

Accuracy Of Tumour Targeting Using A CT-Compatible Robotic System - A Phantom Study

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Aims and objectives

Introduction & Purpose

A new CT-compatible robotic system, MAXIO™ was developed by Perfint Healthcare, USA to assist tumour targeting in biopsy and interventional procedures.

This study aimed to evaluate the accuracy of the robotic system in tumour targeting.

Images for this section:



Fig. 1: MAXIO (Perfint Healthcare, USA) CT-guided robotic system

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Methods and materials

1. Watermelon, with aluminum seeds (1 x 1 mm) implanted at 30, 50, 70 and 90 mm depth, was used as a phantom.
2. The implanted seeds were identified and targeted in the treatment plan.
3. The orbital angulations of the needle insertion were varied at 0°, 30°, 45°, 60°, -30°, -45° and -60°, whereas the cranio-caudal angulations were varied at 0°, 30°, 45°, -30° and -45°.
4. After needle insertion, CT check scans were done to determine the deviation in X, Y and Z axis of the needle tip and target.

Images for this section:



Fig. 2: Right side docking of the robot

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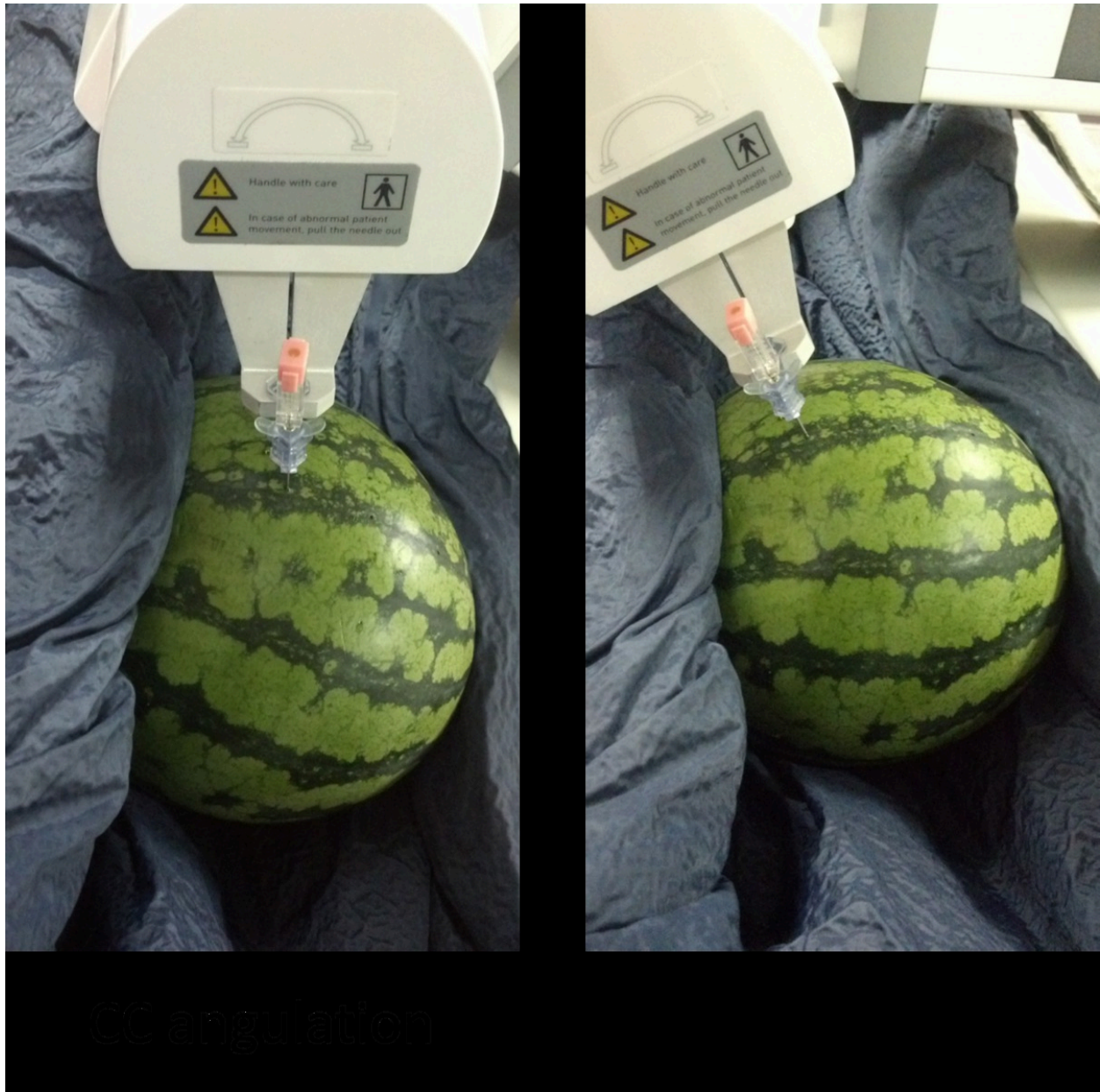


Fig. 3: CC angulation and orbital angulation of the robotic arm positioning

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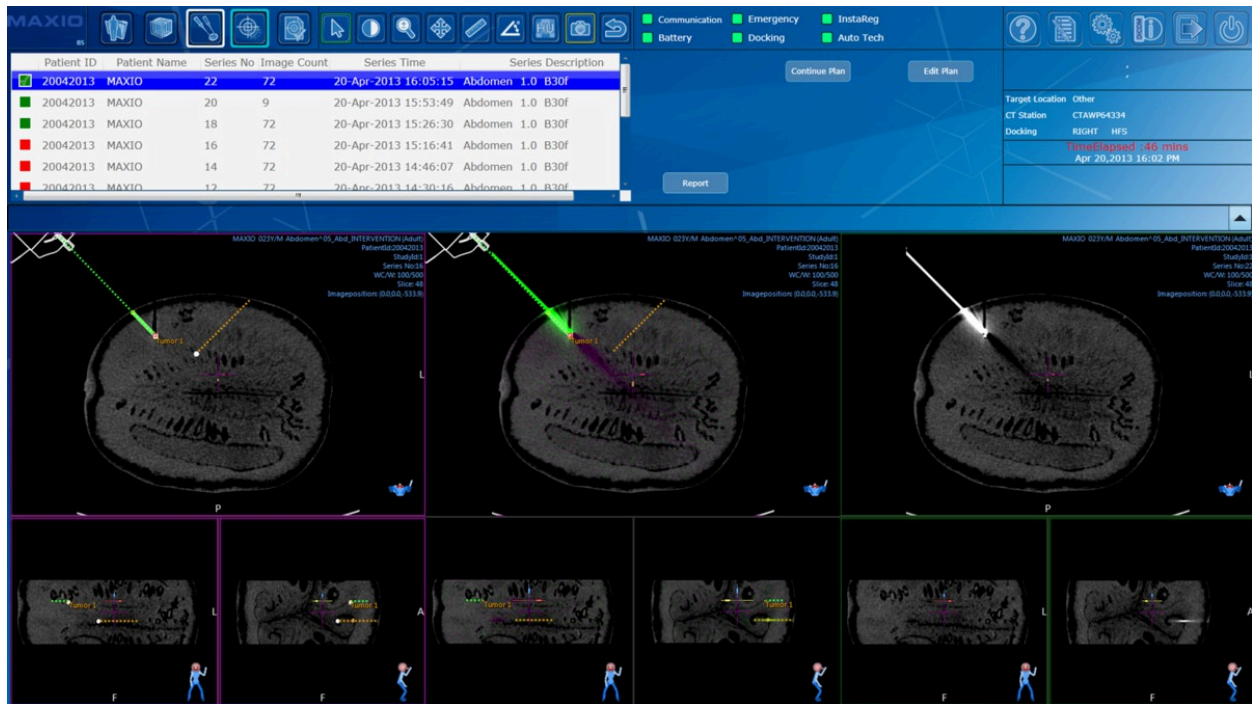


Fig. 4: Maxio 3D simulation and treatment plan

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Results

1. 120 needle trajectories were assessed using 4 watermelons.
2. The depth of target did not show significant difference in affecting accuracy of tumour targeting.
3. The orbital & cc angulation alone did not affect the accuracy.
4. The highest deviation of needle tip from the target was 2 ± 1 mm, occurred more frequently in the combination of orbital & cc angulations, eg. $(45, 45)^{\circ}$, $(-45, 45)^{\circ}$, $(45, -45)^{\circ}$.
5. Higher accuracy was noted with the robot docked at the right compared to the left side of the scanner.

Table 1 and Fig. 6 to 8 show the examples of the accuracy test report of needle targeting in this study.

Images for this section:

Table 1: An example of accuracy test report

Docking: Right Side

Target depth: 27 mm

Needle length: 112 mm

Table height: 126.5 mm

Target Coordinates: X: 1 mm, Y: 1mm, Z: 1mm

Planned Angulations (Degree)		Depth (mm)	Cradle distance (mm)	Deviation (mm)		
A (Orbital)	B (CC angle)			X	Y	Z
0	0	25.23	477.5	0	0	0
30.7	0	23.47	386.5	1	0	0
44.01	0	25.86	386.5	1	0	0
59.47	0	28.55	386.5	1	0	0
-29.88	0	34.18	386.5	0	0	0
-44.72	0	44.37	386.5	0	0	0
-60.36	0	63.13	386.5	0	0	0
0	30.73	29.35	358	0	0	0
0	45.47	35.07	311	0	0	0
0	-29.8	26.16	592	0	0	0
0	-45.26	29.56	641.5	0	0	0
45.58	-44.15	30.15	589	1	0	0
-44.32	45.41	53.36	260.5	0	0	0
45	44.9	34	366.5	0	0	0
-45.79	-45.78	46.05	696.5	1	0	0

Table 1: An example of accuracy test report

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Comparison for deviation of orbital angulation from left and right side at depth $30\pm 3\text{mm}$

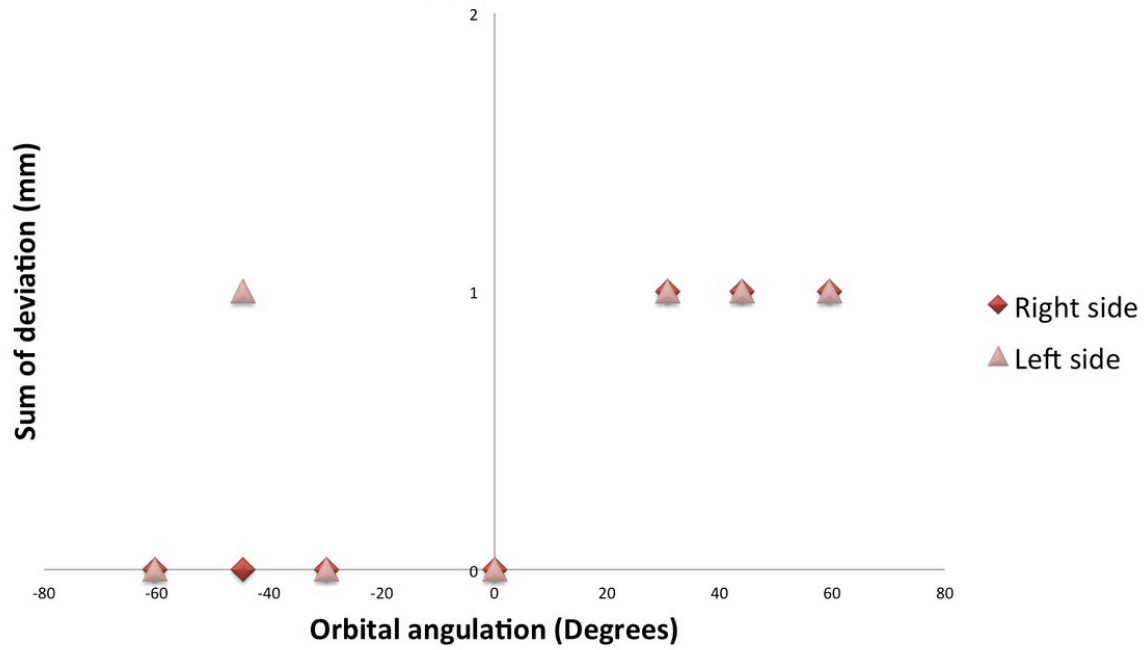


Fig. 6: Comparison for deviation of orbital angulation from left and right docking at depth 30 mm

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Comparison for deviation of craniocaudal angulation from left and right side at depth 30 ± 3 mm

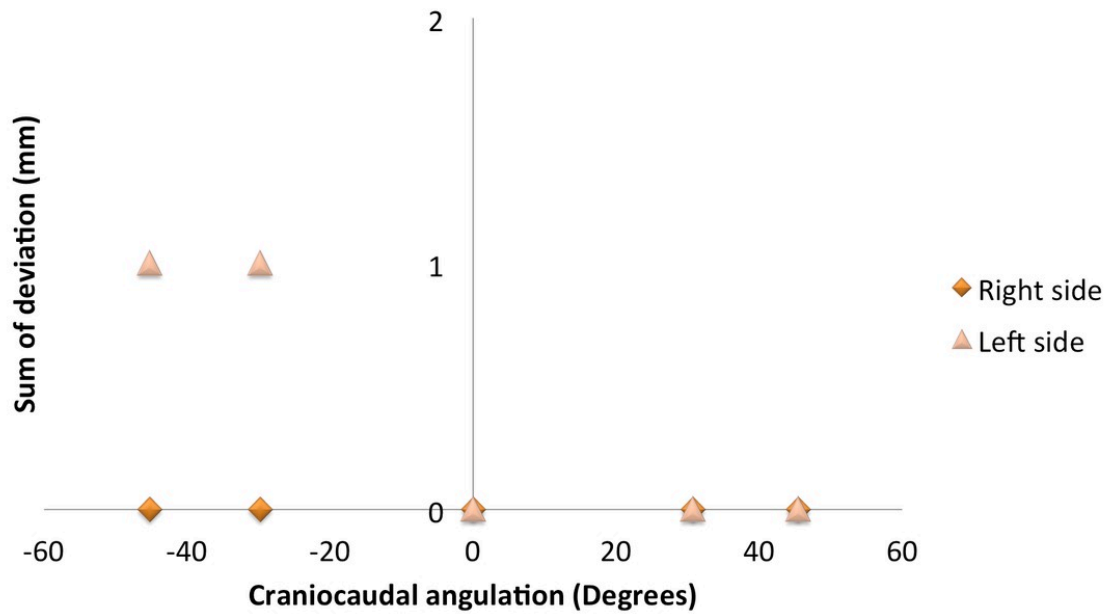


Fig. 5: Comparison for deviation of cranio-caudal angulation from left and right side docking at depth 30 mm

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Comparison of deviation for combine angulation at different depth

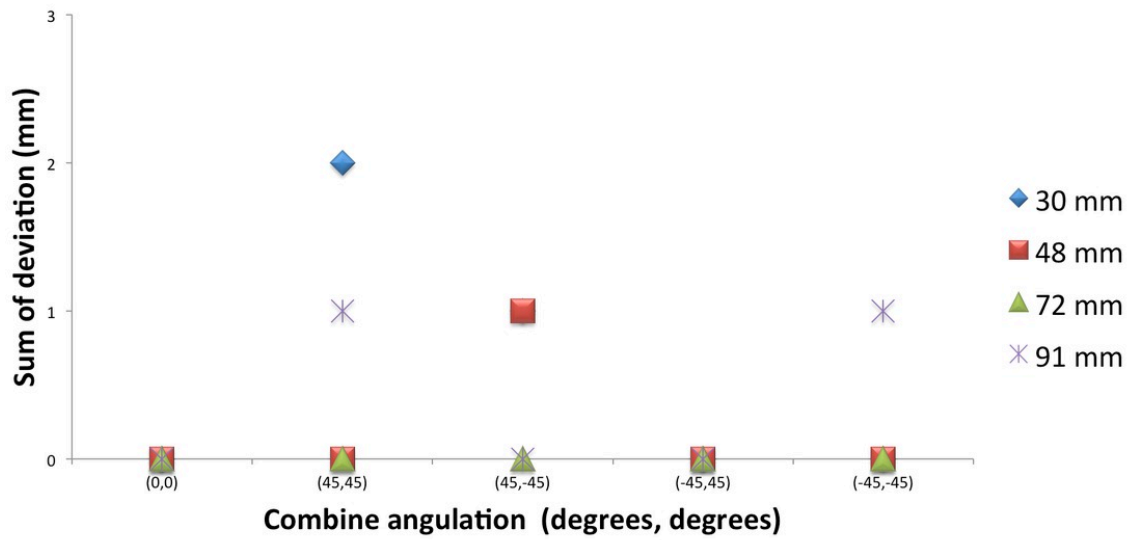


Fig. 7: Comparison of deviation for combination angulation at different depths

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Conclusion

The MAXIO™ robotic system achieved high accuracy of ± 2 mm in tumour targeting. It showed great potential to improve accuracy and minimize radiation exposure during CT-guided biopsy or interventional procedures.

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