



Mobius Airo TruCT Scanner in the Operating Room: An Ergonomic Challenge to Neuroanesthesiologist

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Intraoperative imaging is a ubiquitous tool in neurosurgery, cranial and spinal procedures. Mobius Airo TruCT (Shirley, Massachusetts, United States) is the largest inner bore, mobile intraoperative computed tomography (CT) imaging system that seamlessly integrates into an operating room (OR) setup.¹ In transport mode, the ring is aligned with the base, and the scanner moves on the ramp to the desired location for scanning of the operative site. An intraoperative imaging system that gives high-quality images and a wide field of vision in both two- and three dimensions is provided by this device. There are few reports on use of intraoperative CT in neurosurgery and spine surgeries.^{2–4} There is a paucity of literature on the ergonomics of CT scanner location, anesthetic workstation placement, and patient alignment for CT-guided neuronavigation, or scanning from an anesthesiologist point of view; we found it worthwhile to share our limited experience.

Using a navigation system, accurate, minimally invasive imaging-guided treatments can be performed. As a result, it is less time-consuming, more cost-effective, and less disruptive to the surgical workflow. Anesthesiologists and their workstation environment are intertwined in the OR and the science of ergonomics is the study of this relationship to improve safety, performance, and patient well-being.⁵ Patient, equipment, and monitors should be positioned in such a way that an anesthesiologist can access the patient in a catastrophic situation and allow smooth functioning of the OR.

During routine surgical procedures requiring the need of a mobile CT scanner, all basic standard anesthesia monitors are attached to the patient. The patient is intubated under

controlled conditions and maintained under general anesthesia. Intravenous fluids and infusions necessary for maintaining the adequate depth of anesthesia are securely connected. Positioning should be performed according to lesion localization, with supine, lateral decubitus, modified semiprone, or semisupine positions being all suitable.

The scanning of the head or the desired surgery part is done after induction of anesthesia and before the incision, for brain mapping, after removal of the tumor, and intraoperatively during dissection of the tumor when required. CT-compatible surgical table with surgical head clamp is a vital part of the system that is optimized for neurosurgical workflow and intraoperative imaging. During cranial surgery, the head of the patient is positioned away from the scanner, to allow the use of standard surgical instruments (–Fig. 1). During CT imaging, the table is rotated 180 degrees and the patient's head is positioned in the center of the scanner. At the end of scanning, the operating table swings back in its original place. This setup besides being safe also minimizes movement of anesthetic equipment and has a short transit time to and from the CT imaging scanner. The monitoring cables and ventilation tubing must be of considerable length to allow for this rotational movement and vigilance is required during movement to avoid disconnections. Importantly, the anesthesia workstation pipelines must always be assembled and aligned within the edge of the table to avoid entanglement with the system.

The Association of Anesthetists has released the ergonomic standards for tracheal intubation, which state that the patient's forehead should be at the level of the anesthetist's xiphoid process or nipple while the patient lying on an

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Fig. 1 The scanner is at the tail end of the patient.



Fig. 2 The scanner is at the head end of the patient.

operating table or trolley for tracheal intubation. With the increased height of the mobile CT scanner and its inability to be lowered to accommodate patients in need of emergency airway intervention or placement of central lines, the operating table presents several ergonomic issues. To avoid difficulty, the intubation should be done before the table is set up for a mobile CT scanner. This limitation particularly makes a difficult extubation challenging.

For imaging purposes, it may be necessary to detach the extensions of monitors and lines. Tube dislodgement, inadequate depth of anesthetic, and patient awakening are all possible consequences of this process. The duration of imaging may take 5 to 10 minutes and to avoid light anesthesia, propofol aliquots in the dose of 0.4 to 0.6 mg/kg can be given. The patient is monitored by the main anesthesiologist and a junior resident. We prefer to have the arterial line in place with an extension. Any arrhythmia or hypotension can be monitored with an arterial line in place. If an arterial line is not in place, then the anesthesiologist wearing a lead apron can feel the radial pulse during the imaging. The capnography can help us to detect any disconnection or misplace-

ment of the endotracheal tube. One of the main concerns is the effects of radiation on the anesthesiologist and other healthcare workers. Zhang et al demonstrated that ~50% of the radiation dose is delivered by a routine 64 slice CT scanner.⁶ This is avoided by using the lead aprons during scanning while monitoring the patient.

A comprehensive approach to patient monitoring under anesthesia called closed-loop monitoring has been suggested by Manohar et al.⁷ We applied closed-loop monitoring during intraoperative scanning to prevent disastrous consequences. It includes a closed-loop visual inspection of the patient, anesthesia machine, standard monitors, and surgical field in a definitive sequence to ensure none of the clinical parameters are missed (►**Fig. 2**). Also, the alarm limits should be set appropriately to detect any subtle changes as early as possible. This approach will prevent adverse events as well as improve the safe provision of anesthesia and reduce anesthesia-related morbidity/mortality.

The placement of a mobile CT scanner at the tail end was preferred by neurosurgeons owing to optimum surgical space for them to work. The disadvantages include the following: (1) It requires frequent disconnection of the circuits and lines; (2) there may be an accidental breach in the sterility at the surgical site during rotation of table; (3) if the patient is undergoing neuromonitoring, the leads need to be disconnected and there can be damage while moving. In our practical experience, the optimal placement of the mobile CT scanner should be at the head end during surgical procedures away from the surgical area (►**Fig. 3**). The advantages include the following: (1) It eliminates the need to rotate the table; (2) disconnection of the circuits and lines is not necessary; (3) the depth of anesthesia and hemodynamics of the patient will not be disrupted, while the disadvantages are: (1) The surgical space will be restricted; (2) the sterility of the surgical field will be compromised as the mobile CT scanner occupies the space.

During the logistics, it is of utmost importance to maintain the sterility of the surgical field. We should make sure that the headpin holder applied for neurosurgical procedures is not touching the scanner while imaging or neuronavigation. To maintain sterility, a large transparent surgical drape permitting full coverage of the mobile CT scanner should be used to separate the OR into a sterile and nonsterile part.

Intraoperative mobile CT scanner provides a major benefit to the surgeon in providing real-time imaging and in technically difficult cases and has a smooth workflow. It also avoids patient transport to the radiology department in the immediate postoperative period.

Conclusion

Intraoperative usage of CT scanning is becoming more common. Safety of patient and smooth workflow is of utmost importance. Constant communication with the staff and the surgeons is very essential. Workflows must be established, as they are important to prevent errors during patient movement that requires constant vigilance with no compromise regarding safety and clinical standards.

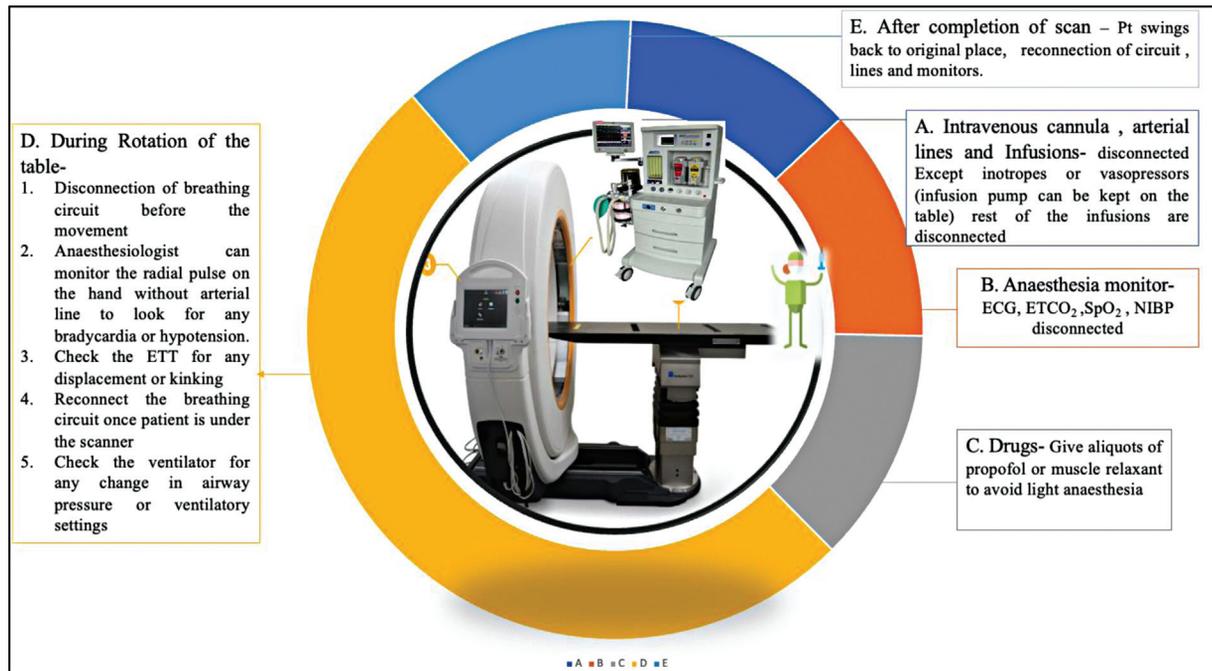


Fig. 3 Closed-loop monitoring includes the following steps: (A) Taking care of intravenous cannula, arterial lines, and infusions; (B) monitoring; (C) drugs; (D) during the rotation of the table; (E) completion of scan. ECG, electrocardiogram; ETCO₂, end-tidal carbon dioxide; ETT, endotracheal tube; NIBP, noninvasive blood pressure; SpO₂, peripheral oxygen saturation.

Conflict of Interest

None declared.

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