgical robots have the potential to help this cause.

- . ***Orthopedic surgical robots fulfil the need for automation*** while performing a surgery and have various advantages such as less post-operative pain, decreased blood loss, and the lower risk of complications and infections.
  - Surgical ***robots increase dexterity and provide efficient representations of the body parts***.
- They ***shorten the recovery time as well as aid surgeons while working on an inaccessible part of the body***. These advancements in orthopedic surgical robots provide the capability to replicate the sensation and tactile feel.
- Increase in the need for automation in the healthcare sector, majorly for orthopedic surgeries, is expected to boost the growth of the orthopedic surgical robots market during the forecast period.

Lack of skillsets among orthopedic surgeons for the use of orthopedic surgical robots across various regions is likely to limit opportunities for the adoption of orthopedic surgical robots, which is likely to hamper the growth of the orthopedic surgical robots market throughout the forecast period. Furthermore, high costs associated with orthopedic surgical robots are also **likely to hamper the adoption of orthopedic surgical robots in developing regions, majorly middle- and low-income countries, which is likely to further restrain the growth of the orthopedic surgical robots market during the forecast period.**

Robot-assisted Implantation Improves the Precision of Component Position in Minimally Invasive TKA


ROSA

A Review Paper

Technology and Cost-Effectiveness in Knee Arthroplasty: Computer Navigation and Robotics

Michael L. Swank, MD, Martha Alkire, CNP, Michael Conditt, PhD, and Jess H. Lonner, MD

Abstract

Our aim in this article is to describe the impact that navigation technology has had on the market share of a community hospital and, specifically, to determine whether a high-volume surgeon using these technologies actually costs the hospital more than other surgeons at the same hospital and more than national means. In addition, we develop a comparable cost-effectiveness model for robotic technology in unicompartmental knee arthroplasty to demonstrate the potential cost-effectiveness at the same hospital.

Introducing new technologies (eg, computer navigation and, more recently, robotics) into the operating room has an undeniable initial capital equipment cost or lease (approximately $150,000-$300,000 for navigation, up to $800,000 for robotics), a per-case disposable cost, and operational costs.[1] Opponents of these technologies argue that these incremental costs are unjustified or unnecessary. Proponents of these technologies have demonstrated that, if the technologies are able to lower revision rates to a specific level, then they may be cost-effective.[2,3] It has been predicted that, after 10 years of computer navigation use in total knee arthroplasty (TKA), revision rates would have dropped by 1.6%, resulting in a relative cost-per-case reduction of $1,100 for computer navigation ($13,200) compared with conventional knee replacement ($14,300).[4] Long-term data regarding whether navigation prolongs implant life or decreases costly revisions are limited because of the relatively recent and slow implementation of imageless systems. Study results have shown that there is an incremental cost of $871 more per case when using computer navigation versus conventional guides.[2] As the volume of arthroplasties increases, the cost lessens a mean of $463 per primary TKA, making computer navigation more cost-effective. Navigation can lengthen operation times by 11 to 18 minutes, possibly more during the learning curve.[5] Surgeons who have trained residents assisting in pin placement have demonstrated decreased overall operating time.[6]

"...if the technologies are able to lower revision rates to a specific level, then they may be cost-effective."

Cost-effectiveness data from actual use of either navigation or robotic technology are scant. Most authors use statistical models or hypothetical scenarios. Dong and Buxton[7] addressed cost-effectiveness in navigated TKAs, but impeding factors caused their model to overestimate, by $430/case, the cost of computer-assisted surgery (CAS). Navigation costs can be justified if intraoperative and postoperative complications can be reduced through use of navigation. Navigation has demonstrated both decreased blood loss[8] and cerebrovascular emboli,[9] thus providing cost savings associated with less transfusion, less unnecessary and wasted autologous blood donation, and decreased cost of hospitalization.

Lack of data has contributed to the slow adoption of these precision technologies. Only 3% to 5% of knee replacements involve navigation technology, despite some evidence that navigation improves radiographic alignment in TKA.[2,5,10-19] Navigation is advocated particularly when there are complex posttraumatic deformities or when hardware makes use of intramedullary instruments impossible or impractical.[6] Diminishing reimbursements have contributed to resistance to adoption of computer navigation technology. Rising costs of implants (up to 50% of the expense of joint replacement service lines), coupled with decreased margins, payer mix, and lower reimbursement, influence decision makers (hospitals, surgeons) when they consider adopting new technology. Category III *Current Procedural Terminology (CPT)* tempo-

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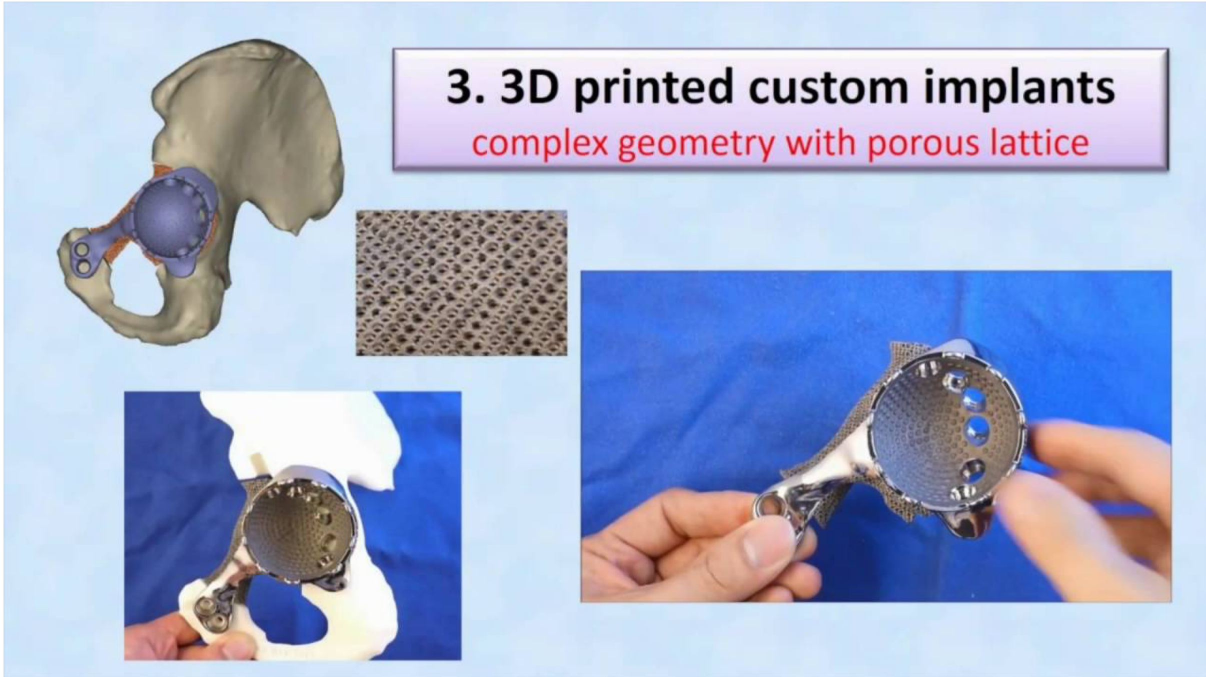
3D Printed Devices in Orthopedic Implants Comprise Nearly Half of Total Sales

Market expected to grow 16 percent annually through 2029.



Computer-Assisted Design and Manufacturing of Surgical Guides

Stereolithography

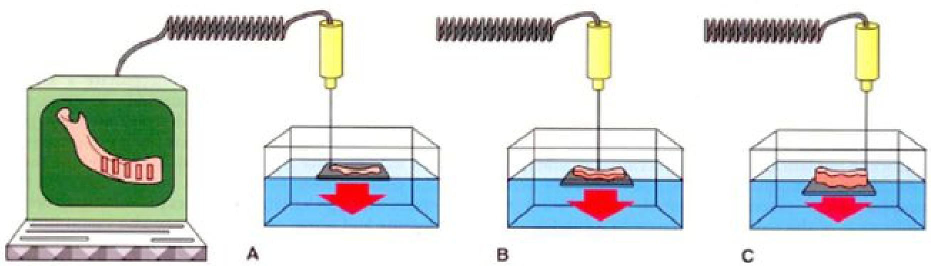


Figure 10-18 Stereolithographic fabrication of surgical guides. After scanning and planning, files are submitted to the manufacturing facility. A, A computer-driven laser cures a thin layer of liquid polymer. B, A moving table is lowered, another layer is applied, and C, the process is repeated until completion of the surgical guide.

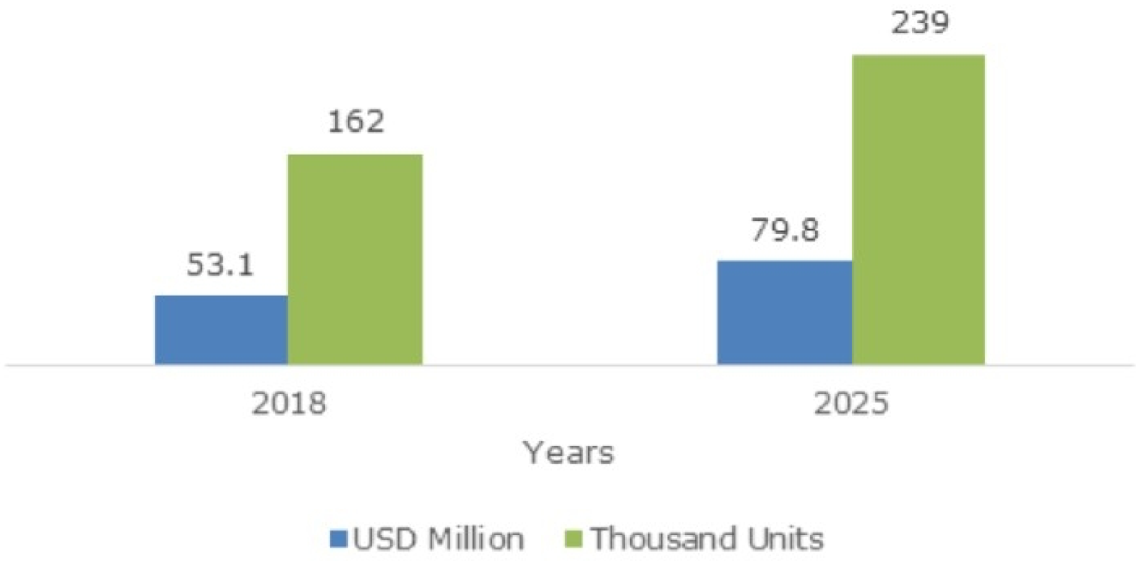
- layer of liquid polymer is deposited and cured by a computerdriven laser. Additional layers or sections are stacked and polymerized until a final model is generated
- the data source is a CT

Global Bone Graft and Substitutes Market to Reach $4.67B by 2027

The global **bone graft and substitutes market** is expected to witness a CAGR of 5.5 percent during the forecast period (2019-2027), owing to increasing number of product approvals for bone grafts and substitutes.

researchers are developing new ideas for bone healing properties of bone marrow derived mesenchymal stem cells, tissue engineering, and gene therapy.

Bone Growth Stimulators Market to Exceed $1.2B by 2025




Bio-inductive Implant

Global Arthroscopy Procedures and Products Market to Hit $8.6B by 2027

Increasing R&D in bioinductive implants is expected to boost growth of the sector.

- Increasing geriatric population is also expected to boost growth of the market over the forecast period. Aging contributes to soft tissue degeneration and related-disorders, which increases demand for arthroscopy procedures.

Based on product type, the external bone growth stimulators segment is anticipated to generate commendable revenues in the forecast period. External bone growth stimulators are portable, nonsurgical treatments offering devices designed specifically to promote healing of bone fractures that have failed to mend naturally.



Robotic Surgery and Computer Navigation in Orthopaedics

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