CAOS or Chaos?

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Computer Assisted Orthopedic Surgery

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Surgical planning

Plaster of Paris

Surgical planning

We are able to see almost everything...

Serious multiple injuries

Trauma by the accident
Trauma by the surgeon
Serious multiple injuries

Trauma by the accident
Trauma by the surgeon

Computer-Assisted Orthopaedic Surgery (C.A.O.S.)

Computer-based technologies

3D Visualization
Preoperative Planning
Intraoperative Navigation
Robotics

Computerized fluoroscopic navigation

Registration - fluoroscopic rather than CT/MRI

Navigation system

CT or X-ray Registration

Localization Camera Array

Image Processing Computer System
Calibration target

- LED tracking
  Enables precise localization of C-arm.
- Radiation sensors
  Allows automatic image acquisition.
- Calibration grid
  Appear in images and are automatically erased.

Tracked instruments

Optical tracking principle

Camera
LED
Infrared beam

Attach reference frame

Aim camera

“Safe Zone”
Percutaneous screw fixation of acetabular fractures with CT guidance


Fluoroscopy in pelvic & acetabular fractures:

Kahler DM: 1 minute of fluoroscopy time about the pelvis = 40 mSv of radiation = 250 chest radiographs

Intraoperative planning of Poller Screws
1st Generation Navigation

- tracking +
- registration +
- visualization

- Accurate
- Simple
- Reduce time and radiation
- Simultaneous multi-image navigation
- Advanced information
What kind of accuracy

- Large bias + high precision
- No bias + high precision
- Large bias + low precision
- No bias + low precision

THE ROLE OF COMPUTERIZED NAVIGATION IN FIXATING FEMORAL NECK FRACTURES

Ben-David D, Mosheiff R, Weil Y, Peyser A, Liebergall M
Significantly better screw scattering
Significantly better screw parallelism

Average fluoroscopy time:

- StdFluoro: 26 seconds
- VirtualFluoro: 6 seconds

(P < 0.01)

Acquired images:

<table>
<thead>
<tr>
<th>Screw type</th>
<th>No of images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sacroiliac</td>
<td>2-3</td>
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<tr>
<td>Ramus-Pubis</td>
<td>3-4</td>
</tr>
<tr>
<td>Transverse/Iliac</td>
<td>2-3</td>
</tr>
<tr>
<td>Posterior-Column</td>
<td>2-3</td>
</tr>
</tbody>
</table>
Tumor irradiation planning—radiosurgery

Devices

Ceilbag

Colibri

registration

Tumor irradiation planning—radiosurgery
Knee prosthesis

Percutaneous screw placement into the humeral head

Multiple landmarks/ACL plasty

Femoral nailing

Reduction
High dose irradiation

3D problem

Reduction
**Image time (radiation)**

*E.g. Distal Locking of IM Nail*

- **160 sec**
- **10 sec**

*conventional* with Navigation

Regazzoni, Messmer, Suhm, University Basel, 2000

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**Cost?**

- Screw (Set)
- Knee Nail (Set)
- CAS System

0
100000
200000
300000

Swiss Francs

but...

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**Clinical view**

- MRI
- CT
- Laser
- X-ray digital
- CAS
- X-ray

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**Aim:** Multifunctional informatical system for complex fracture

- Education
- Research
- Surgical planning
**Virtual surgery**

**FE analysis/education**

**Surgical planning**

**Surgical Planning System**

- DICOM pictures
- Image Processing
- Geometrical model creation
- Surgical planning
- Virtual surgery
- FEA

**Advantages**

- Minimal invasive
- Accuracy
- Radiation ↓
- Complications ↓

**Patient #1**

E.J-né, 47 éves, 143 kg
Team work