

Table 1 Best practice guidelines for avoiding errors in robotic-assisted spine surgery

Section 1: General protocols:

- (1) The use of robotic and/or assisted surgery should be discussed prior to surgery and as part of the informed consent process
- (2) Manufacturer's guidelines for each system should be fully understood and followed

Section 2: Screw planning/execution:

- (1) The attending surgeon should plan their own screws or verify each screw plan
- (2) The attending surgeon should review fluoroscopy-to-CT calibration/matching
- (3) Surgeons should beware of skive potential and select the starting point judiciously
- (4) There should be a formal anatomy check following registration
- (5) If deviation from planned trajectory is suspected, confirm accuracy of navigation before proceeding
- (6) A patient-based fiducial marker is highly encouraged
- (7) If there is concern that navigation inaccuracy has occurred, proceed with re-verification, re-registration/re-calibration, or abandonment of robotics/navigation
- (8) For intraoperative CT imaging acquisition, principles of ALARA (as low as reasonably allowable) should be utilized whenever possible, especially for younger patients
- (9) Imaging should be considered to check implants prior to extubation

Section 3: Optimization of surgical technique:

- (1) During registration and screw track preparation, consider keeping tidal volumes low or holding respirations, when medically permissible, especially in thoracic cases
- (2) The surgical team should always verify that patient positioning is secure to minimize trunk movement. Significant movement after registration should prompt confirmation of tracking accuracy
- (3) Pedicle screw channel preparation should be performed immediately after registration
- (4) When developing the pedicle screw track, the initial cortical pilot hole created with the high-speed burr/drill should be no more than 10 mm
- (5) When introducing a new instrument, the surgeon should confirm that the feel of bone matches the navigated visual cues
- (6) The bone should be felt with haptic feedback and advancement of the burr/tap/drill during drilling

- (7) If the system uses a cannula, the cannula should be withdrawn from the bony surface to allow the first instrument touching the bone to be the burr. This limits cannula-influenced skive
- (8) The burr should be started off the bone at full speed to prevent skive
- (9) It is critical to avoid excess soft-tissue retraction whenever possible
- (10) In open cases, if soft-tissue retraction results in patient micromotion, consider transfascial or percutaneous screw placement
- (11) When neuromonitoring is utilized, if it causes patient motion, the surgeon should be aware that registration may be compromised
- (12) Special attention should be paid to the UIV and LIV regions due to issues regarding distance from reference frame and soft-tissue tension
- (13) The reference frame should be placed as close as possible to the levels of surgery

Section 4: Areas for robotic improvement:

- (1) Formal staff training should be required for nurses and scrub techs for familiarization and troubleshooting of set-up, draping, and preparation of robotic instruments
- (2) Both surgical and assistant teams should have training prior to initiating a robotic spine program
- (3) Surgeon visitation/proctoring should be encouraged

Guidelines accepted met consensus standards ($\geq 80\%$ agreement by expert panelists)

Reference

Spine Deformity

<https://doi.org/10.1007/s43390-025-01060-9>

Building consensus: development of a best practice guideline (BPG)
for avoiding errors in robotic-assisted spine surgery (RASS)

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Received: 10 December 2024 / Accepted: 25 January 2025

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