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Computer-Assisted Urology

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Puncture assistance
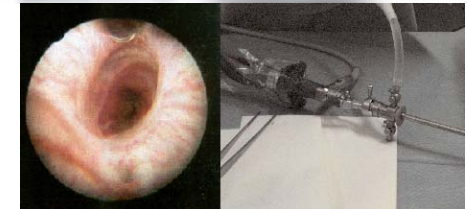
Domain

Urologist

Diagnosis	Therapy
Prostate	
Kidney	
Bladder	

✓3D tracking
✓Image fusion
✓Augmented reality
✓Surgical Planning
✓Measurement
✓Surgical report
✓…

Security-Confidence-Quality
More accuracy
Less morbidity
Less radiation
Shorter stay
More insurance

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Products

- **Software**
  - User friendly
  - 2D/3D imaging & rendering
  - Multimodal image fusion
  - Computerized Surgical Protocol

- **Instruments**
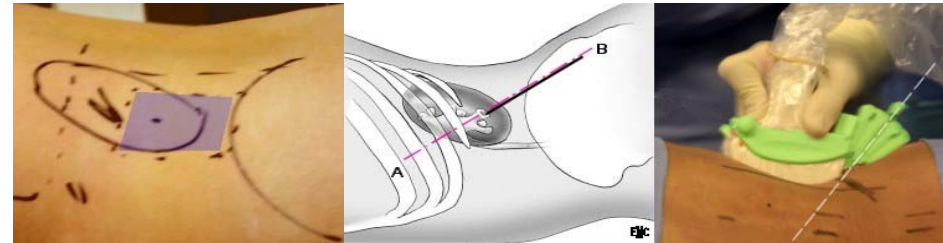 - User friendly
  - Sterilizable

- **Navigation platform**
  - Stereo IR camera
  - Tactile screen
  - Control pedal

Percutaneous Therapy of the Kidney

CONTEXT

- Puncture needle
- Prone position
- CT scan / Fluo Rx
- Ultrasound probe + guide
- Local / Global anaesthesia

PROBLEM

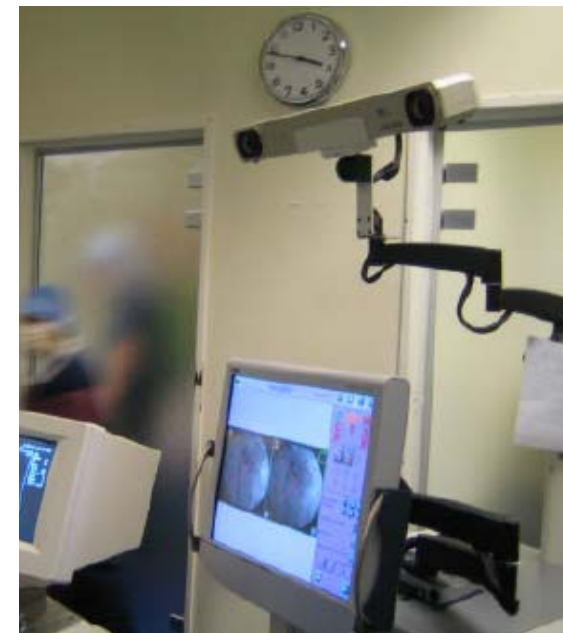- Guide the needle fast & accurately

SOLUTION

- CT navigation / Fluo navigation
- Real-time intra-operative planning

Instrument and image localisation

- Infrared tracking of external references
  - On the calibrated C-arm, the patient and the needle guide
  - Spatial localisation of the fluoroscopic image and the needle trajectory in *patient space*
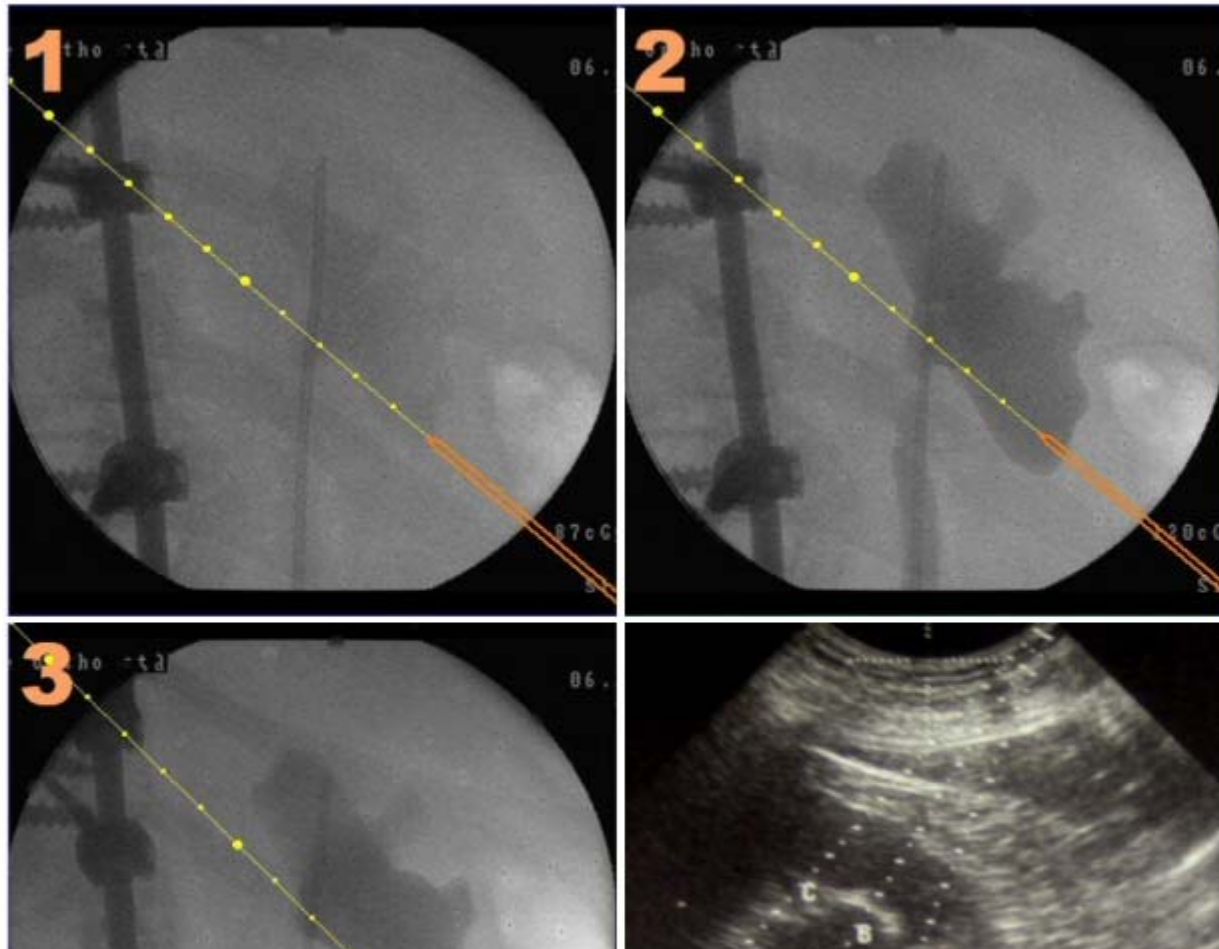

C-arm, needle guide and patient references

infrared camera and visualization system

RÉFÉRENCES

F   M
C   1
P   2
     X

1   **2**   3
4   5   6
7   8   9

Paramètres
d'images

Mémoriser
Outil 1
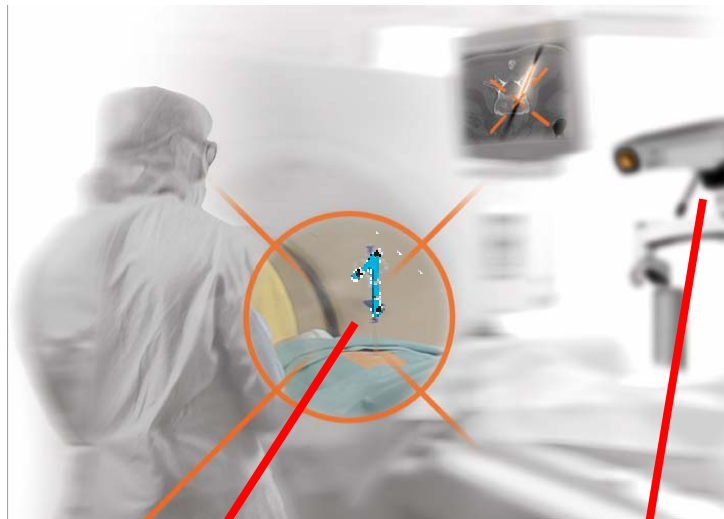
Définir
Axe

Vidéo directe du C-Arm

Computerized Surgical Protocol

1. Install patient and patient reference on table
2. Calibrate C-arm with cage
3. Acquire 2-3 Fluo Rx (apnea)
4. Calibrate needle guide (with or without US)
5. Navigate virtual needle on Rx images
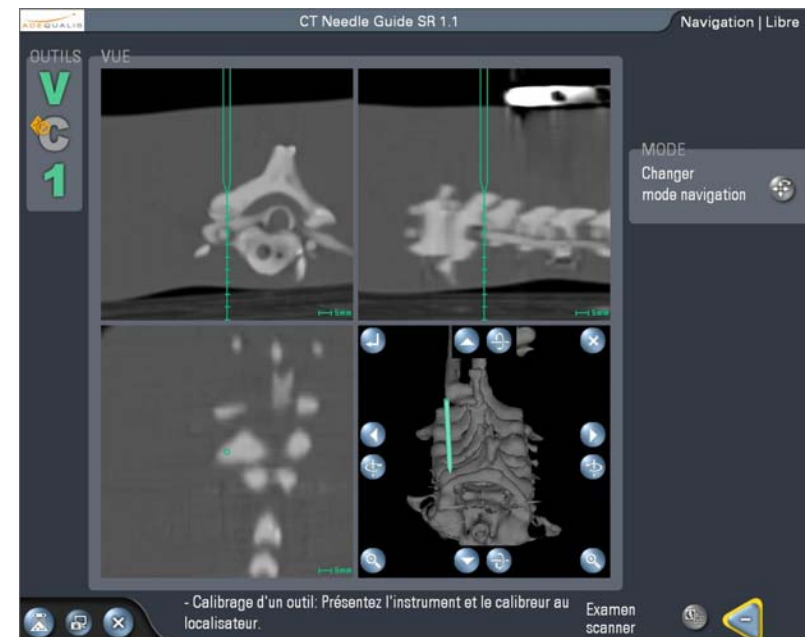6. Perform the puncture confidently

CT Navigation

- Hybrid localisation:
  - Tracking of needle and patient references
  - Image based registration of patient reference, visible in CT scan, with model of the reference shape

Needle reference

Camera

Computerized Surgical Protocol

1. Install patient and patient reference on CT
2. Acquire 1 CT scan (apnea)
3. Calibrate needle guide (with or without US)
4. Match CT images onto patient reference
5. Navigate oblique CT slices
6. Perform the puncture confidently

Work in progress

- 3DRT ultrasound based tracking
  - no external references
  - precise soft tissue tracking
  - patient reference replaced by reference volume of the target organ
  - volume stream registered with reference volume
  - deformation estimation possible
- Challenges
  - robustness
  - computational burden

Navigation and robotics

- Common challenge of navigation systems and robotics: **Precise target localization**

  - Localization systems could be used for **robotic servoing**

    - Localizer based tracking
    - Image stream based tracking
    - Hybrid tracking

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