

STABLE TRIAL

Study of Tool-Lesion Alignment and Breath-Hold Ventilation in Robotic Bronchoscopy for Peripheral Lung Lesions

WVU Medicine Camden Clark Medical Center | IRB Protocol

Principal Investigator	Roshen Mathew, MD, DAABIP
Study Site	WVU Medicine Camden Clark Medical Center, Parkersburg, West Virginia
Study Design	Prospective randomized clinical study
Study Population	Adults undergoing robotic bronchoscopy for biopsy of peripheral pulmonary lesions
Duration of Study	Jan 2025 - Oct 2027.

1. Background and Rationale

Respiratory motion during robotic bronchoscopy may alter the relationship between a peripheral lung lesion and the biopsy tool. Breath-hold is routinely used during imaging and is also currently applied during tissue acquisition at the procedural physician's discretion based on lesion motion. However, whether sustained breath-hold during biopsy improves diagnostic yield remains uncertain, though this is intermittently performed intraprocedural routinely.

The STABLE Trial was designed to test the hypothesis that sustained breath-hold during tissue acquisition improves strict diagnostic yield compared with conventional ventilation during robotic bronchoscopy. Secondary outcomes included lesion localization, tool-lesion relationship, radiation exposure, procedural performance, and safety.

2. Study Objective and Hypothesis

Primary objective: To determine whether sustained breath-hold during tissue acquisition improves strict diagnostic yield during imaging-integrated robotic bronchoscopy compared with conventional ventilation.

Hypothesis: Sustained breath-hold during tissue acquisition will improve strict diagnostic yield by reducing respiratory movement of the target lesion and improving stability of the lesion-biopsy tool relationship.

3. Study Design

This is a prospective randomized study conducted at WVU Medicine Camden Clark Medical Center. After enrollment and before the procedure, patients are individually randomized to sustained breath-hold or conventional ventilation using computer-based simple randomization with equal probability of assignment. Assignment is generated at the time of randomization, with no pre-generated allocation sequence available to the procedural team.

4. Study Population

Adult patients undergoing robotic bronchoscopy for biopsy of a peripheral pulmonary lesion considered appropriate for bronchoscopic sampling are eligible. Final eligibility is determined by the treating procedural physician based on clinical indication and procedural suitability. No patients < 18 yrs of age will be registered.

5. Procedural Intervention

All procedures are performed under general anesthesia using the Noah Galaxy robotic bronchoscopy platform with augmented fluoroscopy (AF) and C-arm-based tomosynthesis (CABT). Both groups undergo brief breath-hold during AF/CABT image acquisition as part of the imaging workflow. This is part of routine workflow.

Breath-hold group: Following imaging confirmation and tool adjustment, sustained end-inspiratory breath-hold is maintained during tissue acquisition when clinically feasible.

Conventional ventilation group: Conventional ventilation is resumed following imaging acquisition and is continued during tissue acquisition.

Tissue acquisition includes transbronchial needle aspiration and transbronchial forceps biopsy according to the standard procedural workflow. Bronchoalveolar lavage, rapid on-site cytologic evaluation, and mediastinal staging with convex-probe EBUS may be performed when clinically indicated.

6. Primary Endpoint

Strict diagnostic yield at the index robotic bronchoscopy, classified according to ATS/ACCP research definitions. A procedure is considered diagnostic when it establishes either a specific malignant (SM) or specific benign (SB) diagnosis. Nonspecific inflammation, normal/nondiagnostic lung tissue, and findings not meeting strict diagnostic criteria are classified as nondiagnostic (ND).

7. Secondary Endpoints

- Successful lesion localization using integrated imaging.
- Imaging-confirmed tool-lesion relationship: tool-in-lesion (TIL), tool-touching-lesion (TTL), or no tool in lesion (NTL).
- Diagnostic yield according to imaging-confirmed tool-lesion position.
- Radiation exposure, including fluoroscopy time, cumulative air kerma, dose-area product, and number of C-arm spins.
- Procedural sampling measures, including number of transbronchial needle aspiration passes and transbronchial forceps biopsy specimens.
- Number of sustained breath-holds performed in the breath-hold group.
- Clinically significant complications, including pneumothorax requiring chest-tube placement and clinically significant bleeding requiring intervention.
- Longitudinal diagnostic accuracy following clinical, imaging, surgical, or other definitive follow-up when available.

8. Diagnostic Classification and Adjudication

Index diagnostic yield is classified using strict ATS/ACCP definitions. Cases are independently reviewed by a second pulmonologist who did not participate in the procedure and is blinded to ventilation assignment and tool-lesion position. Inter-rater agreement is assessed using Cohen's kappa. Discordant classifications undergo consensus review, with third-reviewer adjudication if consensus cannot be reached.

9. Follow-up

Nondiagnostic cases are followed through available clinical records, subsequent imaging, repeat biopsy, surgery, or other definitive diagnostic procedures. Follow-up is used to determine final clinical outcome and

longitudinal diagnostic accuracy without retrospectively reclassifying an initially nondiagnostic index procedure as diagnostic.

10. Statistical Analysis and Sample Size

Continuous variables will be summarized as mean $\pm$ SD or median, as appropriate, and categorical variables as counts and percentages. Baseline balance between randomized groups will be assessed using absolute standardized mean differences without significance testing. Procedural and radiation variables will be compared using the Mann-Whitney U test, and categorical outcomes using Fisher's exact or Pearson chi-square tests, as appropriate. Binary treatment effects will be reported as odds ratios with 95% confidence intervals. Missing data will not be imputed; analyses will use available observations. All analyses will be two-sided.

The study uses a pragmatic sample size based on consecutive enrollment during the prespecified study period; no formal a priori sample-size calculation is planned. Study aim for :120 patients.

11. Risks and Safety

Breath-hold is a ventilation maneuver used during routine bronchoscopic imaging and may be used during tissue acquisition at the procedural physician's discretion. Potential physiologic effects include transient changes in oxygenation, carbon dioxide, and hemodynamics. The anesthesiology and procedural teams may terminate a breath-hold at any time if clinically indicated. Standard procedural risks of robotic bronchoscopy and lung biopsy remain unchanged and include bleeding and pneumothorax. No additional risks to patients have been noticed though breath holds are routinely done during lung biopsies over the years, but this study challenges to see if this practice is useful in its regard at all.

12. Potential Benefits

Participants may not receive direct benefit from study participation. The study may determine whether sustained breath-hold improves diagnostic performance or tool-lesion stability and may inform future ventilation strategies during robotic bronchoscopy.

13. IRB Approval and Informed Consent

The study will be conducted under approval of the appropriate WVU Institutional Review Board. Written informed consent will be obtained before enrollment and prior to bronchoscopy. Breath-hold is a routinely used ventilatory maneuver during bronchoscopic procedures; the study evaluates its standardized use during tissue acquisition within an otherwise standard-of-care robotic bronchoscopy workflow and is not expected to materially increase procedural risk.

14. Confidentiality and Data Management

Study data will be maintained in accordance with institutional privacy and research requirements. Analytic datasets will use coded or deidentified study identifiers whenever into RedCap. Access to identifiable information will be limited to principal investigator only.

15. Study Site

WVU Medicine Camden Clark Medical Center, Parkersburg, West Virginia, USA.