Improving Image Quality of the Sonic Flashlight for Venous Access

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Objectives

The Sonic Flashlight (SF) is an ultrasound (US) device that replaces the conventional ultrasound (CUS) monitor with a small display and a semi-reflective/transparent mirror to reflect real-time US images into the body [1]. Looking through the mirror, the virtual US image appears to float beneath the skin, exactly where the scan is being obtained (Fig 1). The SF merges the US image, probe, needle, operator's hands, and patient into the same field of view, making procedures more intuitive. In contrast, CUS displaces hand-eye coordination by forcing the operator to look away from the operating field to see the US display. We have previously used the SF to successfully place PICC lines in 15 patients [2]. However, because the sterile procedure requires a cover for the US probe, the visibility was significantly degraded. We have since redesigned the SF to solve this problem, and the purpose of this study is to demonstrate the functionality of our solution.

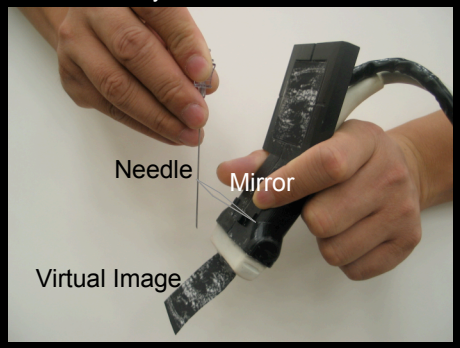

Fig 1. Sonic flashlight with virtual image (simulated by attached paper)

Methods

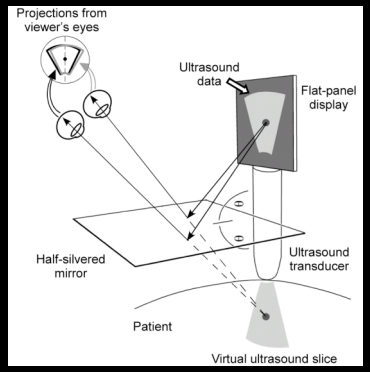

Fig 2. Schematic of virtual image formation using the Sonic Flashlight

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The redesigned SF (Fig 3) consists of a 10MHz US system whose probe is fitted with a small flat-panel display, but without a dedicated mirror. A standard sterile clear probe cover is fitted over the probe and the display (Fig 4). A disposable sterile mirror holder with a semi-reflective/transparent plastic mirror is then fitted outside the cover, pressing the cover flat against the display. 11 patients needing PICCs were enrolled in this study. While scanning their upper arms, the basilic and brachial veins, and brachial artery were identified in the virtual US image. A 21ga needle was guided into the basilic or brachial vein. We recorded the number of punctures and vein accessed.

Results

The vessels were clearly visualized in situ for all patients using the SF. The needle was easily aimed and inserted into the target vein. Successful access was obtained in all 11 subjects: 8 on first puncture, 2 on second, and 1 on third; 8 in the basilic vein and 3 in the brachial vein. Image degradation due to the bag was no longer appreciable.

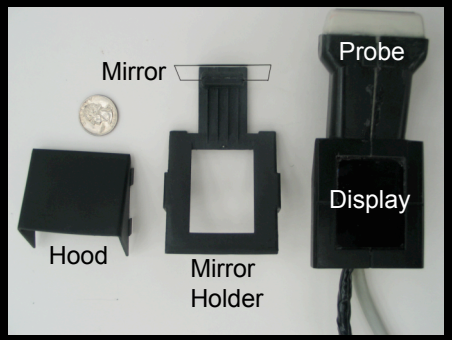

Fig 3. The three components of the Sonic Flashlight: hood, mirror holder, probe+display

Conclusion

This study shows that venous access can be safely obtained using the SF, and we believe our new disposable mirror outside the bag satisfies the requirement for sterility without significantly degrading visibility. Clinical trials to use this system for other central veins, as well as for PICC line placement by nurses at the bedside, are now underway.

Fig 4. The fully assembled version of the Sonic Flashlight with sterile bag [patent pending]

References

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