

Topic	Article Title	Objective	Author	Institution	Journal	Prospective or Retrospective	# of Patients	Summary Statistics
Diagnostic Safety & Efficacy - Yield	Electromagnetic Navigation during Flexible Bronchoscopy	Practicality, accuracy and safety of real-time electromagnetic navigation together with previous acquired CT images in an Animal study	Schwarz Y Mehta A, Ernst A, Herth F, Engele A, Besser D, Becker H.	<ul style="list-style-type: none"> TASMC, Israel. CCF, OH. BID, Boston. Thoraxklinik, Germany. Rambam Medical Center, Israel. 	Respiration 2003 Electromagnetic Navigation during Flexible Bronchoscopy Schwarz, Y.; Mehta, A.C.; Ernst, A.; Herth, F.; Engel, A.; Besser, D.; Becker, H.D. Respiration 2003;70:516-522	Prospective	4 animals	<ul style="list-style-type: none"> Feasible Registration accuracy (AFTRE) 4.5 mm No adverse effects
	Bronchoscopic Biopsy of Peripheral Lung Lesions Under Electromagnetic Guidance	Use of Electromagnetic Navigation in obtaining biopsies with isolated peripheral lung lesions	Becker H, Herth F, Ernst A, Schwarz Y.	<ul style="list-style-type: none"> Heidelberg, Germany; TASMC, Israel. 	Journal of Bronchology 2005 Bronchoscopic Biopsy of Peripheral Lung Lesions Under Electromagnetic Guidance. Heinrich D Becker, MD; Felix Herth, MD; Armin Ernst, MD; Yehuda Schwarz, MD; J of Bronchology; January 2005, Volume 12, Issue 1	Retrospective	30 patients	<ul style="list-style-type: none"> Registration accuracy (AFTRE) 3 mm Diagnostic Yield = 69% No serious complications related to the use of the device
	Innovative Bronchoscopic Diagnostic Techniques: Endobronchial Ultrasound and Electromagnetic Navigation	A review of recent studies that utilize endobronchial ultrasound and electromagnetic navigation and guidance.	Herth F, Ernst A	<ul style="list-style-type: none"> Beth Israel Deaconess, Harvard Thoraxklinik, Germany. 	Current Opinion in Pulmonary Medicine 2005 Innovative Bronchoscopic Diagnostic Techniques: Endobronchial Ultrasound and Electromagnetic Navigation Herth F., Ernst, A., Cancer; Curr Opin Pulm Med 11:278-281.	Review Article	N/A	<ul style="list-style-type: none"> Referenced studies from Dr Yehuda Schwarz and Dr. Heinrich Becker
	Electromagnetic Navigation Diagnostic Bronchoscopy: A Prospective Study	A prospective, open label, single-center study to determine the ability of electromagnetic navigation bronchoscopy to sample peripheral lung lesions and mediastinal lymph nodes with standard bronchoscopic instruments and demonstrate safety.	Gildea T, Mazzone P, Karnak D, Meziane M, Mehta A.	<ul style="list-style-type: none"> CCF, Ohio. Ankara University School of Medicine, Turkey. 	Am J. of Respiratory Critical Care Medicine 2006 Electromagnetic Navigation Diagnostic Bronchoscopy: A Prospective Study; Thomas R. Gildea, Peter J. Mazzone, Demet Karnak, Moulay Meziane, and Atul C. Mehta Am. J. Respir. Crit. Care Med. 174: 982-989.	Prospective	60 patients	<ul style="list-style-type: none"> Diagnostic Yield = 74% Peripheral Lesions; Diagnostic Yield =100% Lymph Nodes 57% of lesions were <2cm in diameter.
	Real-Time Electromagnetic Navigation Bronchoscopy to Peripheral Lung Lesions Using Overlaid CT Images: The First Human Study	Feasibility, accuracy and safety of the superDimension system in navigating to previously unreachable peripheral lung lesions and obtaining biopsy specimens.	Schwarz Y, Greif Y, Becker H, Ernst A, Mehta A.	<ul style="list-style-type: none"> TASMC, Israel. Thoraxklinik, Germany. BID, Boston. CCF, OH. 	CHEST 2006 Real-Time Electromagnetic Navigation Bronchoscopy to Peripheral Lung Lesions Using Overlaid CT Images: The First Human Study Yehuda Schwarz, Joel Greif, Heinrich D. Becker, Armin Ernst, and Atul Mehta; Chest, Apr 2006; 129: 988 - 994.	Prospective	13 patients	<ul style="list-style-type: none"> Diagnostic Yield = 69% No complications
	Multimodality Bronchoscopic Diagnosis of Peripheral Lung Lesions: A randomized controlled trial	Electromagnetic navigation success is high and can be verified by EBUS for higher yield	Eberhardt, R. Anantham, D. Ernst, A Feller-Kopman, D. Herth, F.	<ul style="list-style-type: none"> Beth Israel Deaconess, Harvard Thoraxklinik, Germany. 	American Journal of Respiratory and Critical Care Medicine 2007 Multimodality Bronchoscopic Diagnosis of Peripheral Lung Lesions: A Randomized Controlled Trial Ralf Eberhardt, Devanand Anantham, Armin Ernst, David Feller-Kopman, and Felix Herth ;Am. J. Respir. Crit. Care Med. 176: 36-41.	Prospective	120 patients	<ul style="list-style-type: none"> Positive biopsies obtained from: 27/39 (69%) in EBUS group 23/39 (59%) in EMN group 35/40 (88%) in EBUS+EMN group Yield was independent of lesion size or lobar distribution
	Electromagnetic navigation diagnostic bronchoscopy for small peripheral lung lesions	Prospective evaluation of diagnostic yield and safety of Electromagnetic navigation for small peripheral lung lesions with patients unsuitable for surgery or CT guided needle biopsy	Makris, D. Scherpereel, A. Leroy, S. Ramon, P. Marquette, C.H.	<ul style="list-style-type: none"> University of Lille, France 	European Respiratory Journal 2007 Electromagnetic navigation diagnostic bronchoscopy for small peripheral lung lesions D. Makris, A. Scherpereel, S. Leroy, B. Bouchindhomme, J-B. Faivre, J. Remy, P. Ramon, and C-H. Marquette; Eur. Respir. J., Jun 2007; 29: 1187 - 1192.	Prospective	40 patients	<ul style="list-style-type: none"> Yield = 62.5% 77.2% when divergence ≤ 4 mm
	Electromagnetic Navigation Diagnostic Bronchoscopy in Peripheral Lung Lesions	Electromagnetic Navigation with biopsy has enhanced the yield of flexible bronchoscopy in the diagnosis of peripheral lung lesions. Fluoroscopy may be redundant.	Eberhardt, R. Anantham, D. Herth, F. Feller-Kopman, D. Ernst, A	<ul style="list-style-type: none"> Beth Israel Deaconess, Harvard Thoraxklinik, Germany. 	CHEST 2007 Electromagnetic Navigation Diagnostic Bronchoscopy in Peripheral Lung Lesions; Ralf Eberhardt, Devanand Anantham, Felix Herth, David Feller-Kopman, and Armin Ernst. <i>Chest</i> Jun 2007: 1800-1805.	Prospective	89 patients	<ul style="list-style-type: none"> Positive biopsies obtained for 62 of 92 (67%) lung lesions 88% of positive biopsies obtained for lesions at RML location. Procedure Time 16 to 45 min.
	Advances in Bronchoscopic Diagnosis of Lung Cancer	A review of recent studies that utilize endobronchial ultrasound and electromagnetic navigation and guidance.	Shulman, L. Ost, D.	<ul style="list-style-type: none"> New York University School of Medicine 	Current Opinion in Pulmonary Medicine 2007 Advances in Bronchoscopic Diagnosis of Lung. Shulman, L, Ost D., Cancer; Curr Opin Pulm Med 13:271-277.	Review Article	N/A.	<ul style="list-style-type: none"> Sensitivity summarized from 3 articles 69% to 100%

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	Improved Diagnostic Yield of Bronchoscopy in a Community Practice: Combination of Electromagnetic Navigation System and Rapid on-Site Evaluation	Determine the percentage of patients that had a malignant diagnosis or a plausible non-malignant diagnosis on the day of the procedure.	Wilson, D.	<ul style="list-style-type: none"> Columbus Regional Hospital 	Journal of Bronchology 2007 Improved Diagnostic Yield of Bronchoscopy in a Community Based Hospital: Combination of Electromagnetic Navigation System and Rapid On-Site Evaluation . Wilson, David; Journal of Bronchology, Oct. 2007;14 (4):227-232.	Retrospective	248 patients	<ul style="list-style-type: none"> EMN success of 95% peripheral lesions; 94.3% lymph nodes. On the day of the procedure, 65% of patients received a definitive malignant or plausible non-malignant diagnosis. With follow up – another 5% confirmed as non-malignant
	Electromagnetic Navigational Bronchoscopy: A Surgeon's Perspective	Description of the experience Mount Sinai Medical Center gained with navigational bronchoscopy using electromagnetic guidance to successfully biopsy peripheral lung lesions, place fiducial catheters to aid stereotactic radiotherapy, and to biopsy mediastinal lymph nodes in the staging of lung cancer.	Todd S. Weiser, Kevin Hyman, Jaime Yun, Virginia Litle, Cythinia Chin, Scott J. Swanson.	<ul style="list-style-type: none"> Department of Cardiothoracic Surgery, Mount Sinai Medical Center, New York, New York. 	Ann Thorac Surg 2008 Electromagnetic Navigational Bronchoscopy: A Surgeon's Perspective. Todd S. Weiser, Kevin Hyman, Jaime Yun, Virginia Litle, Cythinia Chin, and Scott J. Swanson. Ann Thorac Surg 2008;85:S797– 801.	Retrospective	9 cases: 4 peripheral lung nodules and 5 mediastinal or hilar node.	<ul style="list-style-type: none"> In 6 out of 9 (66.7%) ENB was successful. 2/3 (66.7%) of the <u>mediastinal lymph node</u> biopsies were diagnostic. 4/5 (80%) of all lymph nodes biopsied were diagnostic. 2/4 (50%) of the lesions biopsied were diagnostic.
	Electromagnetic Navigation Bronchoscopy in Combination with PET-CT and Rapid On-site Cytopathologic Examination for Diagnosis of Peripheral Lung Lesions	To determine the accuracy and safety of ENB in combination with PET-CT and ROSE in subjects with endobronchially invisible peripheral lung lesions.	Bernd Lamprecht, B Porsch, P Pirich, C Studnicka, M	<ul style="list-style-type: none"> Paracclsus Medical University Hospital, Salzburg. Austria 	LUNG 2009 Electromagnetic Navigation Bronchoscopy in Combination with PET-CT and Rapid On-site Cytopathologic Examination for Diagnosis of Peripheral Lung Lesions Bernd Lamprecht, Peter Porsch, Christian Pirich, and Michael Studnicka, LUNG 2009; 1877:55-59	Prospective	13 patients	<ul style="list-style-type: none"> ENS in combination with PET-CT and ROSE is safe and effective in the diagnostic workup of peripheral lung lesions 76.9% Yield No adverse events. “In a small peripheral lung lesion a diagnostic yield of 77% is an excellent result.”
	Accuracy and Feasibility of Electromagnetic Navigated Bronchoscopy under Nitrous Oxide Sedation for Pulmonary Peripheral Opacities: An Outpatient Study	To evaluate the accuracy and the feasibility of ENB under local anesthesia and nitrous oxide/oxygen inhalation as unique sedation in outpatients.	Bertoletti, Laurent Robert, Aurélie Cottier, Michèle Chambonniere, Marie L. Vergnon, Jean-Michel	<ul style="list-style-type: none"> Hôpital Nord, University Hospital of St Etienne & Université Jean Monnet 	Respiration 2009 Accuracy and Feasibility of Electromagnetic Navigated Bronchoscopy under Nitrous Oxide Sedation for Pulmonary Peripheral Opacities: An Outpatient Study. Bertoletti, Laurent, Robert, Aurélie Cottier, Michèle, Chambonniere, Marie L. Vergnon, Jean-Michel	Prospective	54 patients	<ul style="list-style-type: none"> Diagnostic success rates was 71.4% with median tumor size of 28mm All patients but 1 were dismissed 1-hour after procedure & tolerance of procedure was excellent. No anesthesiologist present 4% pneumothorax; 1 requiring a chest tube Good tolerance and outpatient strategy
	Comparison of Suction Catheter versus Forceps Biopsy for Sampling Solitary Pulmonary Nodules Guided by Electromagnetic Navigational Bronchoscopy.	To evaluate the performance of two different biopsy tools, i.e. catheter aspiration and forceps biopsy in the diagnosis of small pulmonary nodules guided by electromagnetic navigational bronchoscopy.	Eberhardt, Ralf Morgan, Ross Ernst, Armin Beyer, Thomas Herth, Felix	<ul style="list-style-type: none"> Thoraxklinik, University of Heidelberg, Heidelberg, Germany Beth Israel Deaconess Medical Center, Boston, MA Lungenklinik Ballenstedt, Ballenstedt, Germany 	Respiration 2009 Comparison of Suction Catheter versus Forceps Biopsy for Sampling Solitary Pulmonary Nodules Guided by Electromagnetic Navigational Bronchoscopy. Berhardt, Ralf, Morgan, Ross, Ernst, Armin, Beyer, Thomas, Herth, Felix	Prospective	54 patients	<ul style="list-style-type: none"> 55 SPNs were sampled with both techniques EBUS was used to verify accuracy of target lesion localization by ENB 75.5% overall diagnostic yield independent of lesion size, location or technical parameters Catheter aspiration was positively correlated with success rate Diagnostic yield = 93% when EBUS verified lesion location after ENB navigation and only 48% when lesion was not confirmed.

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	Navigational Bronchoscopy Overview of Technology and Practical Considerations- New Current Procedural Terminology Codes Effective 2010	This article overviews this technology and the current procedural terminology codes that have been created for its use	Edell, Eric Krier-Morrow, Diane	<ul style="list-style-type: none"> Mayo Clinic, Rochester MN Diane Krier-Morrow & Associates Inc, Evanston IL 	CHEST 2010 Navigational Bronchoscopy Overview of Technology and Practical Considerations- New Current Procedural Terminology Codes Effective 2010 Eric Edell, Diane Krier-Morrow; CHEST 2010;137(2):450-454	Topics in Practice Management	NA	<ul style="list-style-type: none"> Summarized reported clinical data of ENB experience on a total of about 600 patients Conclusion; The technology has potential to improve the diagnostic yield of transbronchial biopsies and may be useful in the early diagnosis of lung cancer
New Technique	Endobronchial Ultrasound and/or superDimension Bronchoscopic Placement of Fiducial Markers in Malignant Mediastinal Lymph Nodes and Lung Cancers: A Novel Approach for Highly Selective External Beam Radiation Therapy	Gold marker fiducials can be placed via the superD system to improve e-beam treatment	McLemore T.L.	<ul style="list-style-type: none"> Paris, TX 	World Congress of Bronchology 2006 Endobronchial Ultrasound and/or superDimension Bronchoscopic Placement of Fiducial Markers in Malignant Mediastinal Lymph Nodes and Lung Cancers; McLemore, Liming, Ochrans, Grizzle, Kerley; 14 th World Congress of Bronchology; June 2006; 57-62.	Prospective	20 patients	<ul style="list-style-type: none"> All markers were implanted successfully and remained in place even when the lesion/lymph node diminished in size after radiation therapy Safe & Accurate Method
	Implantation and Stability of Metallic Fiducials Within Pulmonary Lesions	Transbronchial marker placement is less invasive than transcutaneous placement. Transcutaneous placement is associated with high pneumothorax rates.	Kupelian, P Forbes, A Willoughby, T Wallace, K Mañon, R Meeks, S Herrera, L Johnston, A Herran, J	<ul style="list-style-type: none"> M. D. Anderson Cancer Center Orlando, Orlando, FL Florida State University College of Medicine, Tallahassee, FL 	International Journal of Radiation Oncology (Red Journal) 2007 Implantation and Stability of Metallic Fiducials within Pulmonary Lesions Patrick A. Kupelian, Alan Forbes, Twyla R. Willoughby, Karen Wallace, Rafael R. Mañon, Sanford L. Meeks, Luis Herrera, Alan Johnston, Juan J. Herran. Int. J. Radiation Oncology Biol. Phys. 2007; 69 (3): 777-785.	Prospective	8 superD 15 transcutaneous	<ul style="list-style-type: none"> Lower pneumothorax rate markers stable
	Radiotherapy Monitoring Device Implantation into Peripheral Lung Cancers: A Therapeutic Utility of Electromagnetic Navigational Bronchoscopy	EMN Bronchoscopy is a tool for diagnosis and also supports therapeutic utility for marker placement for radiotherapy or to guide surgical resection.	McGuire F, Kerley M, Ochrans T, Bedekar A, Swafford R, McLemore T.	<ul style="list-style-type: none"> University of South Carolina School of Medicine Paris Regional Cancer Center and Medical Center 	Journal of Bronchology 2007 Radiotherapy Monitoring Device Implantation into Peripheral Lung Cancers: A Therapeutic Utility of Electromagnetic Navigational Bronchoscopy McGuire F, Kerley M, Ochrans T, Bedekar A, Swafford R, McLemore T. Journal of Bronchology. July 2007; 14(3):173-176,	Prospective	N/A	<ul style="list-style-type: none"> feasibility of EMN placement of RMDs into malignant lung nodules
	Electromagnetic navigation bronchoscopy guided fiducial placement for robotic stereotactic radiosurgery of lung tumors -- a feasibility study	EMN Bronchoscopy as a tool for fiducial marker placement to facilitate radiosurgery.	Anantham D, Feller-Kopman D, Shanmugham L, Berman S, DeCamp M, Gangadharan S, Ralf, Eberhardt R, Herth F, Ernst A.	<ul style="list-style-type: none"> Beth Israel Deaconess Medical Center, Harvard Medical School ThoraxKlinik 	CHEST 2007 Electromagnetic navigation bronchoscopy guided fiducial placement for robotic stereotactic radiosurgery of lung tumors -- a feasibility study Anantham D, Feller-Kopman D, Shanmugham L, Berman S, DeCamp M, Gangadharan S, Ralf, Eberhardt R, Herth F, Ernst A. CHEST 2007; 132:930-935	Prospective	9 patients	<ul style="list-style-type: none"> Feasibility of EMN placement of fiducial markers. 89% successful deployment (8 of 9 patients). 7 of 8 with fiducial within tumor (88%).
	Electromagnetically Navigated Brachytherapy as a New Treatment Option for Peripheral Pulmonary Tumors	To describe the principles of navigated brachytherapy for treatment of peripheral non-small cell lung cancer (NSCLC).	Harms, W Krempien, R Grehn, C Hensley, F Debus, J Becker, H	<ul style="list-style-type: none"> Heidelberg, Germany; Thoraxklinik, Germany. 	Strahlentherapie und Onkologie 2006 Electromagnetically Navigated Brachytherapy as a New Treatment Option for Peripheral Pulmonary Tumors Wolfgang Harms, Robert Krempien, Christian Grehn, Frank Hensley, Jürgen Debus, Heinrich D. Becker, Strahlentherapie und Onkologie 2006; 182:108-11	Prospective Feasibility	1	<ul style="list-style-type: none"> Patient tolerated well the ENB catheter and Brachytherapy over 5 days 12 month follow up showed complete remission by histology, partial remission by CT and ultrasound

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	Fiducial Marker Placement Using Endobronchial Ultrasound and Navigational Bronchoscopy for Stereotactic Radiosurgery: An Alternative Strategy	To report the results of Fiducial Marker placement using endobronchial ultrasound (EBUS) and navigational bronchoscopy in 43 patients	Harley, D Krinsky, W Sarkar, S Highfield, D Aygun, C Gurses, B	<ul style="list-style-type: none"> Franklin Square Hospital, Baltimore MD 	Ann Thorac Surg 2010 Fiducial Marker Placement Using Endobronchial Ultrasound and Navigational Bronchoscopy for Stereotactic Radiosurgery: An Alternative Strategy Daniel P Harley, William S. Krinsky, Saiyad Sarkar, Davis Highfield, Cengiz Aygun, Burak Gurses; Ann Thorac Surg 2010; 89:368-74	Prospective	43 Patients	<ul style="list-style-type: none"> ENB was used in 12 patients with peripheral lesions Average of 3.7 FMs per patient were deployed 86.7% FM identified radiologically at SRS planning CT 2 weeks after deployment No clinically significant hemoptysis 1 small pneumothorax (pigtail cath placement) No anesthetic-related complications All patients were able to undergo SRS without additional FM placement or other procedures