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# Evaluation of a CT Guided Robotic Positioning System to Minimize Needle Manipulation During Placements to Small in Vivo Targets

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# Acknowledgement and Disclosures.

The presentation includes additional results from data collected following original abstract submission.

# Background.

## Available Technologies

- **Electromagnetic navigation**
- **Laser guidance**
- **Optical guidance**
- **Robotic systems**

## Potential Benefits

- **Radiation dose reduction.**
- **Improved accuracy.**
- **Reduced dexterity requirement.**
- **Novice physicians.**

## Evaluation

- **Phantom models**
  - Unrealistic tissue interaction.
- **Ex-vivo tissue**
  - Simplistic scenarios.
- **Large animal study**
  - Very few pre-clinical studies.
- **Patients**
  - Lack of control (manual insertion).
  - Heterogeneous targets.
  - Self assessed outcomes.

**Unanswered Question:** How do assistance systems compare with performance of an experienced physician?

# Hypothesis.

When an **experienced IR physician** performs needle placement **manually** and with assistance from CT-guided **robotic positioning system** (RPS) for **the same target** ….

1. When compared to manual needle placement, placement using RPS will **require fewer needle manipulations** and **check scans** to reach the target.

2. The use of RPS will result in **placement accuracy** that is **non-inferior to** accuracy achieved during **manual placement**.

# Experimental Methods.

- **Participant Demographics**
  - 7 experienced physicians from MSKCC IR service.
  - 6 years of independent median experience with needle placement procedures.

- **In-vivo Targets**
  - 7 healthy female swine (40-50kgs).
  - 4 targets, distributed over all lobes of the liver (50-120mm depth).
  - 5mm long, 18G dia seeds.

- **Materials and Protocol**
  - Placement of 18G, 150mm or 100mm coaxial needle.
  - Manual placement preceded RPS assisted placement.

**7 physicians X 4 targets = 28 data points/cohort. 56 total samples.**

# Experimental Methods.

- **Manual Placement**
  - Standard clinical procedures (sequential CT or CT fluoroscopy) .
  - Self judged time vs. accuracy optimization.

- **RPS Assisted Placement**
  - Paralytic induced breath hold.
  - Needle insertion in one go.
    - Did not include stop and check or needle holder available with the system.
  - One repeat if result was poor.

# Metrics.

- **Number of needle manipulations.**
  - Total number of times the physician adjusts the needle till the tip reaches satisfactory end point.

- **Number of check scans.**
  - Total number of check scans, excluding planning scan and confirmation scan, used to complete needle placement.

- **Placement accuracy.**
  - Shortest distance between needle tip and closest location on the seed when measured on confirmatory scan CT images.

- **Procedure time.**
  - Time taken to complete placement, starting with planning scan and ending with final confirmatory scan.
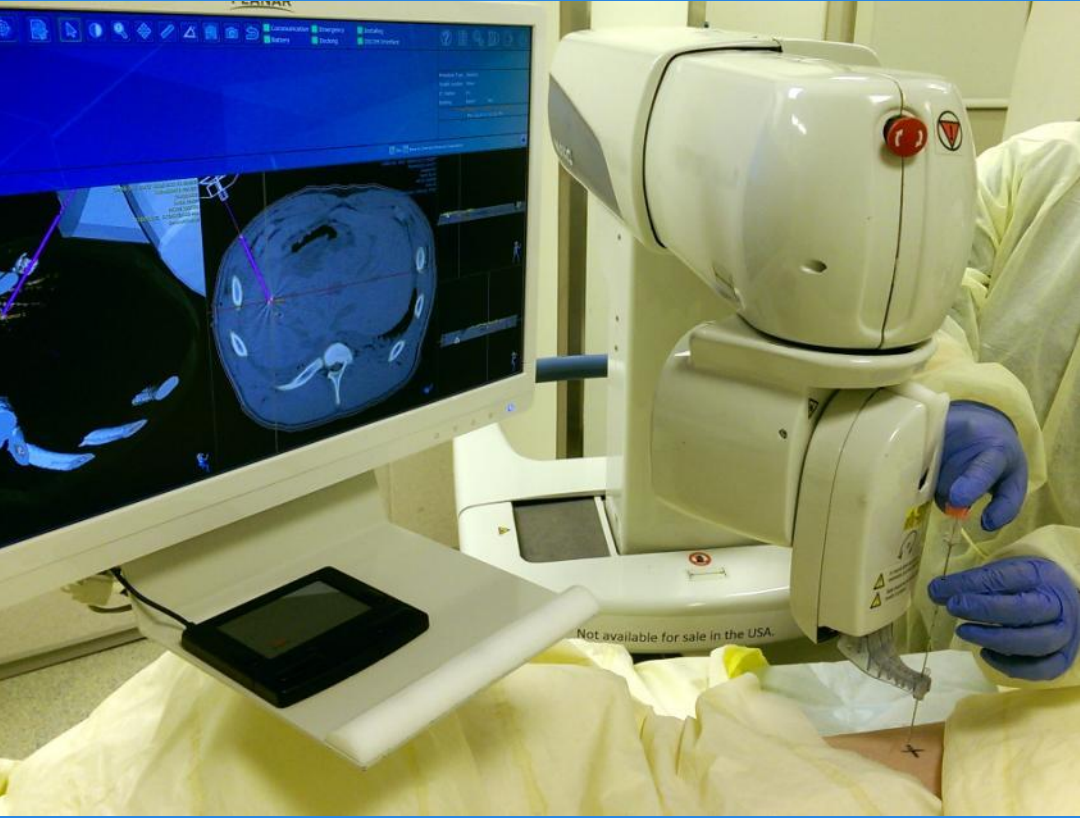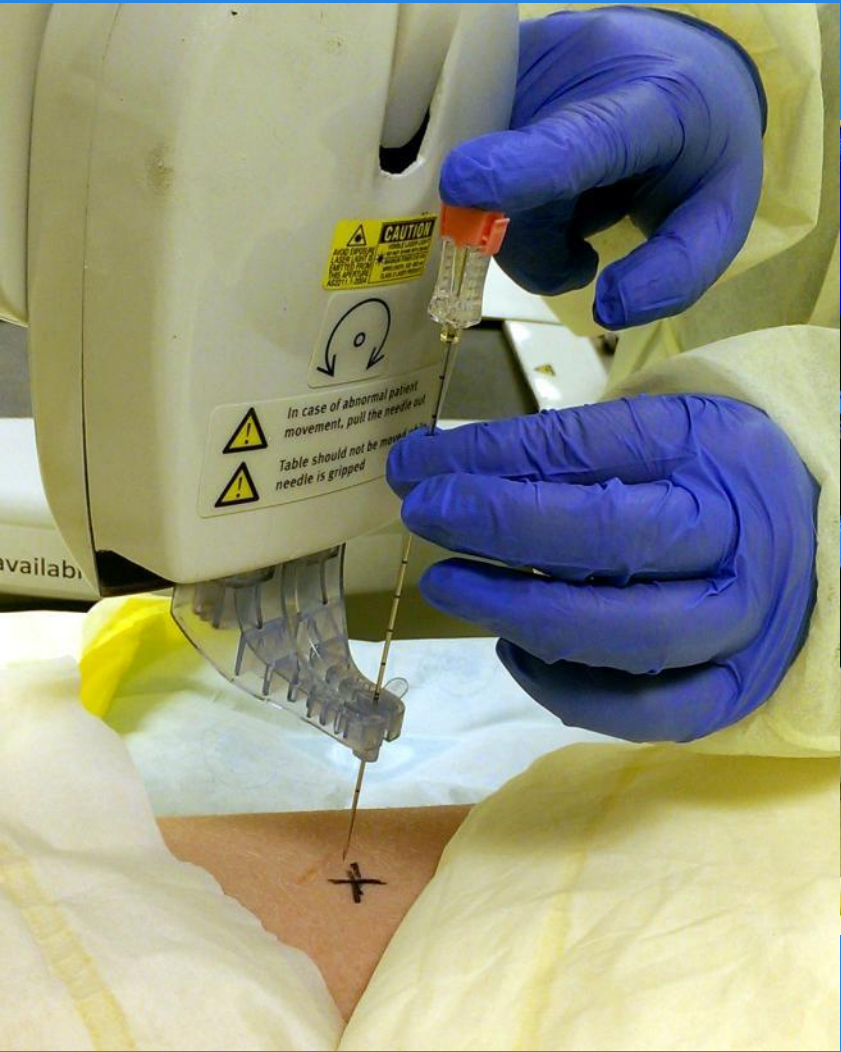
# Work Flow.
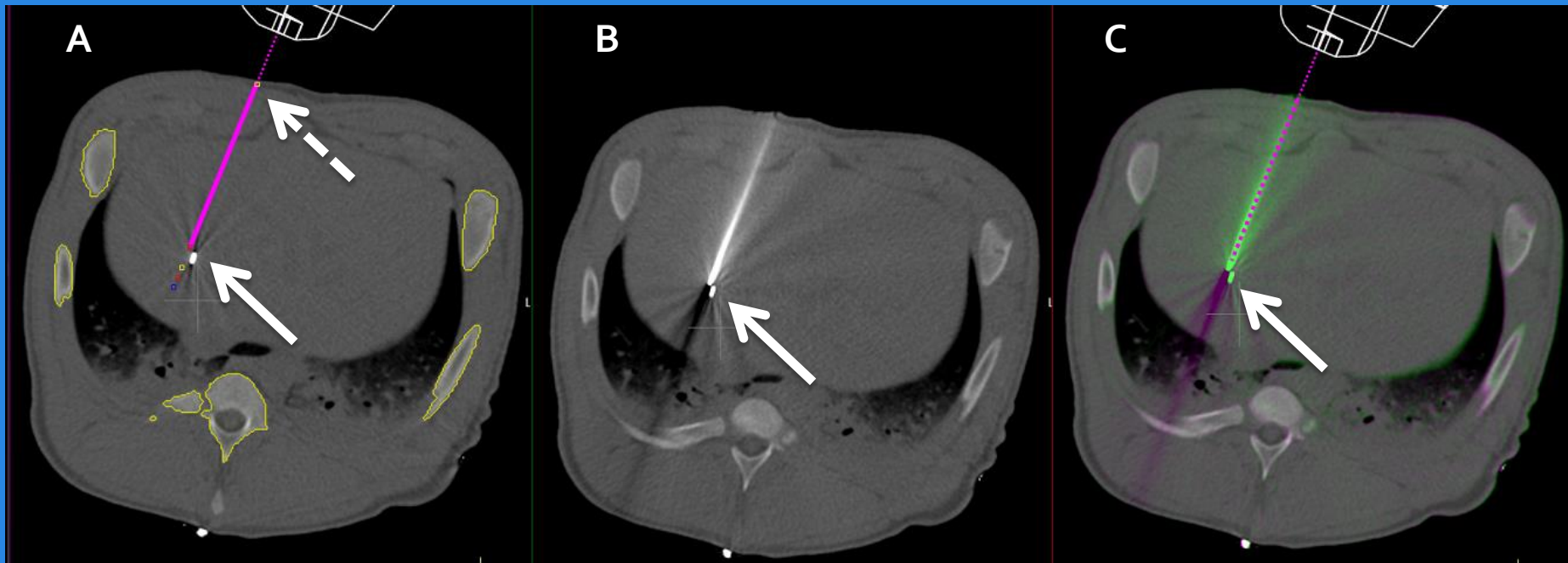


**A:** Planning image, magenta line shows planned needle trajectory from skin entry (dashed arrow) to target seed (arrow).
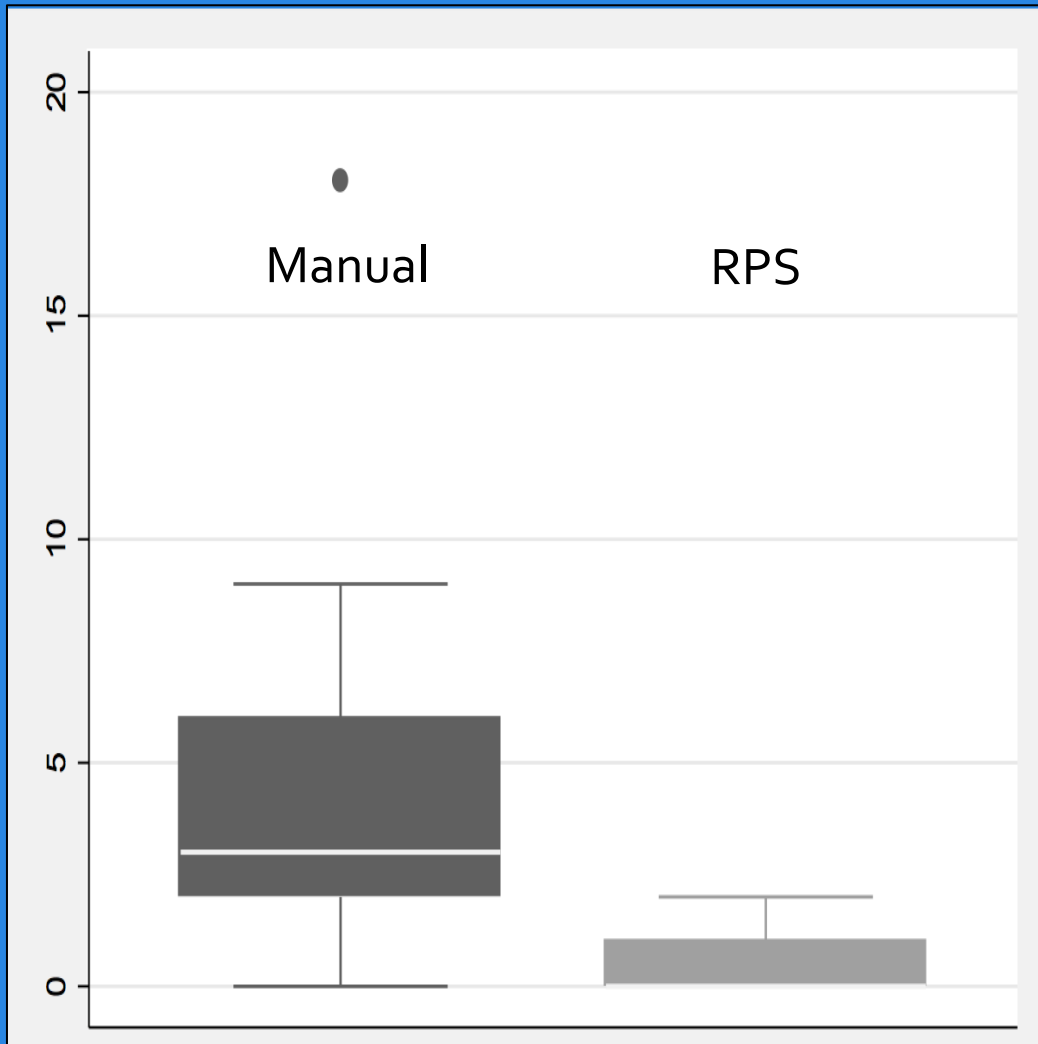
**B:** Post needle placement CT image.

**C:** Image overlay comparing planned trajectory (dashed line) and actual needle position.
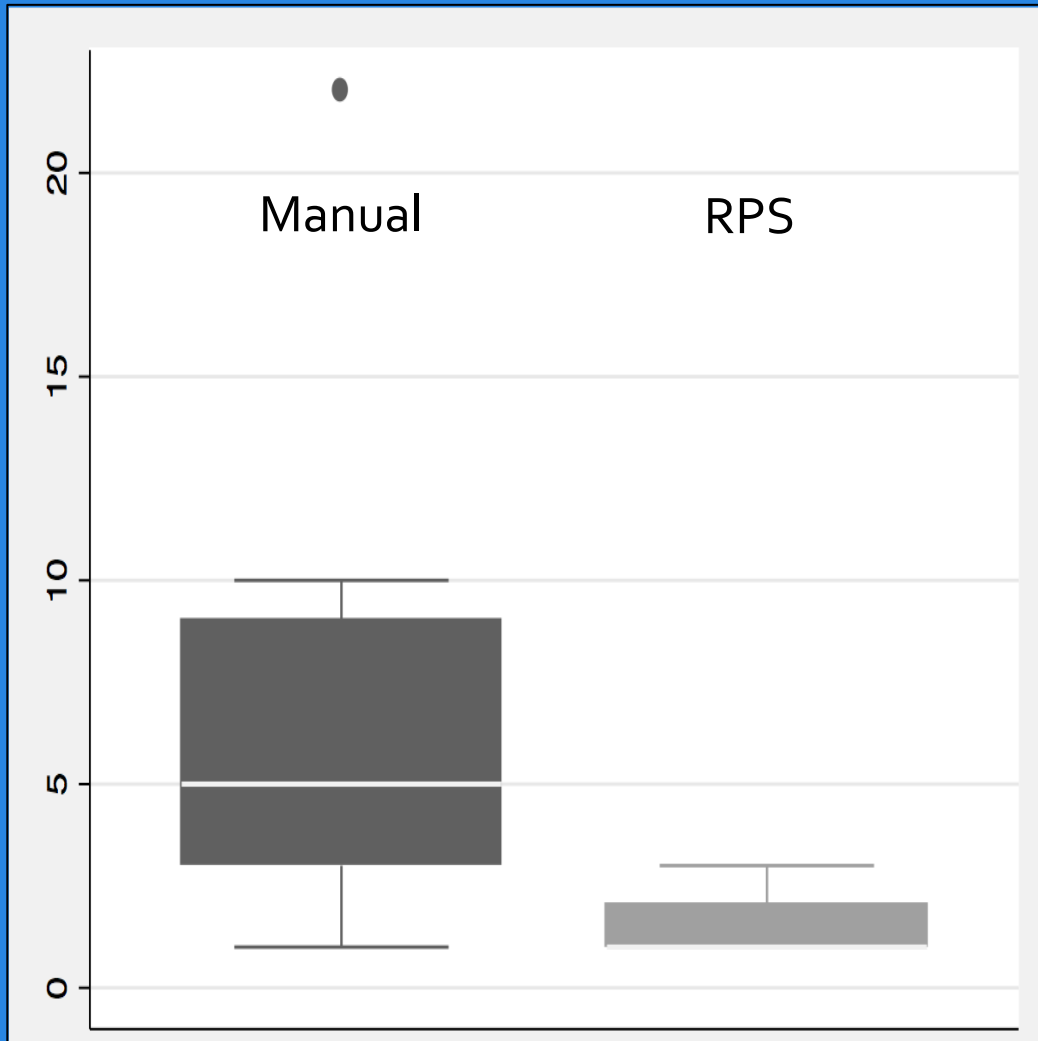
# System in Action.

# Results: Number of Needle Manipulations.



|  | Manual | RPS |
|---|---|---|
| Mean | 4.06 | 0.39 |
| S.D | 3.48 | 0.57 |
| t-Test | p= 0.0000076 | |

**Hypothesis 1: Means are significantly different. RPS has lower mean.**

# **Results:** Number of Checkscans.



| | Manual | RPS |
|---|---|---|
| Mean | 6.13 | 1.43 |
| S.D | 4.29 | 0.63 |
| t-Test | p= 0.0000149 | |

**Hypothesis 1: Means are significantly different. RPS has lower mean.**

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# Results: Accuracy.
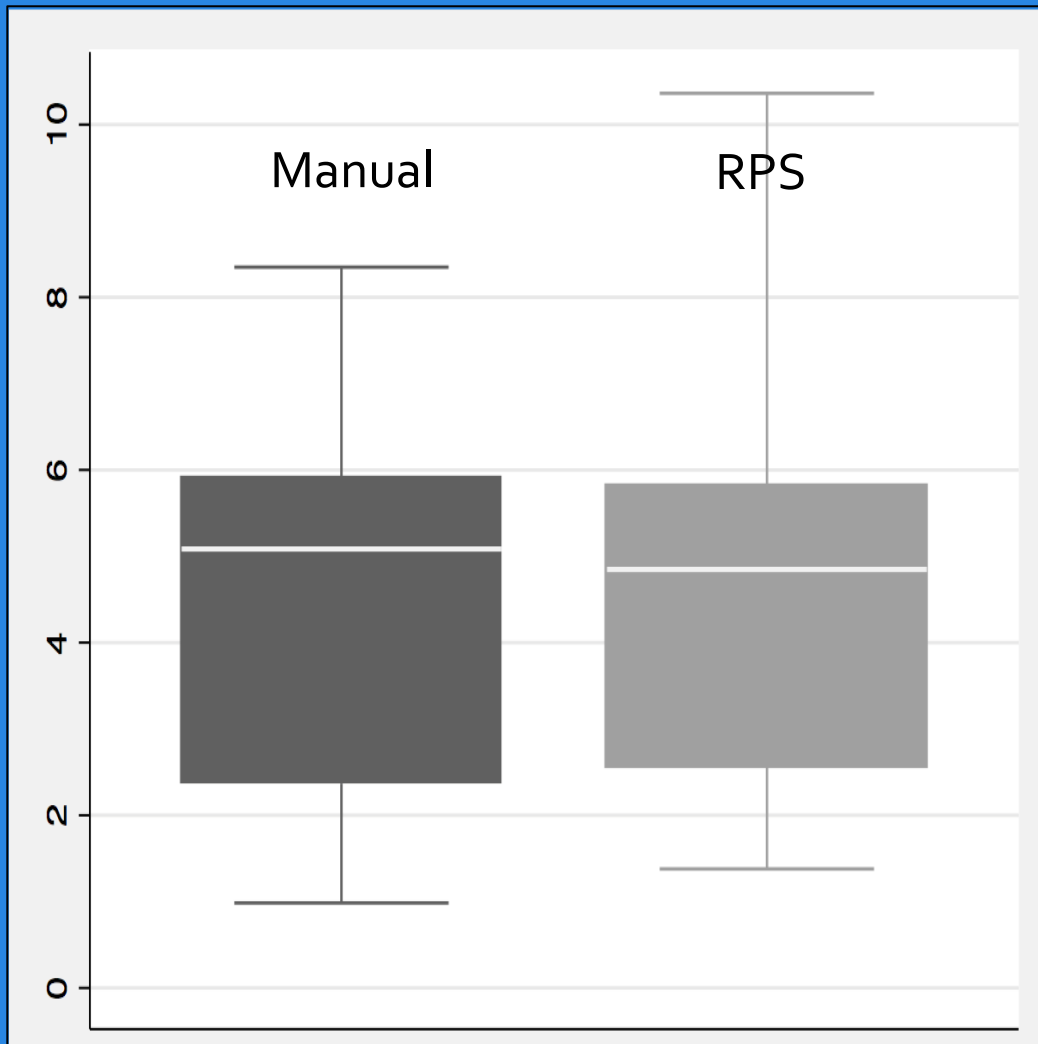


| | Manual | RPS |
|---|---|---|
| Mean | 4.59 | 4.81 |
| S.D | 2.01 | 2.38 |
| t-Test | p= 0.59 | |

**Hypothesis 2: There is no difference in means of the two study arms.**

# Results: Procedure Time.
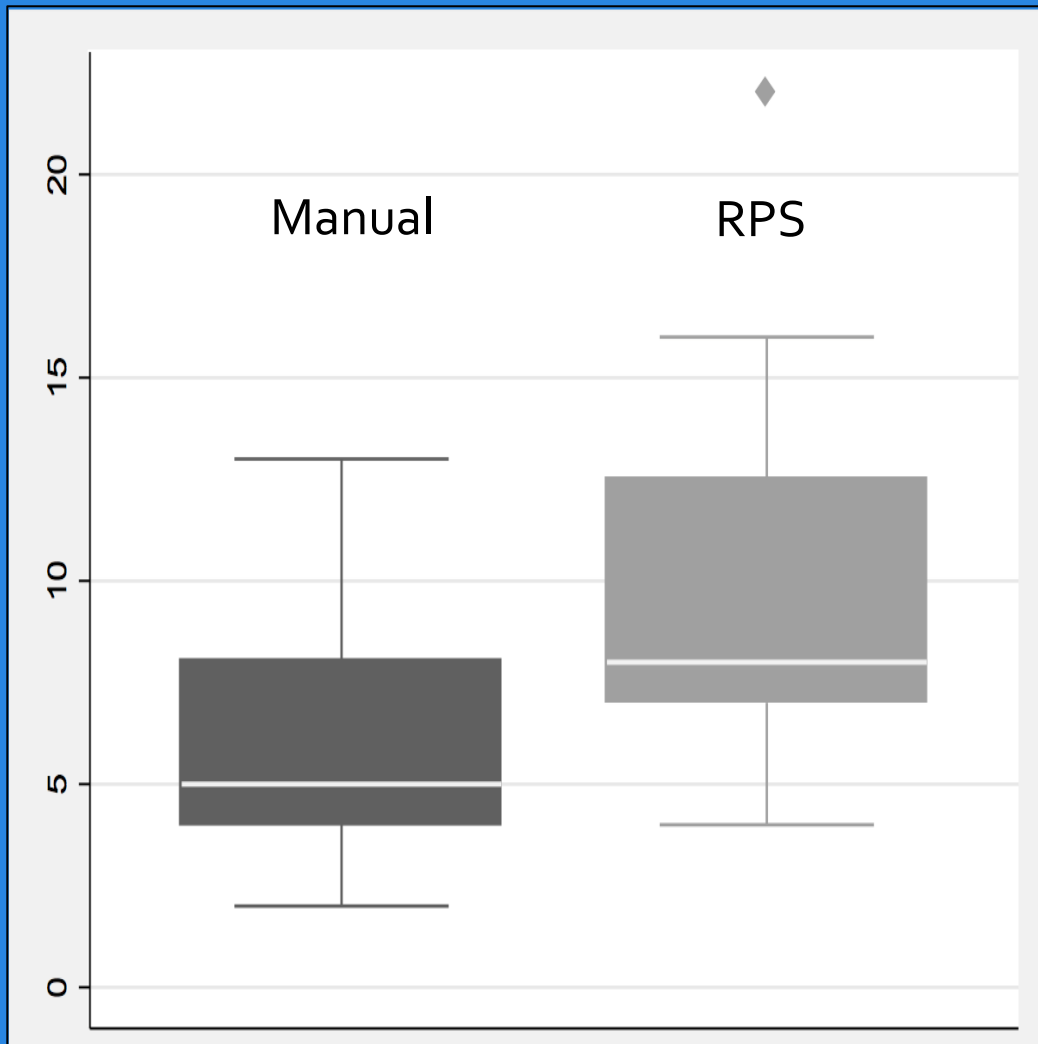


| | Manual | RPS |
|---|---|---|
| Mean | 6.19 | 9.64 |
| S.D | 2.89 | 3.98 |
| t-Test | p= 0.000231 | |

**Means are significantly different. Manual has lower mean.**

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# **Results:** Radiation Dose.

|        | Manual  | RPS    |
|--------|---------|--------|
| Mean   | 1075.77 | 636.4  |
| S.D    | 717.74  | 373.32 |
| t-Test | p= 0.03 |        |

**Means are significantly different.
RPS has lower mean.**

# Discussion.

- **Experienced physician or Novice robot operator?**
    - The learning curve.
    - Cognition (experience) vs. dexterity (robot).
    - Multi-plane approach.
    - Procedure time for multiple RPS placement.
- **Effect of standardized work flow.**
    - Reduction of inter-operator variance.
- **Limitations.**
    - Breath holds may work differently in patients.
    - Irregular or poorly defined targets in patients.
    - Blind insertion in one go.
    - Bending or other effects.

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Questions and Comments.