A validation study of multi-sections continuum robot for transbronchial lung biopsy

Lenny Dupourqué
National Center for Image-Guided Therapy (NCIGT), Brigham and Women’s Hospital (BWH) - Harvard Medical School (HMS)

Contexte
- Lung cancer has the highest mortality rate and is the leading cause of cancer-related death in the United States. An outstanding issue in lung cancer management is delay in initial cancer diagnosis.
- To potentially decrease the delay, recent progress in low-dose computed tomography has made it possible to detect pulmonary nodules at an earlier stage and at a smaller size. Then, to diagnose whether the nodule is benign or malignant, a biopsy is required to collect tissue samples of the suspicious nodule.
- However, small pulmonary nodules are mostly located in the upper lobes and in the peripheral areas of the lung, making it difficult to access using a transbronchial biopsy procedure.

Issues & Challenges
- Current manual transbronchial biopsy procedure is characterized by a bronchoscope and a manual catheter extended from the bronchoscope to reach distal areas of the lung.
- Manual catheter lacks steering ability. To control it, the physician has to rely on the wall of the lung, thus making the navigation in the peripheral areas of the lung difficult.
- Diagnostic yield of current manual transbronchial biopsy for nodules in the peripheral areas of the lung vary between 59% and 73%. Resulting in the use of a more invasive approach in certain cases, therefore leading to some potential medical complications.

Potential Solution & Hypothesis
- Researchers have proposed robotic catheter, using multi-section continuum robot and enhanced with FTL motion, as a potential alternative to manual catheter.
- To compare the performance of the manual catheter and the robotic catheter to reach peripheral areas of the lung, the deviation from the center line in 3 areas of a planar phantom, and the force applied to the wall of the phantom, as metrics for maneuverability, for both catheters were measured.

Results
- In average, the robotic catheter deviated 0.94 mm (SD=0.50mm) while the manual catheter deviated 1.86 mm (SD=0.74mm) (p<0.01). In average, the force applied to the wall was 0.13 N (SD=0.11 N) for the robotic catheter whereas 0.94 N (SD=0.30 N) for the manual catheter (p<0.01).

Conclusion
- The study demonstrated an improvement of the maneuverability of the robotic catheter. This indicate a greater ability to reach peripheral area of the lung, therefore a potential increase of the diagnostic yield. Moreover, a decrease of the force applied to the wall also indicates a potential safer medical procedure.

Supervisors:
- Professor Nobuhiko Hata, BWH/HMS
- Professor Selman Sakar, EPFL

Acknowledgments:
- Fumitaro Masaki, Takahisa Kato, Canon Healthcare Optics Laboratory

September 2018