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Hand dose assessment in combined cone-beam CT and real-time fluoroscopy guided needle puncture procedures using needle guidance devices

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Results

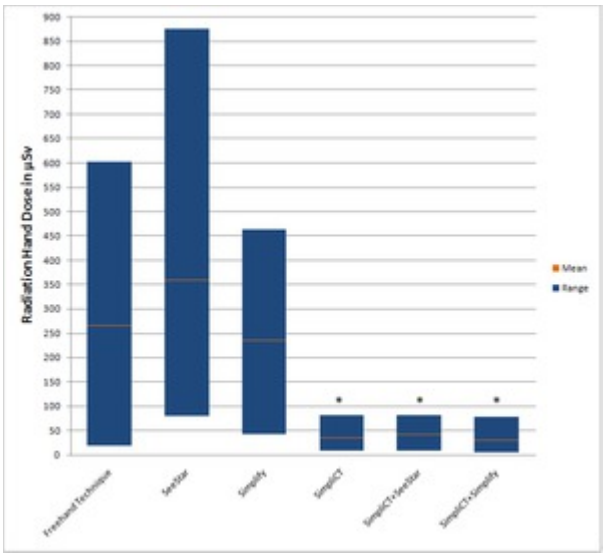

Fig. 1: The measured radiation hand dose of all performed procedures are visualized in...

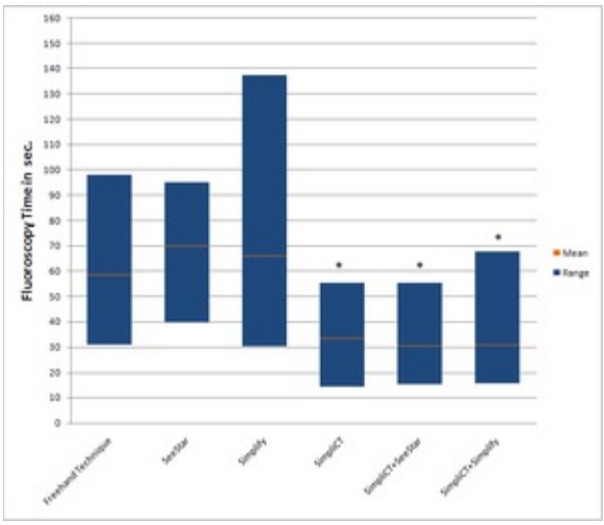

Fig. 2: The results of the fluoroscopy time necessary to guide the needle onto the...

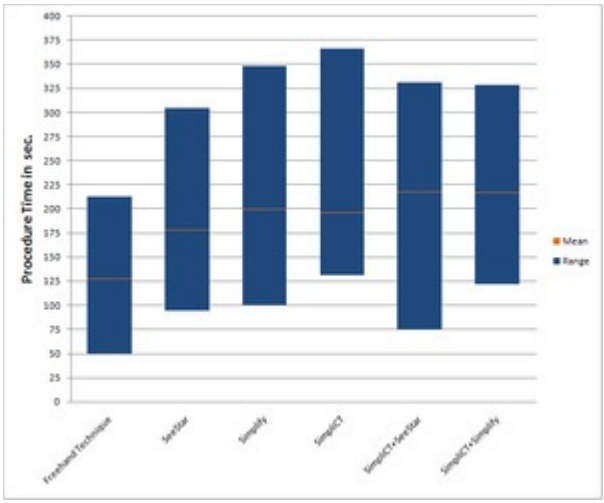

Fig. 3: The procedure time of guiding a needle onto the target point for each puncture...

Accuracy in mm	Freehand Technique	SeeStar	Simplify	SimpliCT	SimpliCT+SeeStar	SimpliCT+Simplify
Mean	1.3	0.6	1.4	0.6	0.7	0.4
Max	2.0	1.5	2.7	1.8	1.3	1.7
Min	0.1	0.0	0.1	0.0	0.0	0.0

Fig. 4: The accuracy of the performed puncture procedures per needle guidance device.

In total 72 punctures were performed on the phantom. All four operators used each needle guidance device three times in this phantom study.

Radiation dose

The result of the measured radiation hand dose by Unfors EDD-30 is visualized as the blue bar (the range); the orange line represents the mean radiation dose measured during the procedure (Fig. 1). The puncture procedures which used the SimpliCT to guide the needle, have a significantly lower mean radiation dose ($p < 0.01$) compared to the procedures performed by using the freehand technique. Large differences in hand dose are observed between operators for the freehand and needle holder techniques. The radiation dose for the freehand technique for example is in a range of 19.5 - 603.2 µSv. By contrast, the laser guided puncture procedures all result in similarly low operator hand dose levels (4.9 - 82.3 µSv).

Fluoroscopy time

The necessary fluoroscopy time is a measure for the amount of fluoroscopy needed to visualize, position and guide the needle onto the target point, the results are shown in Fig. 2. The fluoroscopy time results are in line with the radiation dose results. By using the SimpliCT for needle guidance, with or without needle holder, the fluoroscopy time is significantly lower ($p < 0.01$) in comparison to the freehand technique. In the majority of cases, both needle holders alone required more fluoroscopy to place the needle on the target point in comparison to the freehand technique and the laser guided puncture procedures.

Procedure time

The procedure time is the time required for the operator to position the needle on the target point. This time starts after an needle trajectory is planned and ends after the operator indicates to have reached the target (Fig. 3). The results show that by adding needle guidance devices to the procedure, extends the total procedure time by approximately 60 to 90 seconds when compared to freehand placement. The placement of the SimpliCT for visualizing the needle trajectory for the operator has only minor effect on the procedure time when needle holders are also used . During the freehand technique, the mean procedure time is 127 seconds and the mean fluoroscopy time is 59 seconds. For a by freehand guided puncture procedure, the operators use almost half of the procedure time fluoroscopy.

Accuracy

The accuracy of each needle guidance device is measured by calculating the distance between the final position of the needle tip and the target point of the puncture procedure in the control XperCT. All punctures were performed with an accuracy within 3 mm from the needle to the target point. More than 90% of the punctures have an accuracy of less than 2 mm distance between the needle and the target. Especially the punctures performed using the SeeStar, the SimpliCT, and the SimpliCT with both the needle holders have a high accuracy (Fig. 4).

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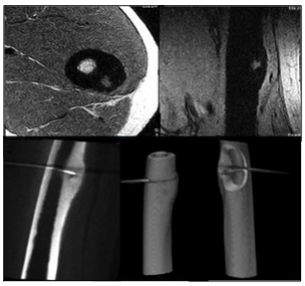

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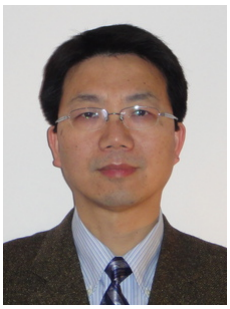

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J. Cheng; Shanghai/CN

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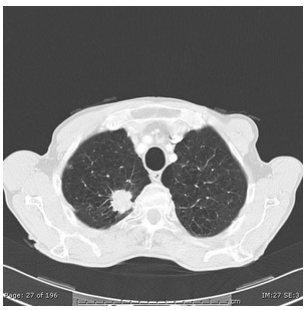

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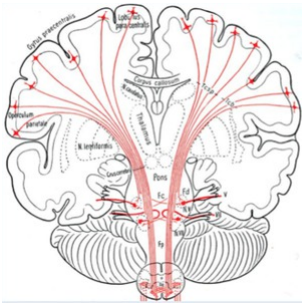

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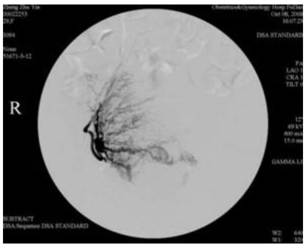

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G. Zhang, S. Gu, T. Wang, Z. Han; Shanghai/CN

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SYSTEM	MODEL (Manufacturer)	TARGET/FILTER in clinical use	DETECTOR TYPE (Manufacturer), pixel pitch
B1 (DR)	Senographe DS (GE)	Mo/Mo, Mo/Rh, Rh/Rh	AMFPI, indirect CsI (GE), 100 µm
B2 (DR)	Senographe 2000 (GE)	Mo/Mo, Mo/Rh, Rh/Rh	AMFPI, indirect CsI (GE), 100 µm
A1, A2 (DR)	Selenia (Lorad)	Mo/Mo, Mo/Rh 2010: W/Rh, W/Ag	AMFPI, direct a-Se (Hologic), 70 µm
A3 (DR)	Mammomat Inspiration (Siemens)	(Mo/Mo), W/Rh	AMFPI, direct a-Se (Anrad), 85 µm
A4 (DR)	Amulet (Fujifilm)	(Mo/Mo), W/Rh	FP, direct a-Se, photocond. switch. Readout (Fuji), 50 µm
D1 (DR)	MicroDose (Sectra Mamea)	W/Al	Scanning photon counting (Sectra), 50 µm
A5 (DR)	Dimensions (Lorad)	W/Rh, W/Ag, W/Al	AMFPI, direct a-Se (Hologic), 70/140 (TOMO) µm
C1 (CR)	CR85/DMR+ (Agfa/GE)	(Mo/Mo, Mo/Rh) Rh/Rh	Powder phosphor (AGFA), 50 µm
C2 (CR)	CR35/Sophie (Agfa/Planmed)	Mo/Mo	Powder phosphor (AGFA), 50 µm

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N. Oberhofer; Bolzano/IT