






Kliniske metoder i forbindelse med bronkoskopi

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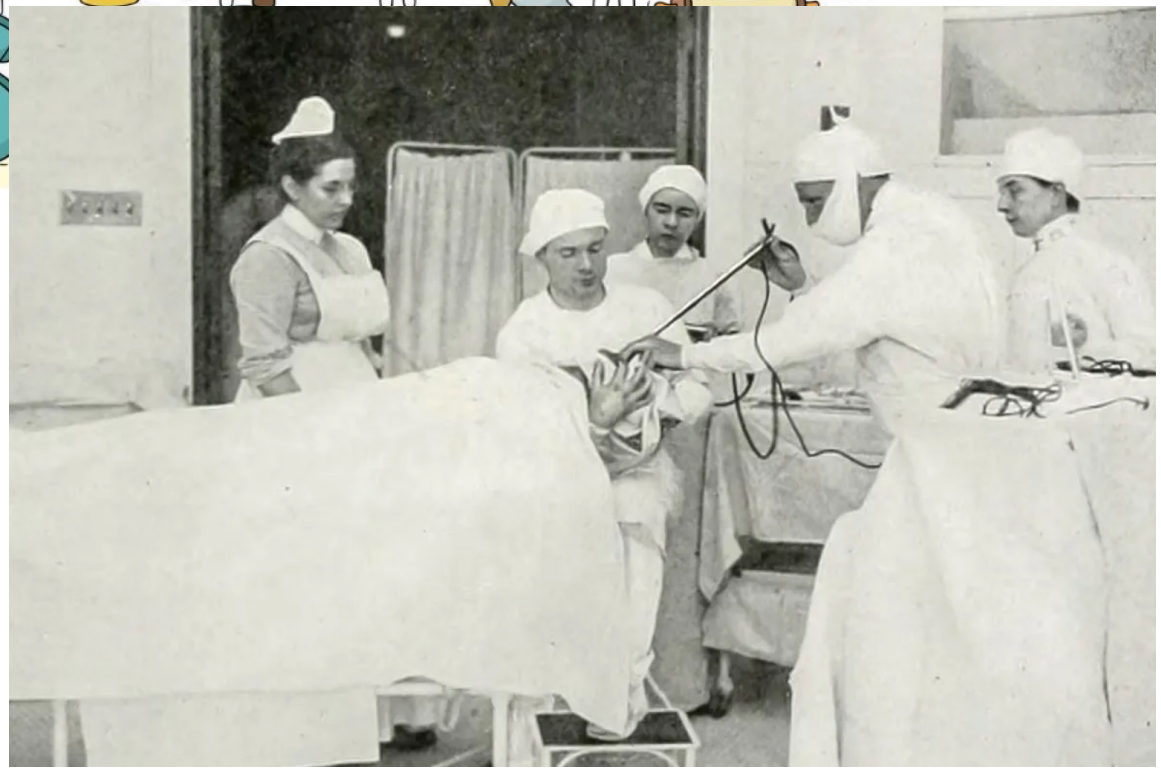
Dansk Cytologi Forenings Årsmøde 1. marts 2024



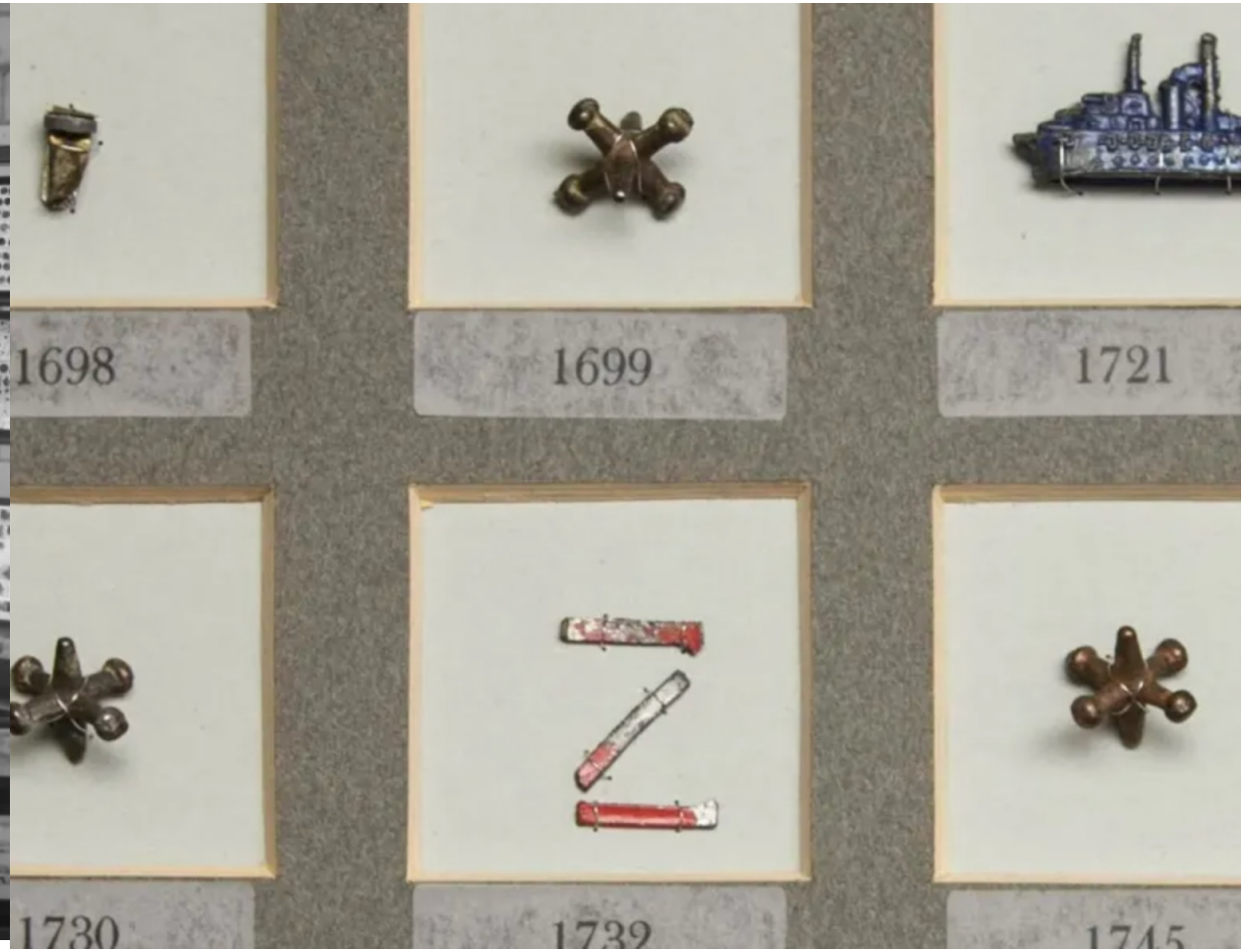
Basal bronkoskopi

Gustav Killian (1876)
Laryngoscope



Chevalier Jackson (1904)
Rigid bronchoscope

Basal bronkoskopi



Basal bronkoskopi

Shigeto Ikeda

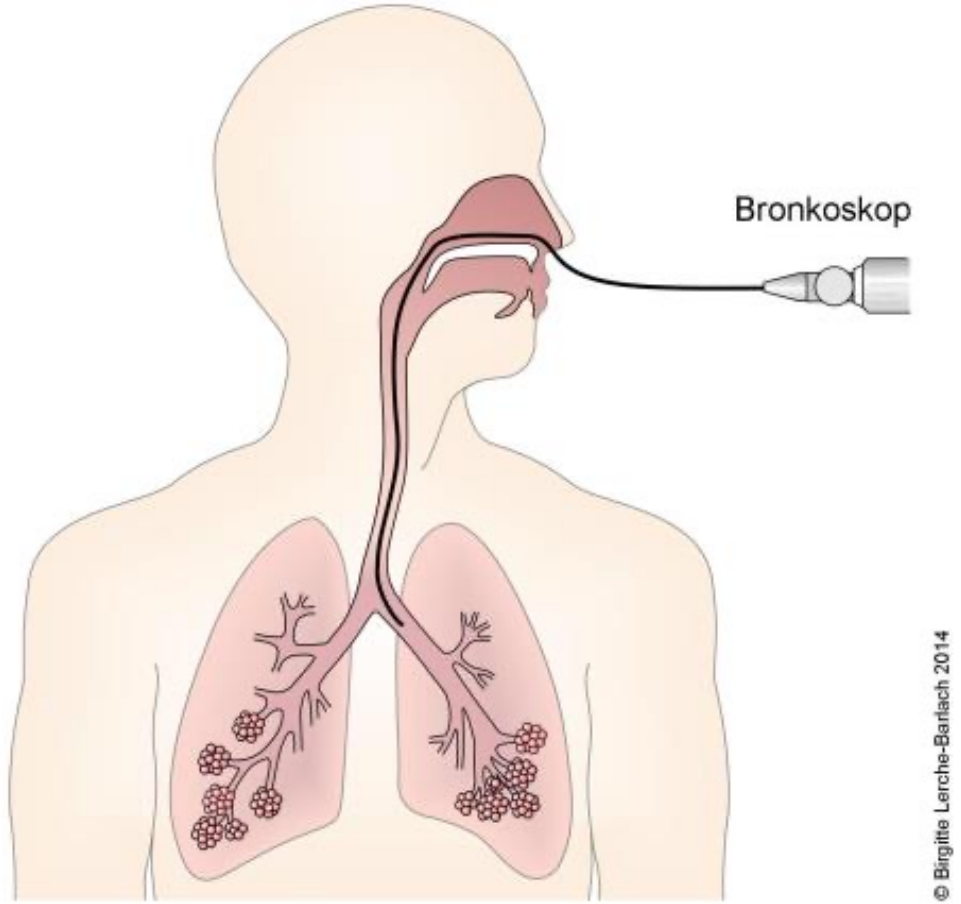
Udviklede det fleksible bronkoskop i 1966
i samarbejde med Machida Med.
(Pentax) og Olympus.

"there is more hope with the bronchoscope"

Basal bronkoskopi

Bronkoskopi

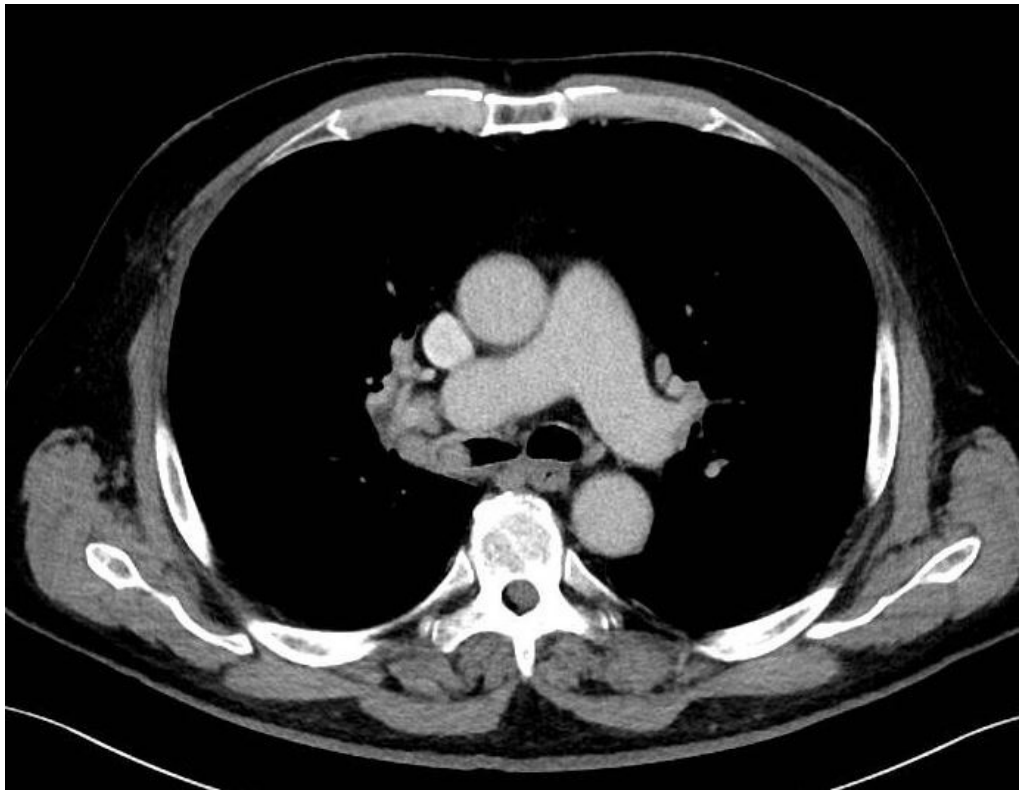
- Diagnosticering af cancer
- Udredning af lungeinfektioner
- Udredning af interstitiel lungesygdom
- Fjerne aspirerede fremmedlegemer
- Fjerne slimpropper



Basal bronkoskopi

Diagnosticering af cancer i central luftvej

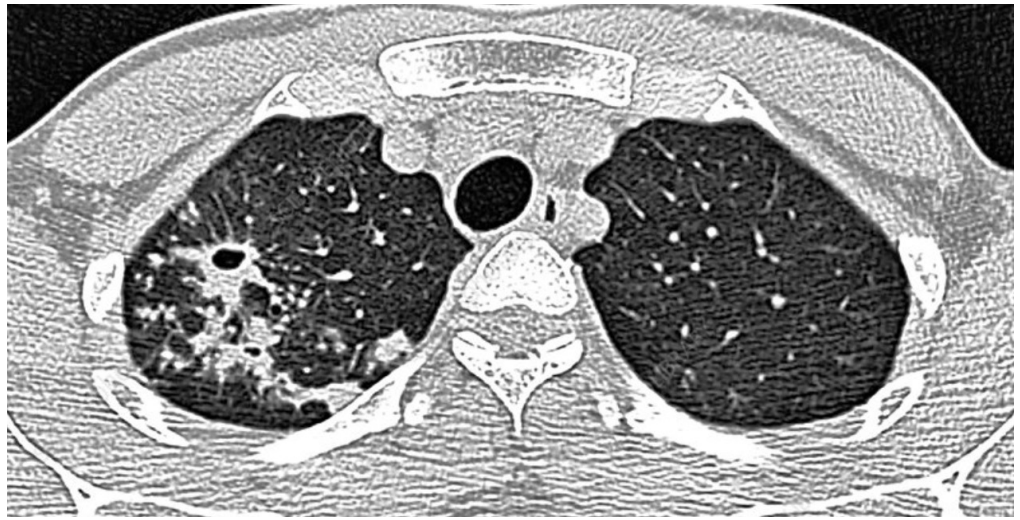
- Tangbiopsi
- Børste biopsi
- Nåleaspiration
- Bronkialskyl
- Cryobiopsi



Basal bronkoskopi

Udredning af lungeinfektion

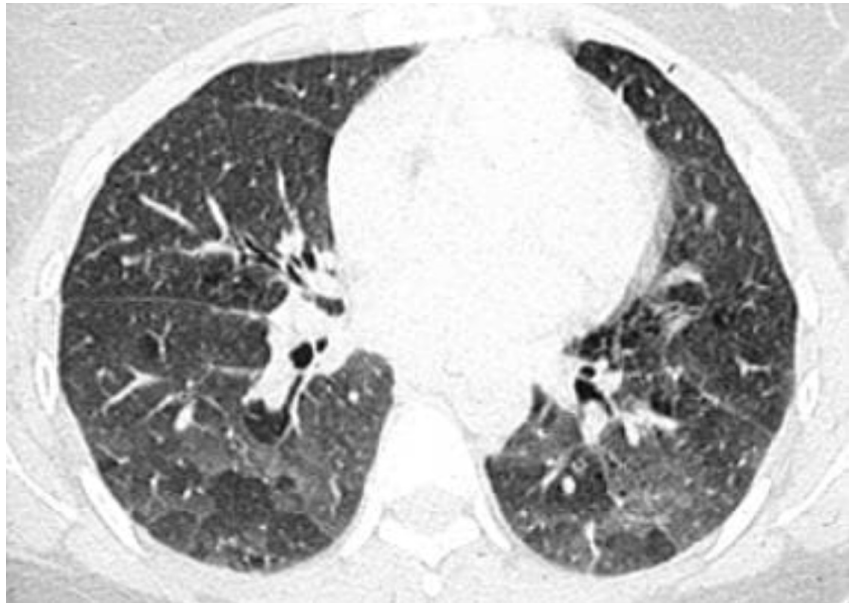
- Bronkial skyl
- Bronchoalveolær lavage

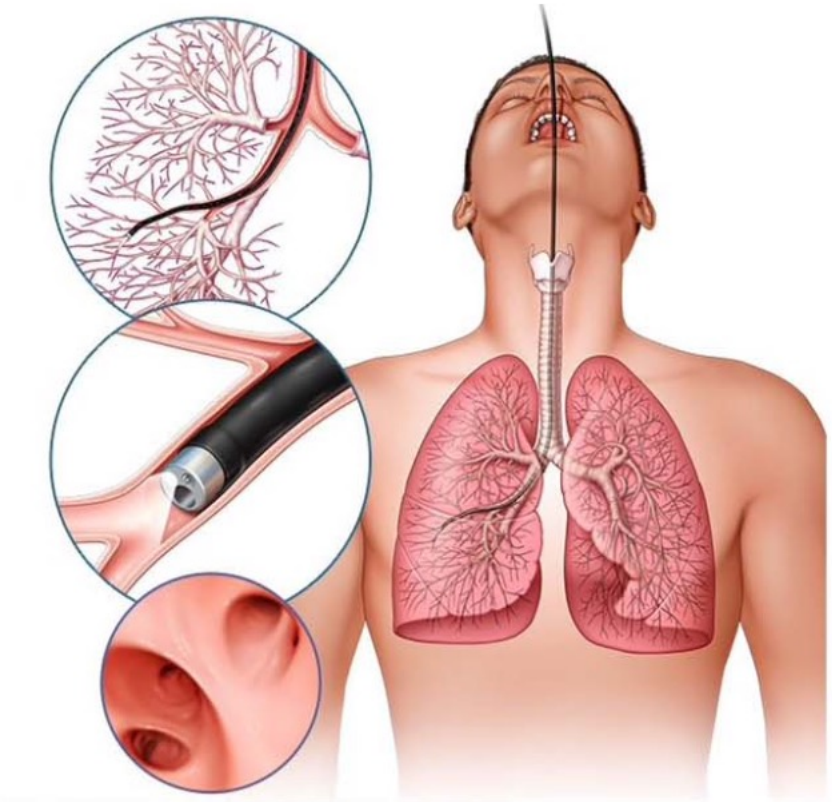


Basal bronkoskopi

Udredning af interstitiel lungesygdom

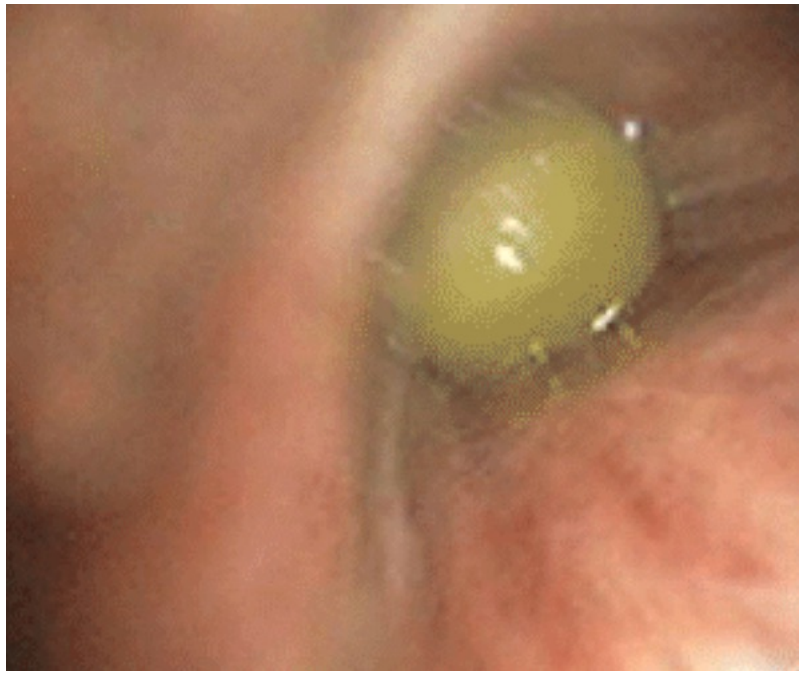
- Bronchoalveolær lavage
- Transbronchiale (cryo)biopsier

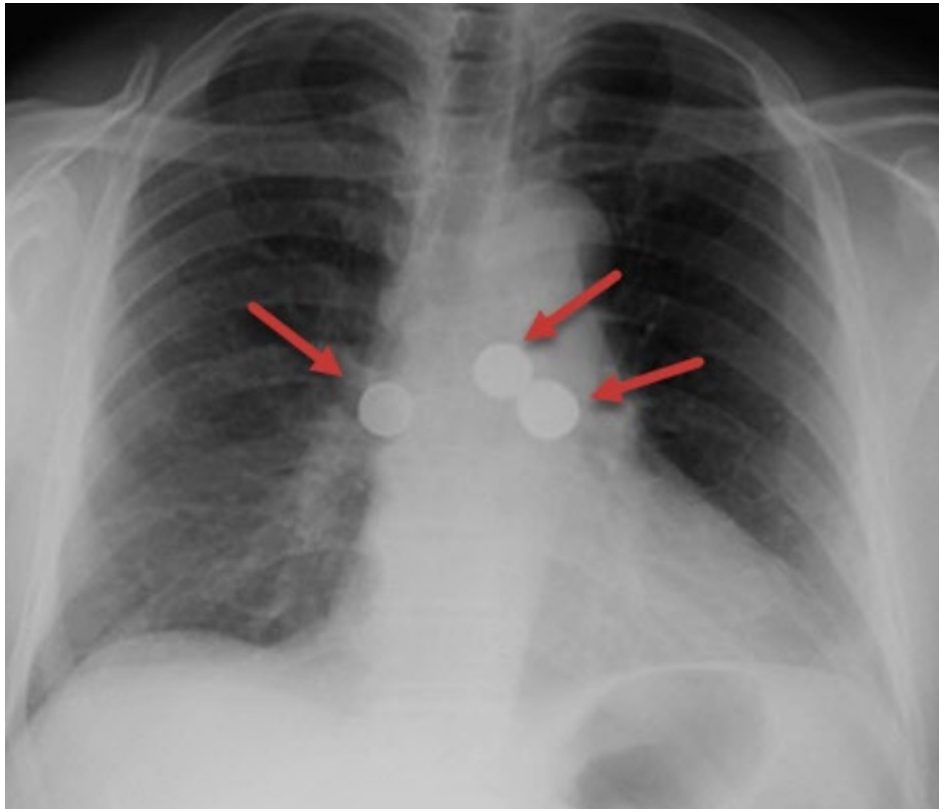




Basal bronkoskopi

Fjernelse af aspirerede fremmedlegemer

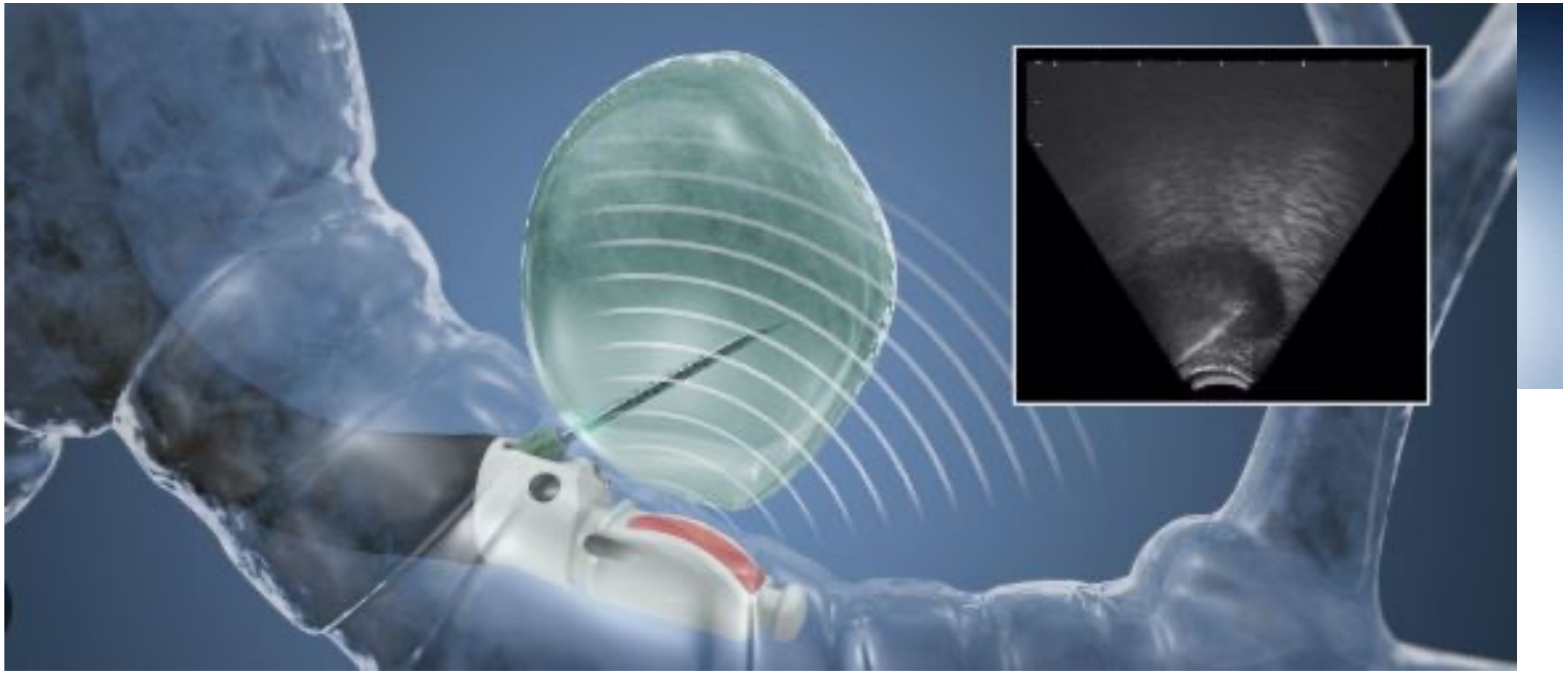




Basal bronkoskopi

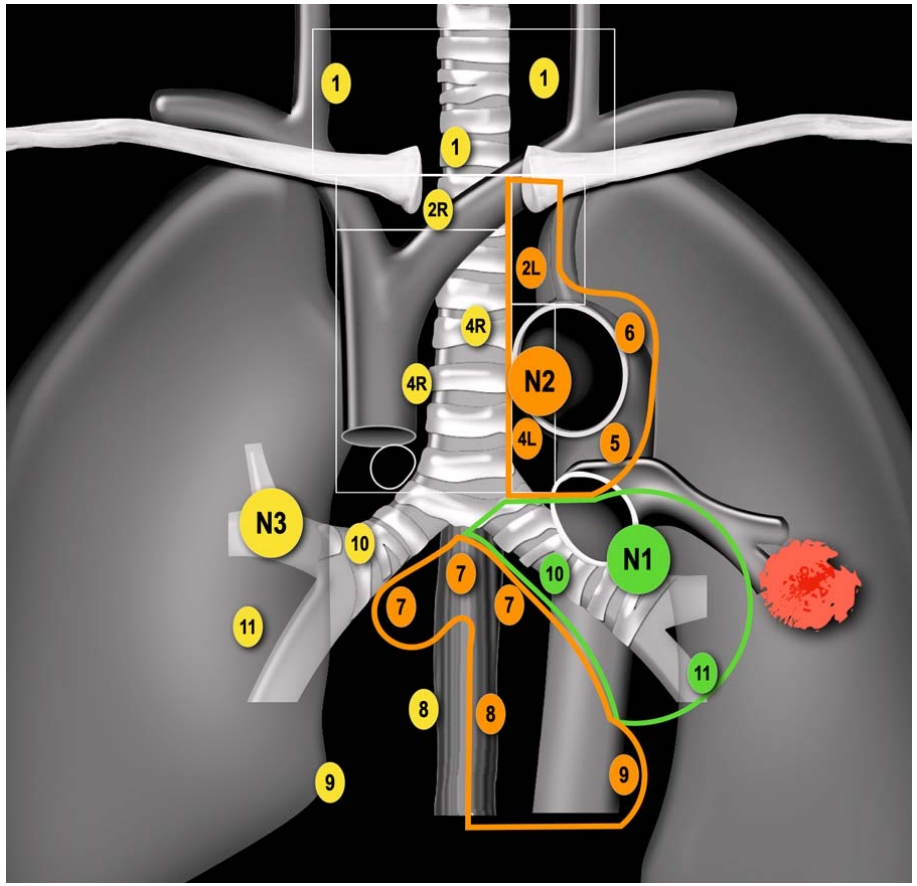
Fjernelse af slimpropper

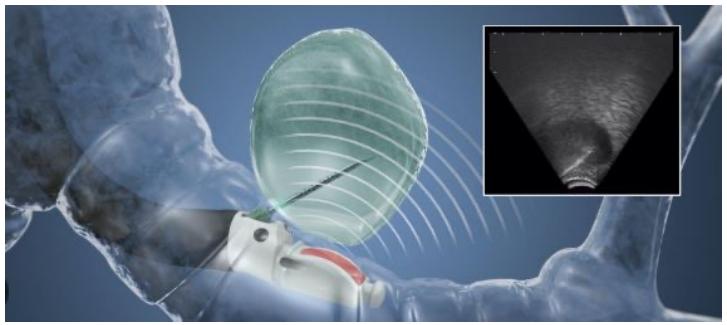
Endobronchial ultrasound (EBUS)



Endobronchial ultrasound (EBUS)

Mediastinal udredning

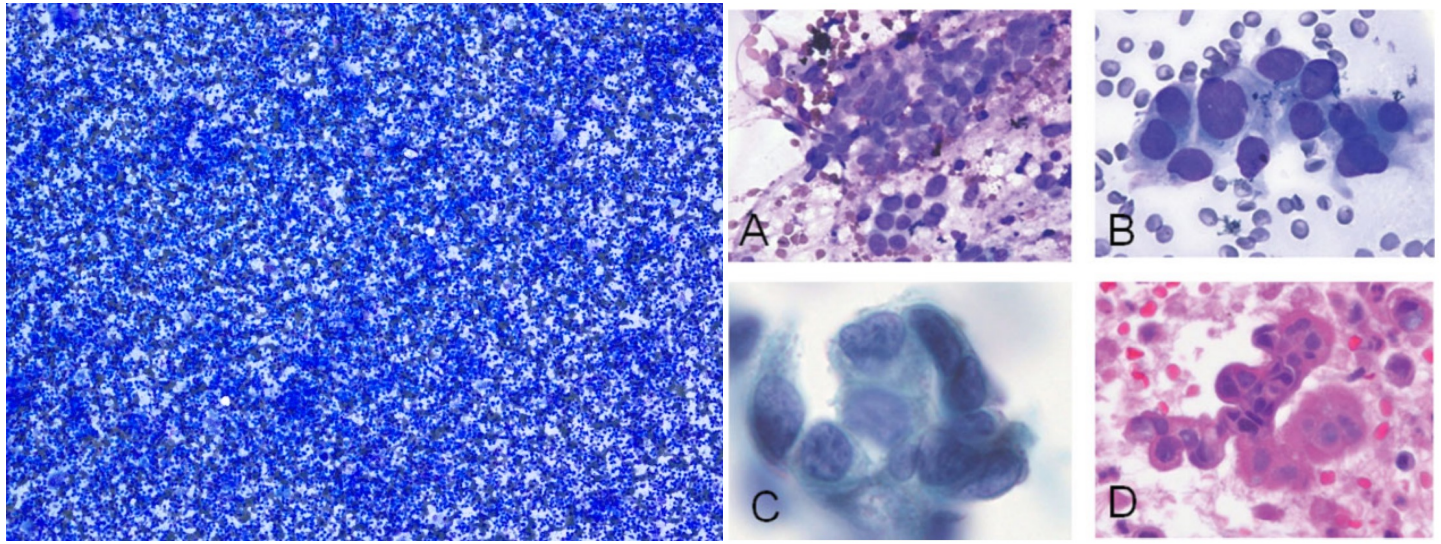




Endobronchial ultrasound (EBUS)

Mediastinal udredning

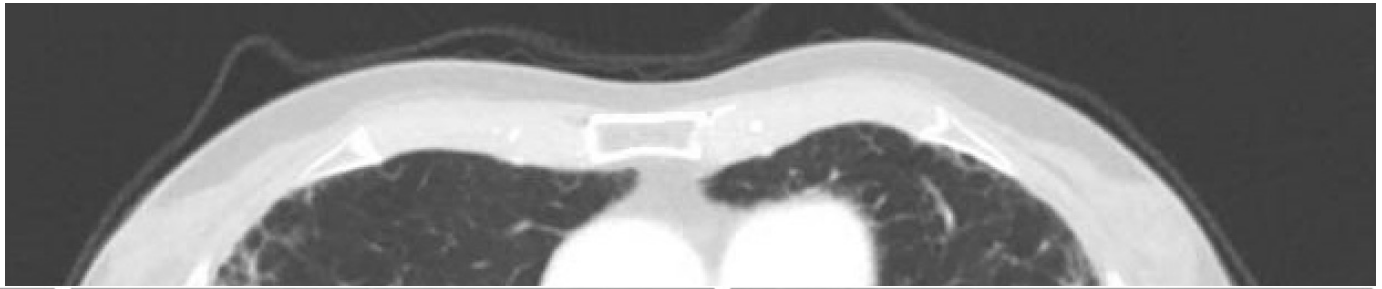
Rapid on-site evaluation

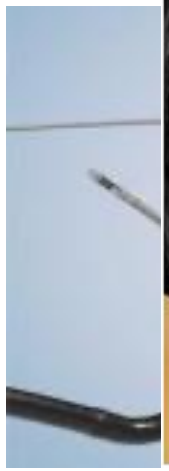


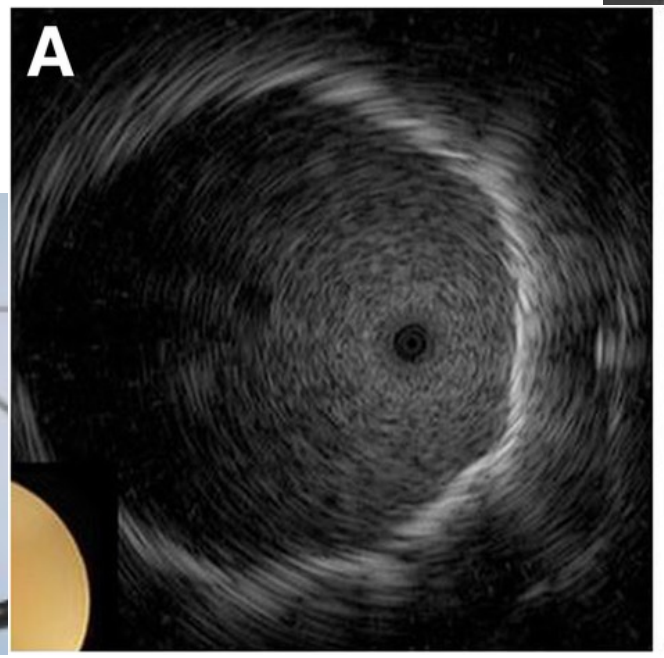
Radial EBUS

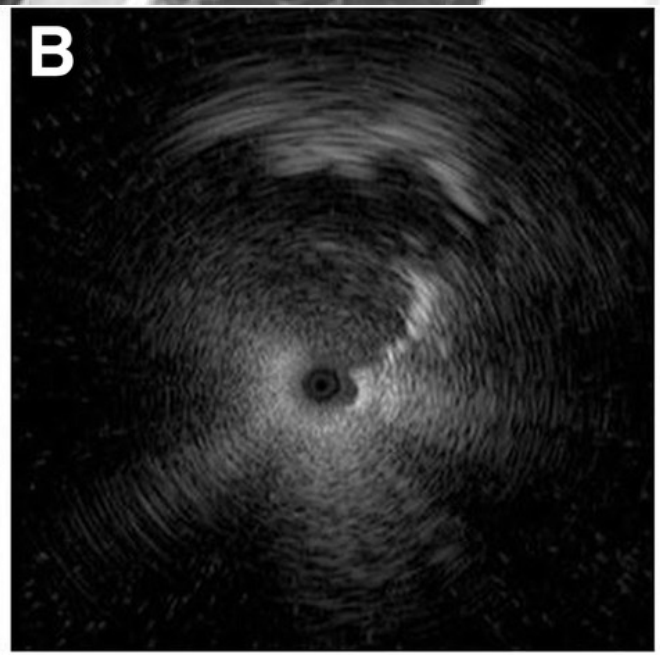
Radial EBUS probe

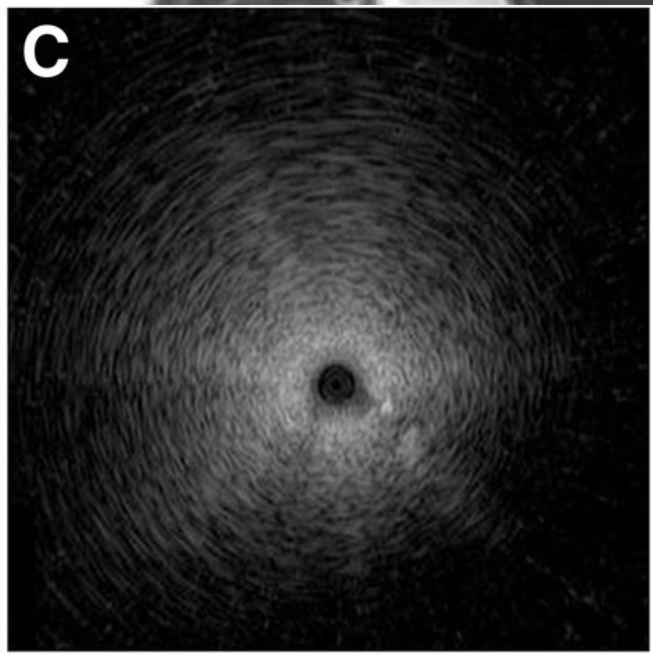
Tynd arbejds-sheat indføres



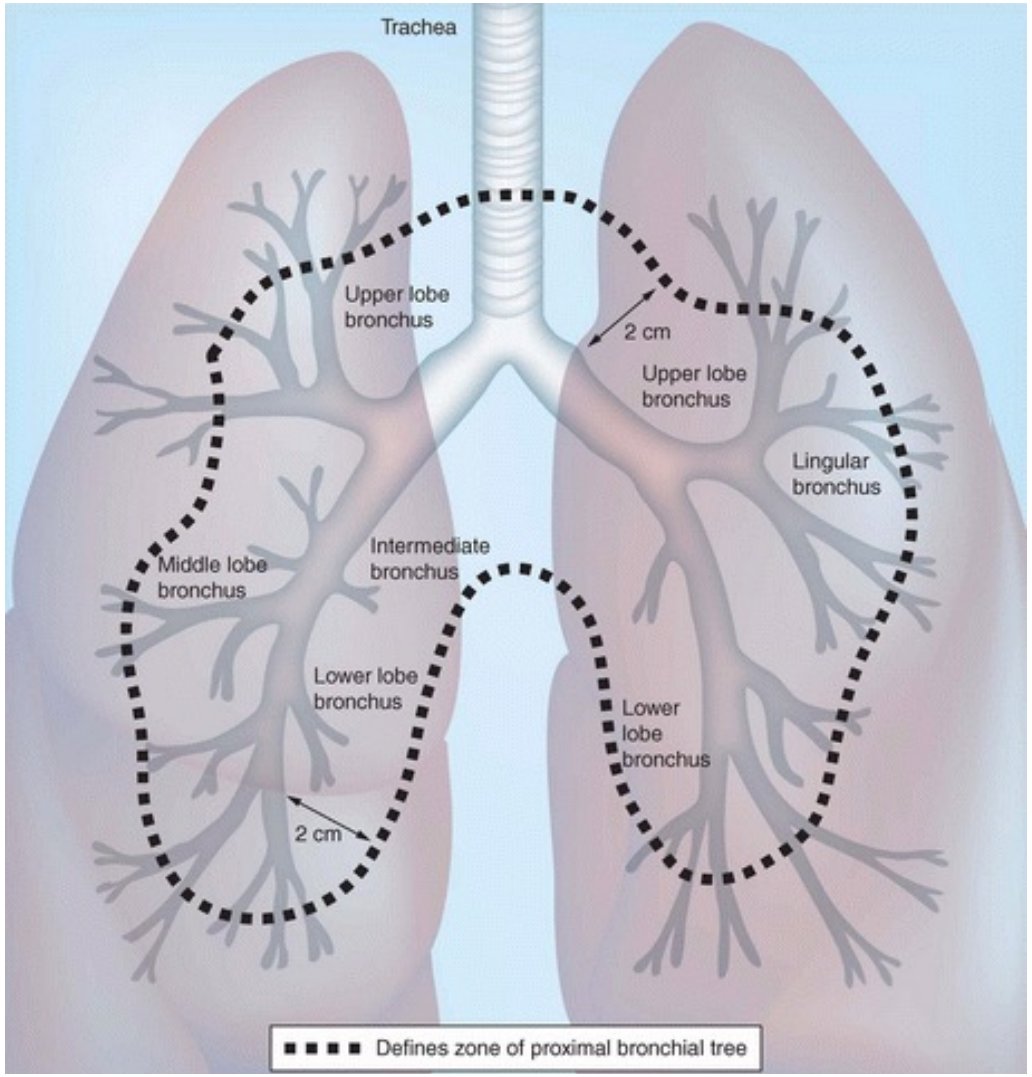








Perifere infiltrater



Perifere infiltrater

- Pneumothorax
- 17-27%[1,2]
- Stærkt afhængig af comorbiditet (KOL) 46% vs. 7%. [1]

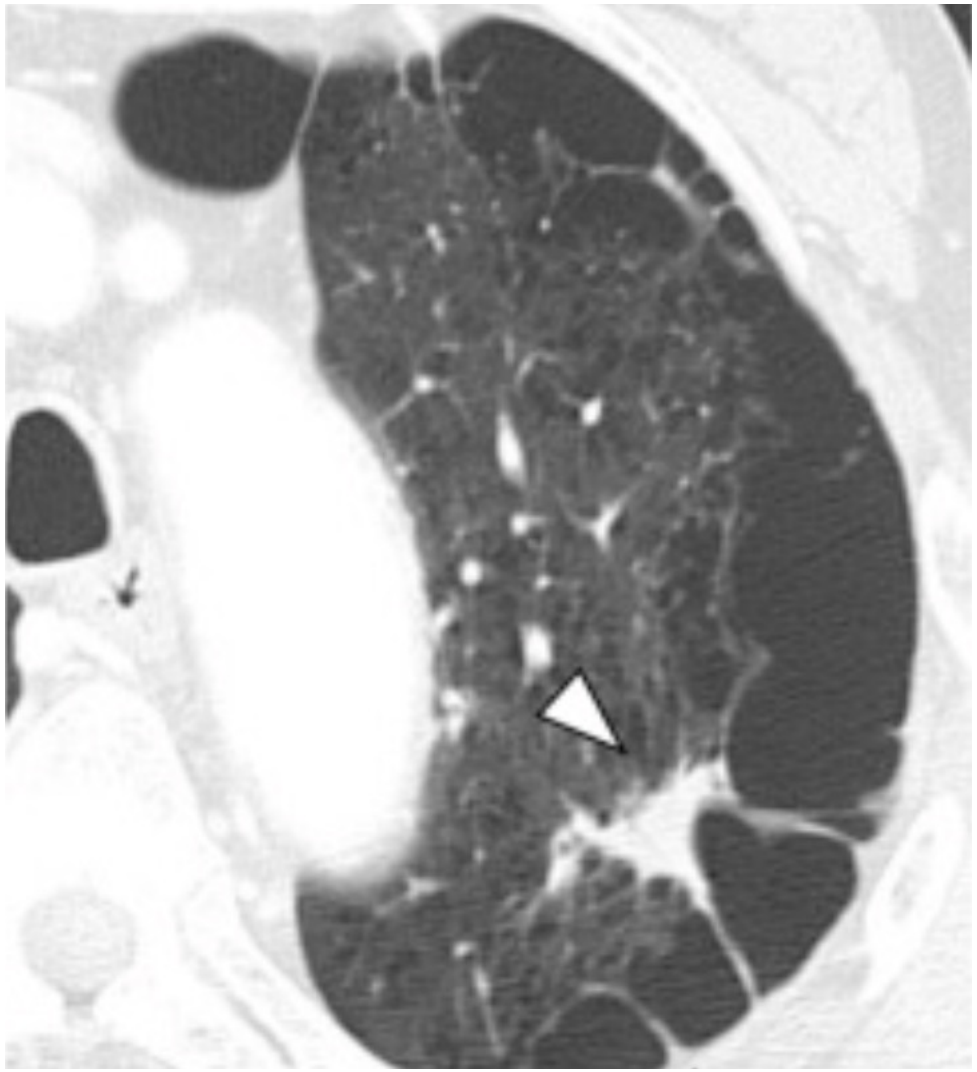
- Blødning
- 4-27% [2]
- Dræn og indlæggelse
- 1-14%[1,2]

1. Covey et al. Vasc Interv Radiol 2004

2. Yeov et al. Chest 2004

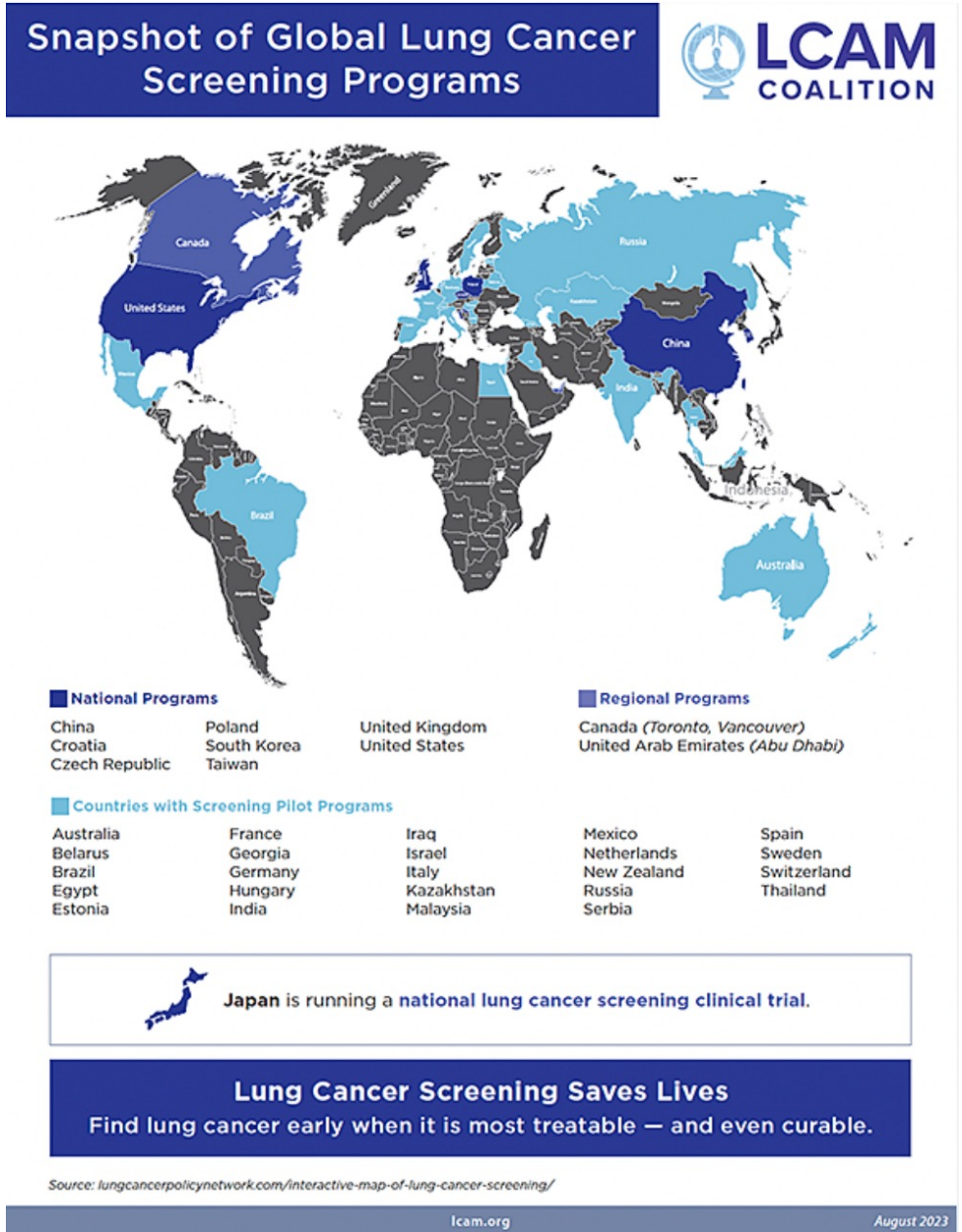
Perifere infiltrater

Transthorakal biopsi ikke mulig



Perifere infiltrater

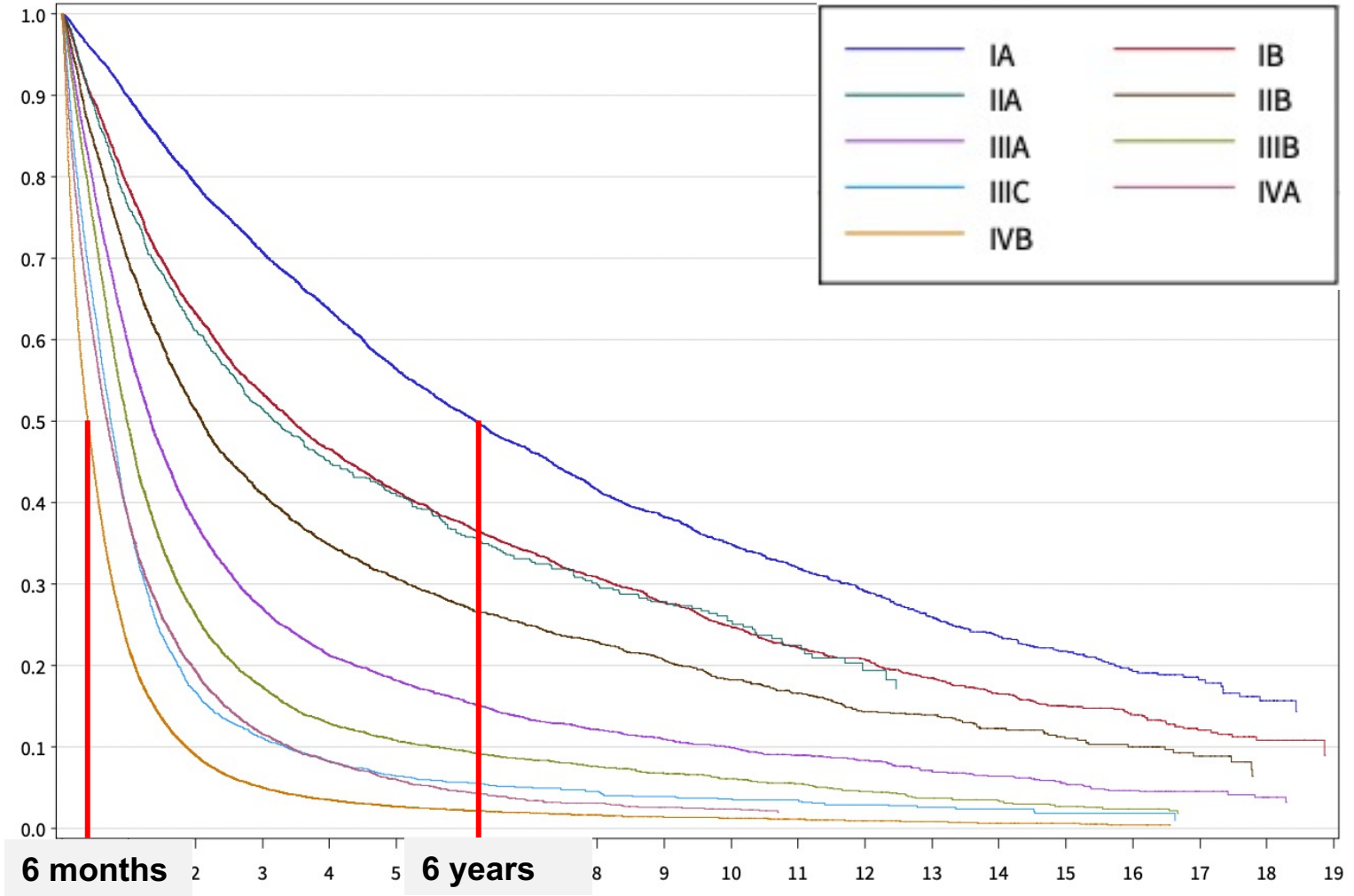
Perifere infiltrater



Region Syddanmark

Sygehus Lillebælt

Perifere infiltrater



Kaplan-Meier survival curves segregated by stage. Danish lung cancer patients 2003-2021. DLCR annual report 2021.

Region Syddanmark

Sygehus Lillebælt

Perifere infiltrater

TABLE 2. HISTOLOGY AND CANCER STAGE OF 209 SCREEN-DETECTED LUNG CANCERS IN 200 PARTICIPANTS

	Cancer Stage*							
Histology†	IA n (%)	IB n (%)	IIA n (%)	IIB n (%)	IIIA n (%)	IIIB n (%)	IV n (%)	Overall n (%)
Adenocarcinoma	75 (70.1)	9 (8.4)	8 (7.5)	0 (0.0)	9 (8.4)	4 (3.7)	2 (1.9)	107 (51.2)
Bronchoalveolar carcinoma	11 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11 (5.3)
Squamous cell carcinoma	21 (61.8)	0 (0.0)	3 (8.8)	0 (0.0)	8 (23.5)	0 (0.0)	2 (5.9)	34 (16.3)
Adenosquamous carcinoma	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (1.9)
Large cell carcinoma	7 (41.2)	1 (5.9)	0 (0.0)	0 (0.0)	6 (35.3)	2 (11.8)	1 (5.9)	17 (8.1)
Large cell neuroendocrine carcinoma	2 (50.0)	1 (25.0)	0 (0.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)	4 (1.9)
Small cell carcinoma	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (62.5)	0 (0.0)	3 (37.5)	8 (3.8)
Small/large cell carcinoma	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	1 (50.0)	2 (1.0)
Pleomorphic carcinoma	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)
NSCLC-NOS	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	2 (1.0)
Carcinoid	6 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (2.9)
No histological diagnosis‡	12 (92.3)	0 (0.0)	1 (7.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	13 (6.2)
Total	137 (65.6)	11 (5.3)	14 (6.7)	0 (0.0)	30 (14.4)	7 (3.3)	10 (4.8)	209 (100)

Definition of abbreviations: NOS = not otherwise specified; NSCLC = non–small cell lung carcinoma.

In 10 lung resection specimens the pathologist found, besides the lung cancer, a focus of atypical adenomatous hyperplasia.

* According to Reference 16.

† According to Reference 17.

‡ In 13 participants no histological diagnosis was established because biopsies were unsuccessful or not performed and the patient did not undergo thoracic surgery because of poor pulmonary function (n = 7), poor heart function (n = 1), poor general condition (n = 1), metastasized prostate carcinoma (n = 1), death due to mesenteric ischemia before intended surgery (n = 1), radiotherapy because of participation in other clinical trial (n = 1), and refusal (n = 1).

Horeweg et al. AJRCCM 2013

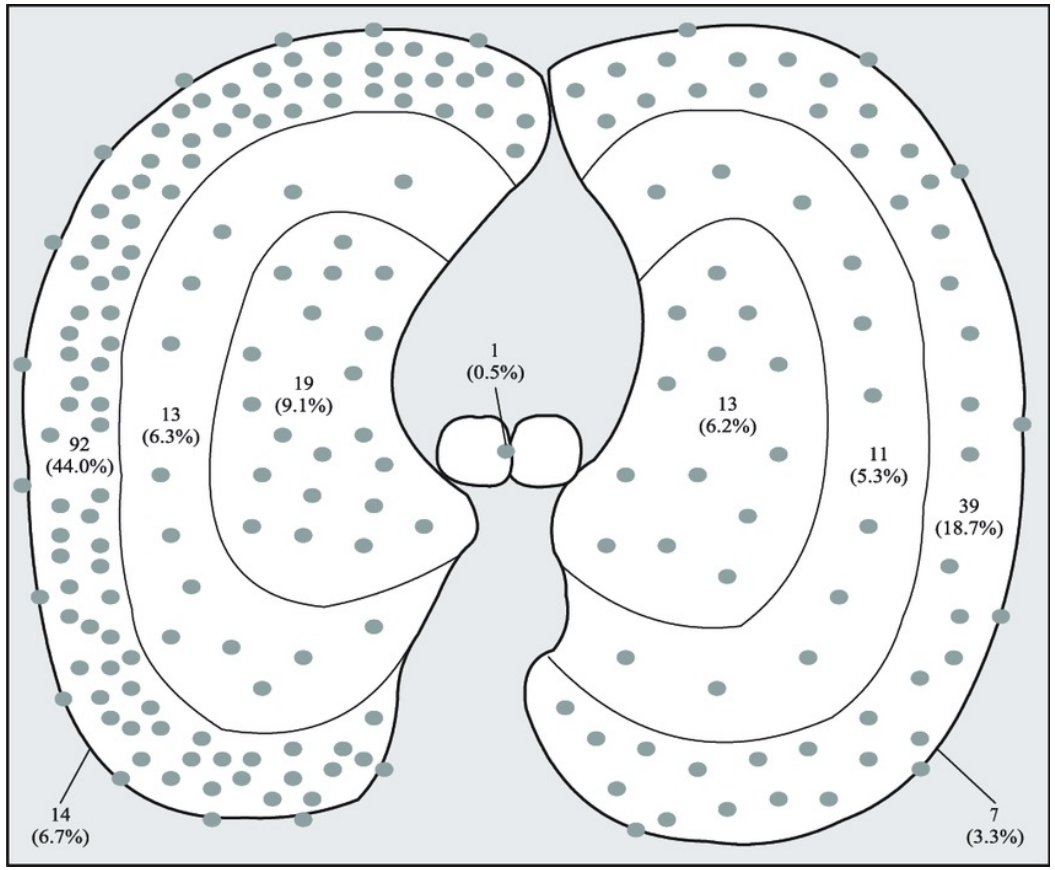
Perifere infiltrater

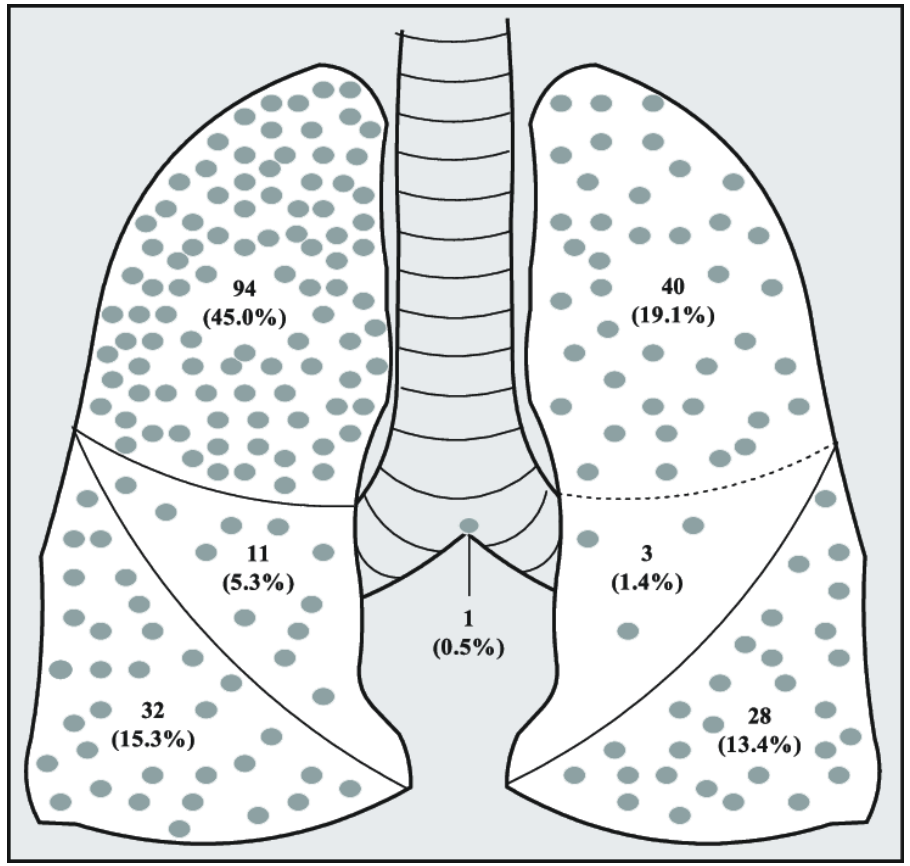
Tabel 7.1.4.3 cTNM stadie fordeling i %

	I alt	IA	IB	IIA	IIB	IIIA	IIIB	IIIC	IVA	IVB	Uoplyst
2022	5043	19.4	7.9	2.1	5.6	8.7	6.1	3.5	10.0	34.6	2.0
2021	5108	18.9	6.8	1.8	6.7	8.4	6.9	2.6	11.0	35.8	1.2

Horeweg et al. AJRCCM 2013

Perifere infiltrater





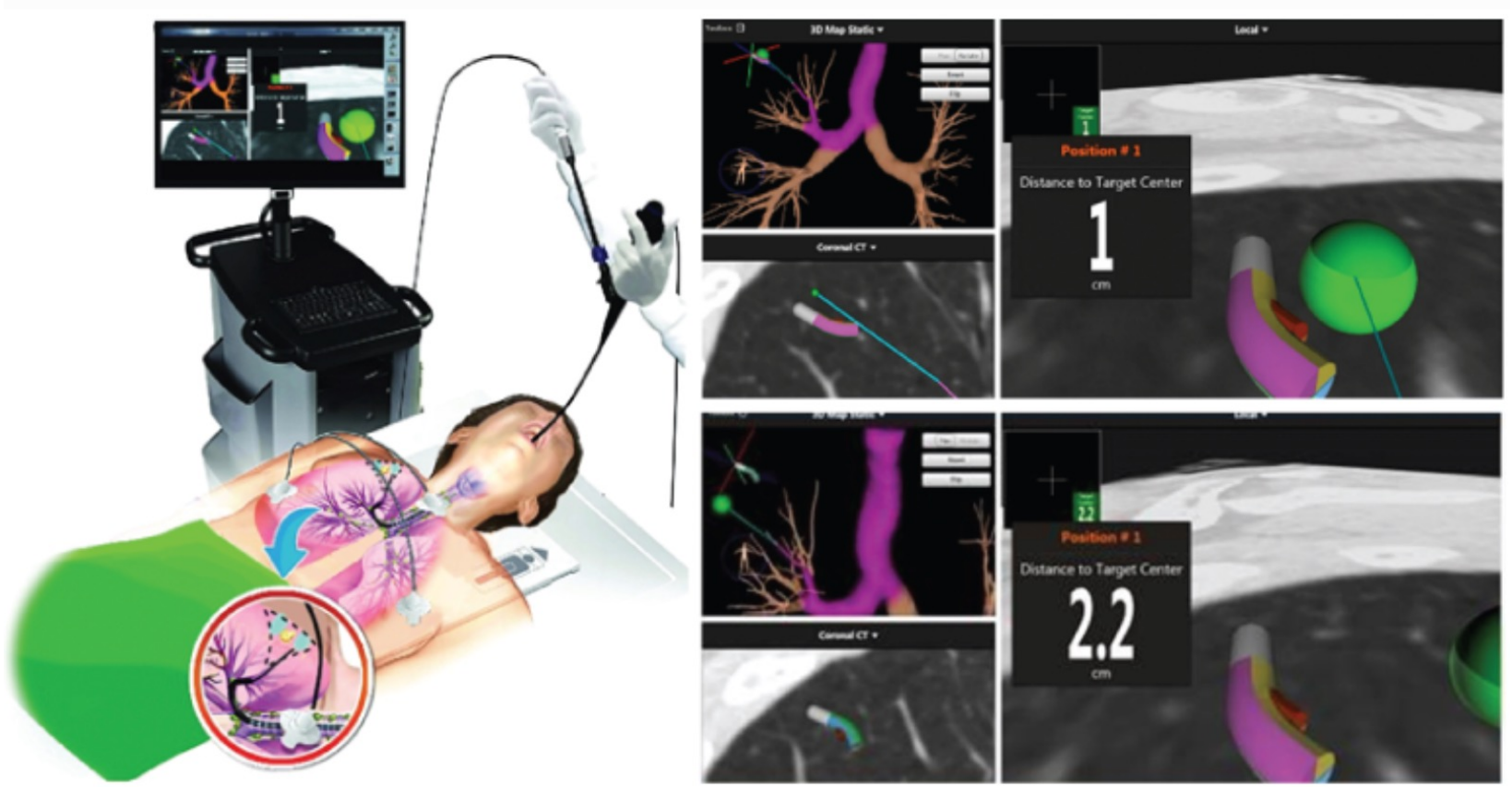
Horeweg et al. AJRCCM 2013

Perifere infiltrater

Horeweg et al. AJRCCM 2013

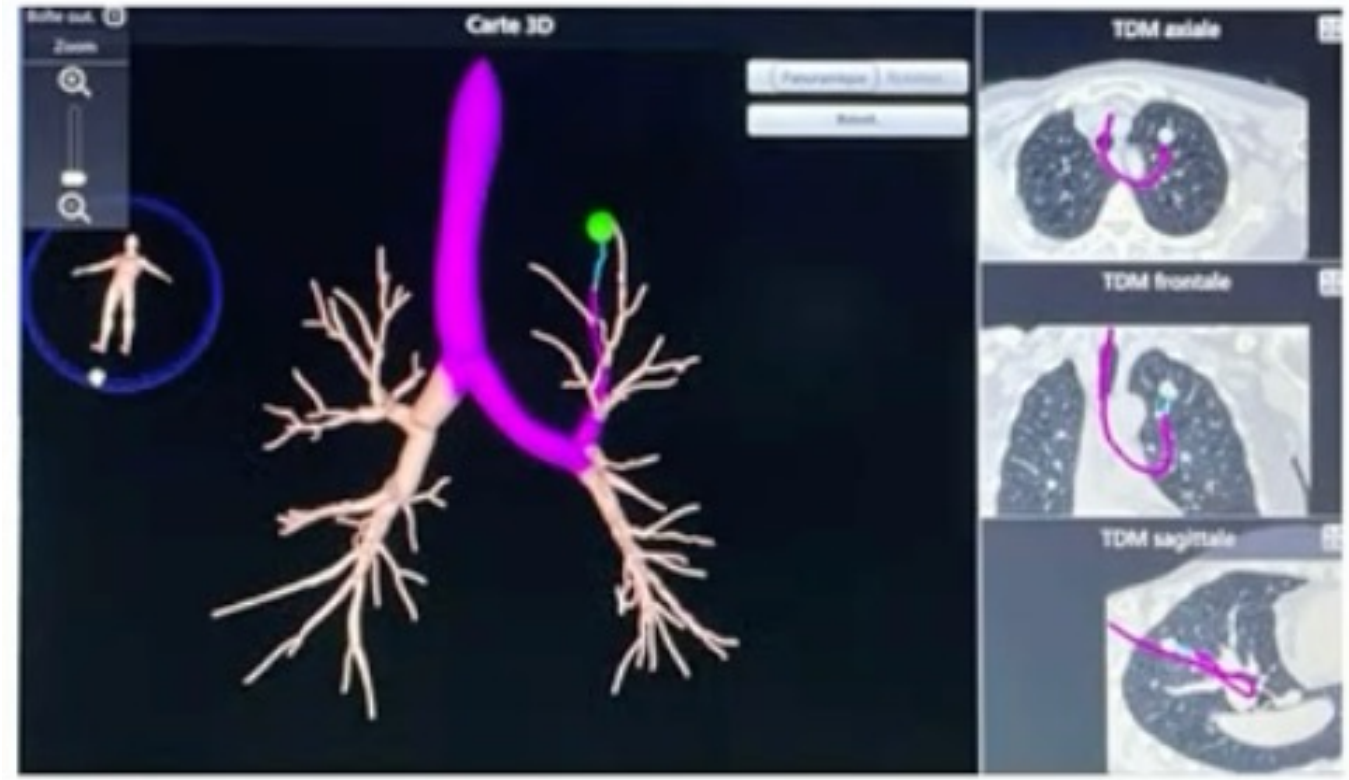
Perifere infiltrater

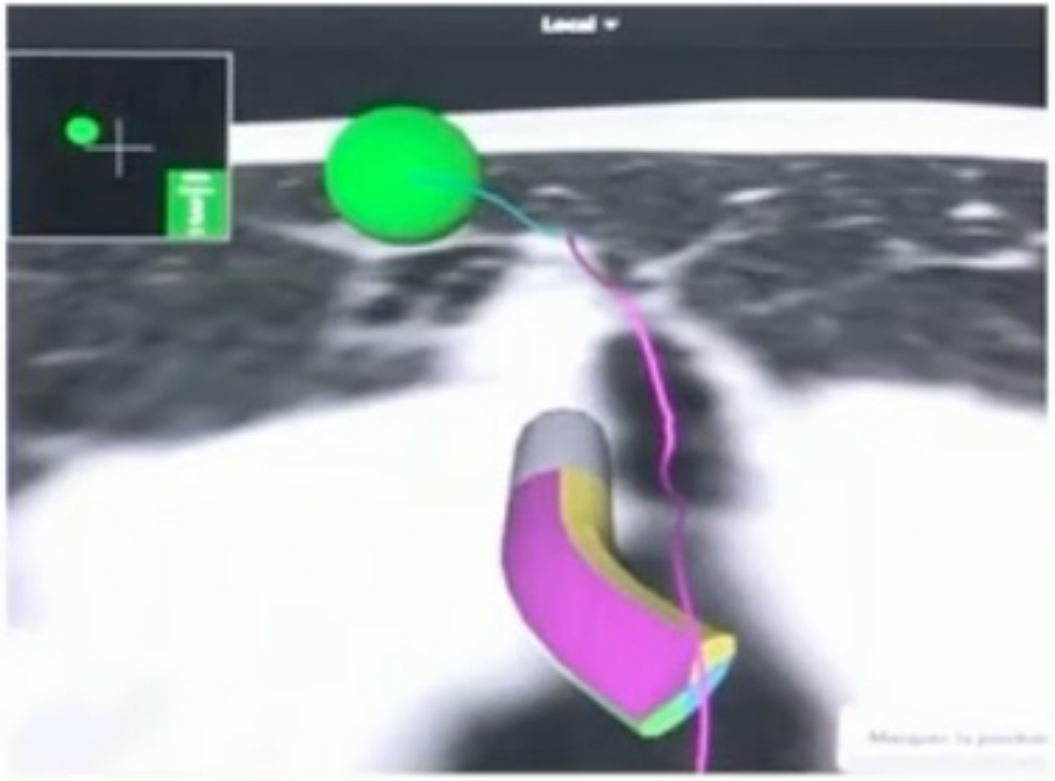
Elektromagnetisk navigationsbronkoskopi (ENB)
https://www.youtube.com/watch?v=YOmni-LkykQ



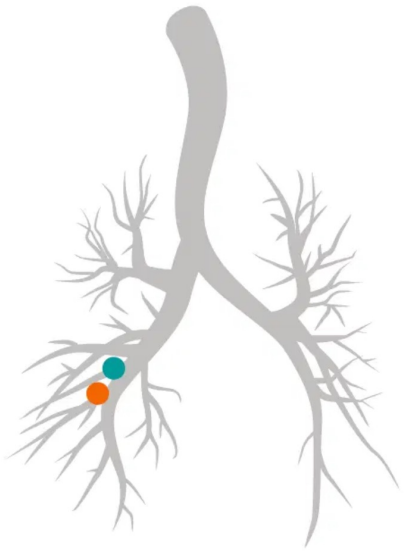
Perifere infiltrater

Elektromagnetisk navigationsbronkoskopi (ENB)

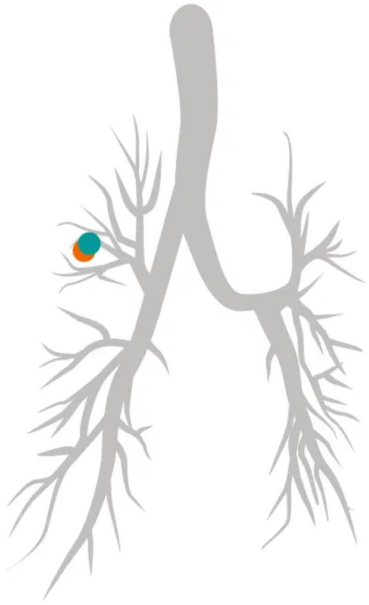




Perifere infiltrater



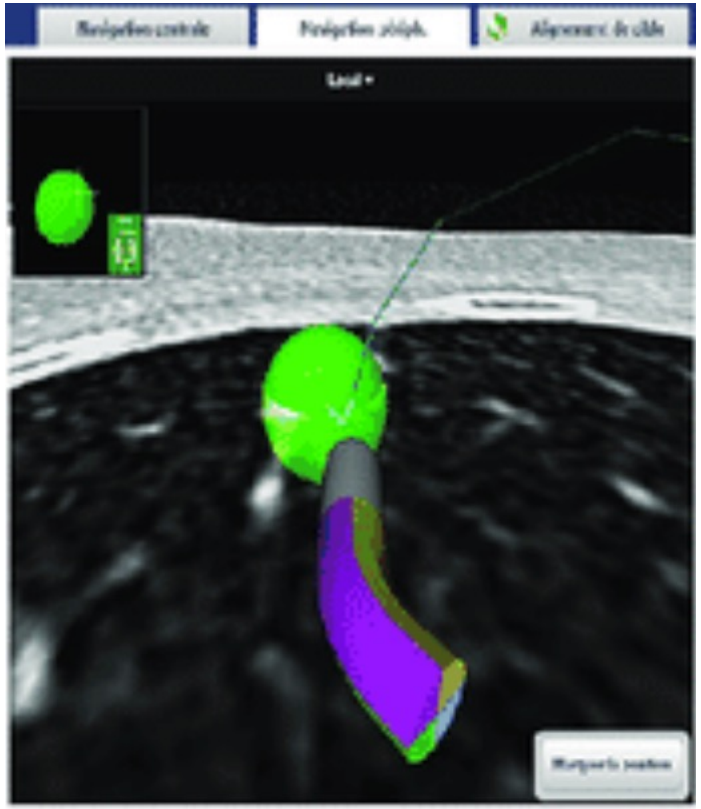
High
CT-to-body-divergence



Small
CT-to-body-divergence

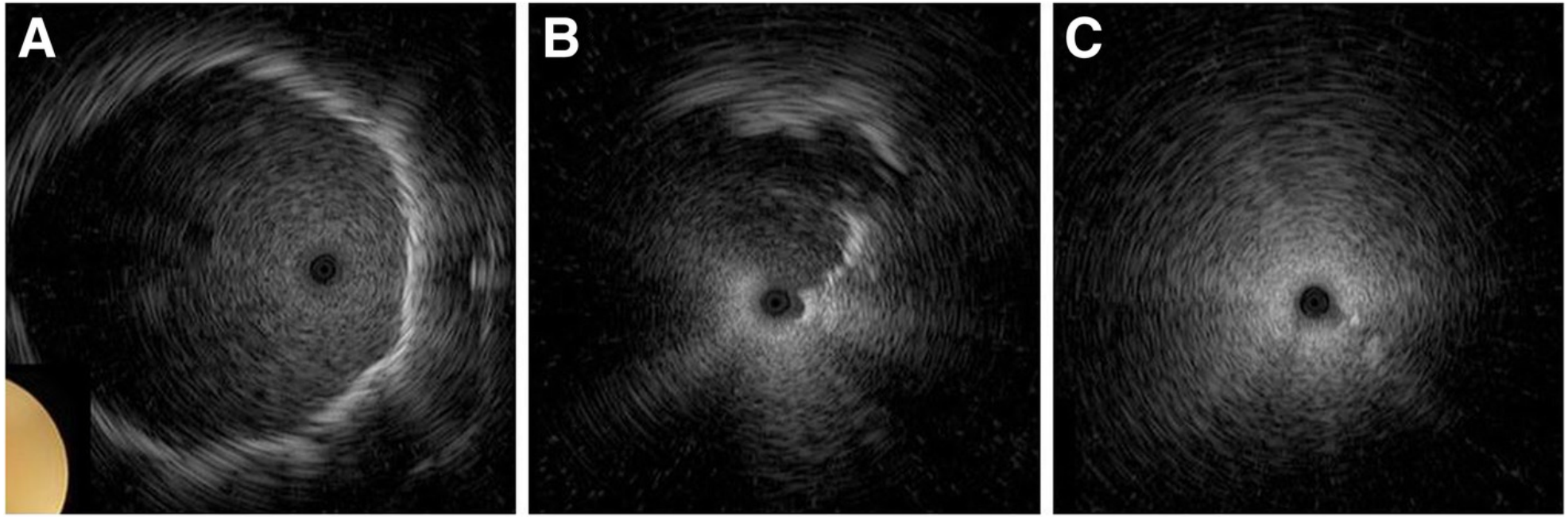
Target location in intraoperative CBCT

Target location in preprocedural CT



Perifere infiltrater

ENB og verificering med radial EBUS



Perifere infiltrater

Study	Diagnostic yield ENB, %	Diagnostic yield ENB + rEBUS, %	*p* value	Malignant cases/ patients, *n*	Adverse events	Size of lesion	Mean age, years (SD)
Eberhardt et al. [12]	59	88	0.02	60/79	Pneumothorax 6%	26 mm, 13–58 mm (mean, range)	53 (13)
Ozgul et al. [17]	71	73	Not reported	42/56	Pneumothorax 1.7% (1 patient)	30 mm, 23–44 mm (median, range)	60 (9.6)
Ost et al. [18]	39	47	Not reported	Only reported for full study/ 314 patients in the ENB and ENB + rEBUS groups	Pneumothorax, hypoxia, bleeding, respiratory failure, 2.2% in total	62% < 20 mm, 38% > 20 mm	67.1 (12.6)
Folch et al. [19]	76	71	0.04	768/1,157	Pneumothorax 4.3%, bleeding 2.5% respiratory failure in 0.7%	20 mm, 14–30 mm (median, range)	67.6 (11.3)
Bellinger et al. [16]	Not reported	Not reported	–	185 malignant lesions/271 lesions	Pneumothorax 3%, bronchospasm and hypoxia 1.9%, pneumonia and COPD exacerbation within 1 week 1.1%, moderate to severe bleeding 0.4% hemoptysis without admission 0.7%, other without admission 0.7% In total 7.8%	24.2 mm (12.1 SD)	67.2 (10.5)

Juul et al. Respiration 2022

Perifere infiltrater

Table 5 NEBULA endpoints			
	Control n= 66	Intervention n= 71	p- value
Primary endpoint			
Diagnostic yield	44% CI95% 32 -57	45% CI95% 33-57%	0.894
Secondary endpoints			
Malignant yield	51% CI95% 37-65	48% CI95% 33- 63%	0.761
Benign yield	20% CI95% 4-48	23% CI95% 20 - 61	0.215
Overall procedure complications n (%)	18 (27) CI 95% 17-40	17 (24) CI95% 15-36	0.655
Severe procedure complications n (%)	2 (3) CI95% 4-11	1 (2) CI95% 0-8	0.276
Procedure time min median (Q1-Q3)	30 (20-37)	27 (15-35)	0.656
"ready to treat" (days) median (Q1-Q3)	27 (19-43)	26 (19-40)	0.767

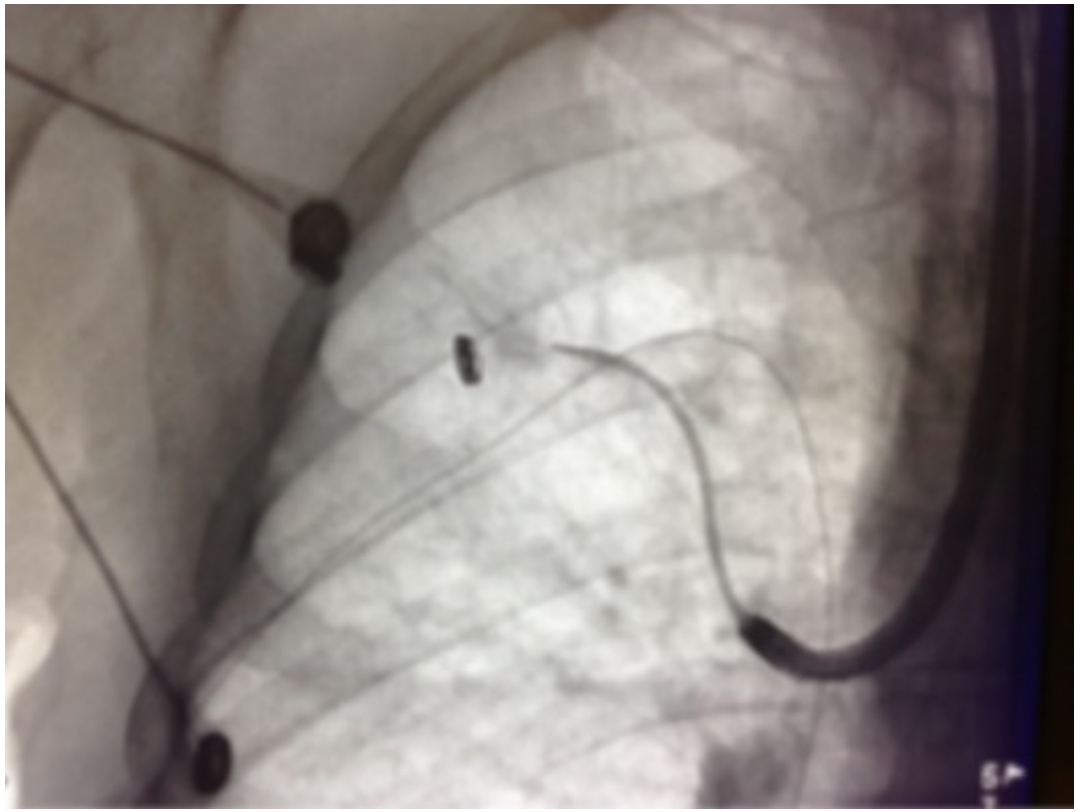
Juul. PhD dissertation 2024

Perifere infiltrater

ENB og verificering med gennemlysning

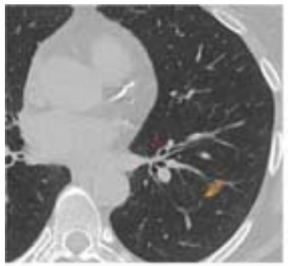
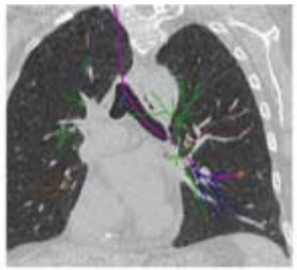
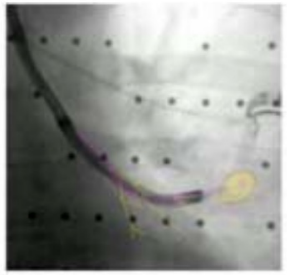
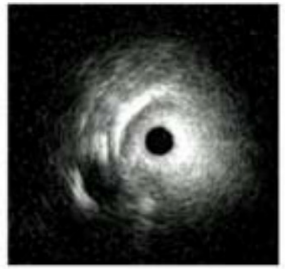
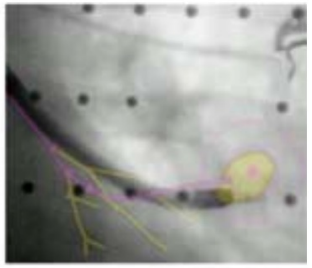
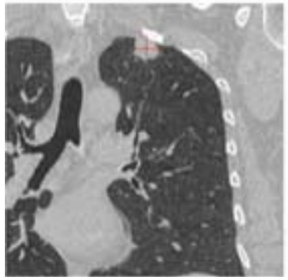
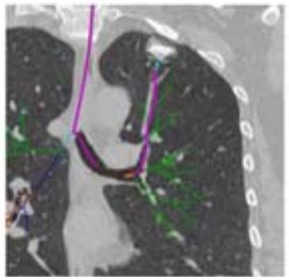
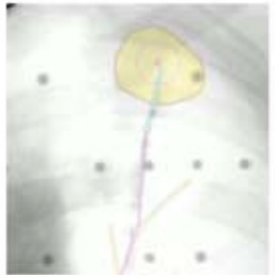
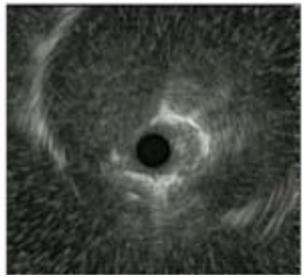
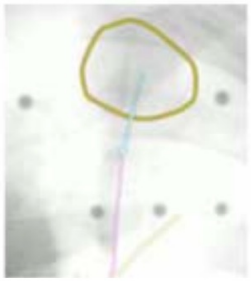
Infiltrater kan være svære at identificere på gennemlysning

2D billede gør det svært at bioptere selve infiltratet



Perifere infiltrater

LungVision – augmented fluroscopy

A Nodule Location	B Nodule Size (mm)	C CT Image	D Navigation Pathway	E Navigation	F REBUS Verification	G Biopsy
LLL	13.0					
LUL	18.0					

Cicenia et al. J Bronchol Intervent Pulmonol. 2020

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ENB og verificering med cone-beam CT

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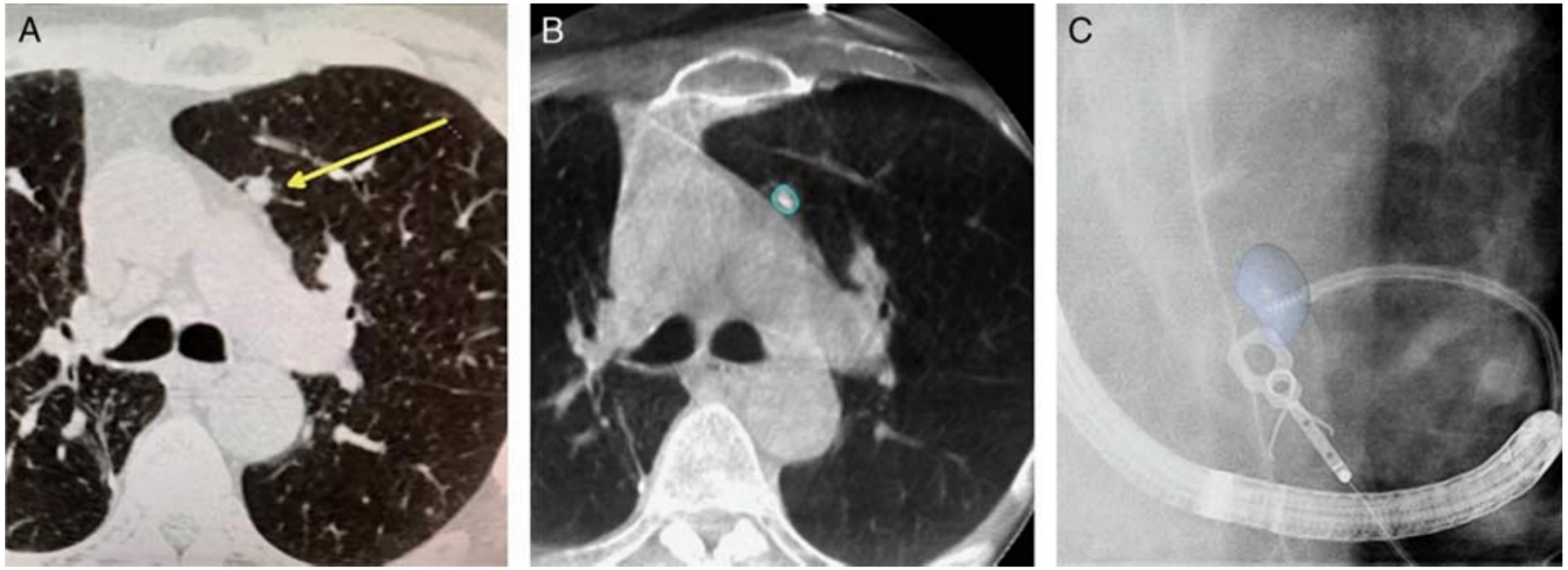
ENB og verificering med cone-beam CT



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ENB og verificering med cone-beam CT

Table 1 CBCT combined with navigation for diagnosis peripheral pulmonary lesions

Studies	Design	Procedural modalities	CBCT used	Overall diagnostic yield	Lesions	Nodule size	Radiation information
Pritchett *et al.*	Retrospective study	CBCT + ENB + AF	Allura Xper FD20; Philips	83%	93	Median nodule size 20 (range, 7–55) mm	2.0 mSv per CBCT run, average 1.5 runs, 3.5 mSv
Sobieszczyk *et al.*	Retrospective study	CBCT + ENB + R-EBUS + TBAT	Not reported	77.2%	22	Median nodule size 21 (range, 7–52) mm	Not reported
Casal *et al.*	Prospective observational cohort study	CBCT + R-EBUS + Ultrathin Bronchoscope	Not reported	70%	20	Median nodule size 21 (range, 11–30) mm	Estimated to range between 8.6 to 23 mSv, average fluoroscopy time 8.6 minutes (range, 5–15.4 minutes)
Bowling *et al.*	Retrospective study	CBCT + ENB + TBAT	Artis Zeego; Siemens	71%	14	Median nodule size of 18 (range, 9–30) mm	4.3 mSv (range, 3 to 5 mSv), and the average fluoroscopic time was 17 minutes (range, 2 to 44 minutes)
Ali *et al.*	Prospective study	CBCT + VBN + Ultrathin Bronchoscope	Artis Zeego; Siemens	90%	40	Median nodule size 20 (range, 9–30) mm	Not reported

CBCT, cone beam computed tomography; ENB, electromagnetic navigation bronchoscopy; R-EBUS, radial endobronchial ultrasound; AF, augmented fluoroscopy; TBAT, Trans Bronchial Access Tool.

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Robotterne kommer

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Robot-assisted bronchoschopy

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Table 1. Technical Differences in Robotic Bronchoscopy Platforms.

	Monarch Robotic Bronchoscopy System (Auris Health, Inc., Redwood City, CA, USA)	Ion Robotic Bronchoscopy System (Intuitive Surgical©, Sunnyvale, CA, USA)	The Galaxy System (Noah Medical, San Carlos, CA, USA)
Navigation Technology	Electromagnetic Navigation	Shape Sensing	Electromagnetic with digital tomosynthesis TiLT+ Technology™
Catheter Outer Diameter	Outer Sheath: 6 mm Inner Scope: 4.2 mm	3.5 mm	4.0 mm
Working Channel Diameter	2.1 mm	2 mm	2.1 mm
Vision during Biopsy	Yes	No	Yes
Scope Reprocessing	Yes	Yes	No, disposable
Compatibility with Cone Beam or Advanced Fluoroscopy	Yes	Yes	Yes
Therapeutic tools	Under Investigation	Under Investigation	Unclear
FDA Approval	Yes	Yes	Pending

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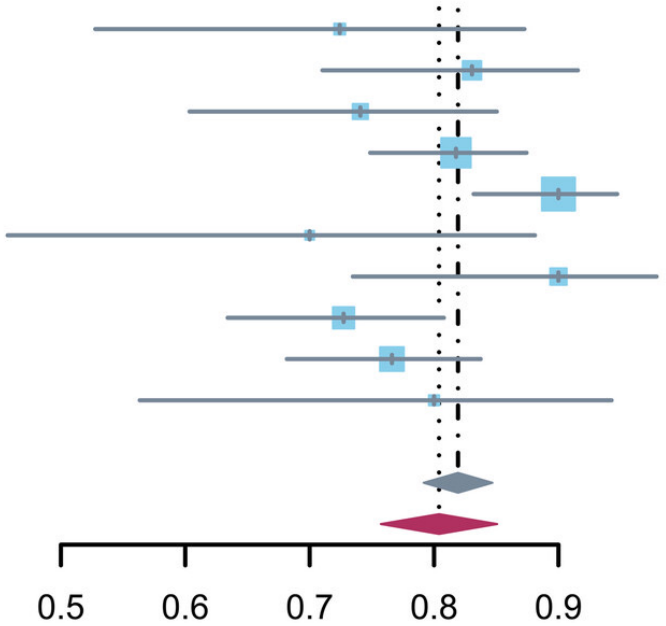
Diagnostisk yield ved robotbronkoskopi

Study	Events	Total	Proportion	95%−CI	Weight (common)	Weight (random)
Fielding−2019	21	29	0.724	[0.528; 0.873]	2.9%	5.8%
Benn−2021	49	59	0.831	[0.710; 0.916]	8.3%	10.8%
Chen−2021	40	54	0.741	[0.603; 0.850]	5.6%	8.8%
Kalchiem−Dekel−2022	130	159	0.818	[0.749; 0.874]	21.1%	14.8%
Oberg−2022	108	120	0.900	[0.832; 0.947]	26.4%	15.6%
Cumbo−Nacheli−2022	14	20	0.700	[0.457; 0.881]	1.9%	4.2%
Xie−2022	27	30	0.900	[0.735; 0.979]	6.6%	9.6%
Vu−2023	80	110	0.727	[0.634; 0.808]	11.0%	12.1%
Agrawal−2023	95	124	0.766	[0.682; 0.837]	13.7%	13.1%
Manley−2023	16	20	0.800	[0.563; 0.943]	2.5%	5.2%
Common effect model		725	0.819	[0.792; 0.847]	100.0%	−−
Random effects model			0.804	[0.757; 0.851]	−−	100.0%

Heterogeneity: I^2 = 59%, τ^2 = 0.0029, p < 0.01



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Diagnostisk yield ved robotbronkoskopi

TABLE 3 Results of subgroup analyses.

	No. of studies (lesions)	Pooled diagnostic yield (95% CI)	Heterogeneity	Test for subgroup differences
Platform				
Ion	6 (507)	82.5% (76.5%–88.5%)	$I^2 = 68\%, p < 0.01$	$p = 0.11$
Monarch	4 (218)	75.8% (70.2%–81.5%)	$I^2 = 0\%, p = 0.88$	
Study design				
Pro	5 (192)	81.4% (76.0%–86.8%)	$I^2 = 24\%, P = 0.26$	$p = 0.81$
Retro	5 (533)	79.8% (72.8%–86.8%)	$I^2 = 76\%, p < 0.01$	
Mean/median lesion size				
≤20 mm	6 (407)	80.5% (76.7%–84.3%)	$I^2 = 36\%, P = 0.17$	$p = 0.87$
>20 mm	4 (318)	79.6% (70.4%–88.8%)	$I^2 = 77\%, p < 0.01$	
Use of cryoprobes				
Yes	1 (120)	90.0% (83.2%–94.7%)	–	$p < 0.01$
No	9 (605)	79.0% (75.8%–82.2%)	$I^2 = 22\%, p = 0.25$	
Use of CBCT				
Yes	2 (79)	80.6% (72.0%–89.3%)	$I^2 = 24\%, p = 0.25$	$p = 0.89$
No	8 (646)	80.5% (75.1%–85.9%)	$I^2 = 66\%, p < 0.01$	

Abbreviations: CBCT, cone beam computed tomography; CI, confidence interval; Pro, prospective; Retro, retrospective.

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Diagnostisk yield ved robotbronkoskopi

TABLE 2 Diagnostic yield by lesion characteristics.

	No. of studies (lesions)	Pooled diagnostic yield (95% CI)	Test for subgroup differences
Lesion size, mm			
≤20	4 (176)	78.0% (72.0%–84.1%)	$p = 0.09$
>20	4 (156)	88.4% (78.6%–98.1%)	
Lesion size, mm			
≤30	4 (267)	79.5% (71.7%–87.3%)	$p = 0.03$
>30	4 (90)	92.4% (86.8%–98.0%)	
rEBUS view			
Concentric	5 (169)	89.4% (84.8%–94.0%)	$p = 0.01$
Eccentric	5 (154)	79.8% (73.5%–86.0%)	
Bronchus sign			
Positive	4 (242)	82.9% (78.2%–87.6%)	$p = 0.02$
Negative	4 (124)	71.9% (64.0%–79.8%)	
Lesion appearance			
Solid	3 (210)	80.2% (74.9%–85.6%)	$p = 0.60$
Nonsolid[a]	3 (102)	77.6% (69.6%–85.7%)	
Lesion location			
Upper lobe	3 (190)	79.5% (73.8%–85.2%)	$p = 0.90$
Nonupper lobe	3 (122)	78.9% (71.7%–86.2%)	

Abbreviations: CI, confidence interval; rEBUS, radial endobronchial ultrasound.
[a]Including: ground-glass, mixed solid and ground-glass, and cavitary lesions.

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https://www.intuitive.com/en-us/products-and-services/ion

https://www.youtube.com/watch?v=RGRhm1WNXR8

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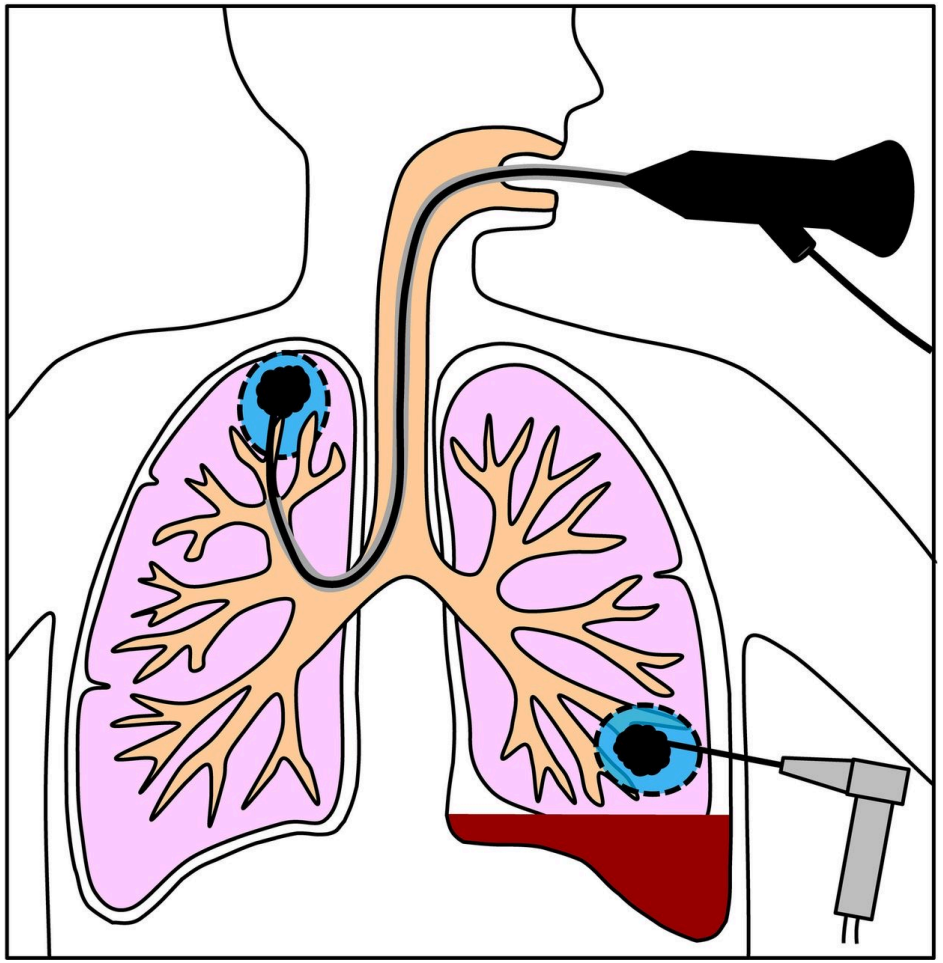
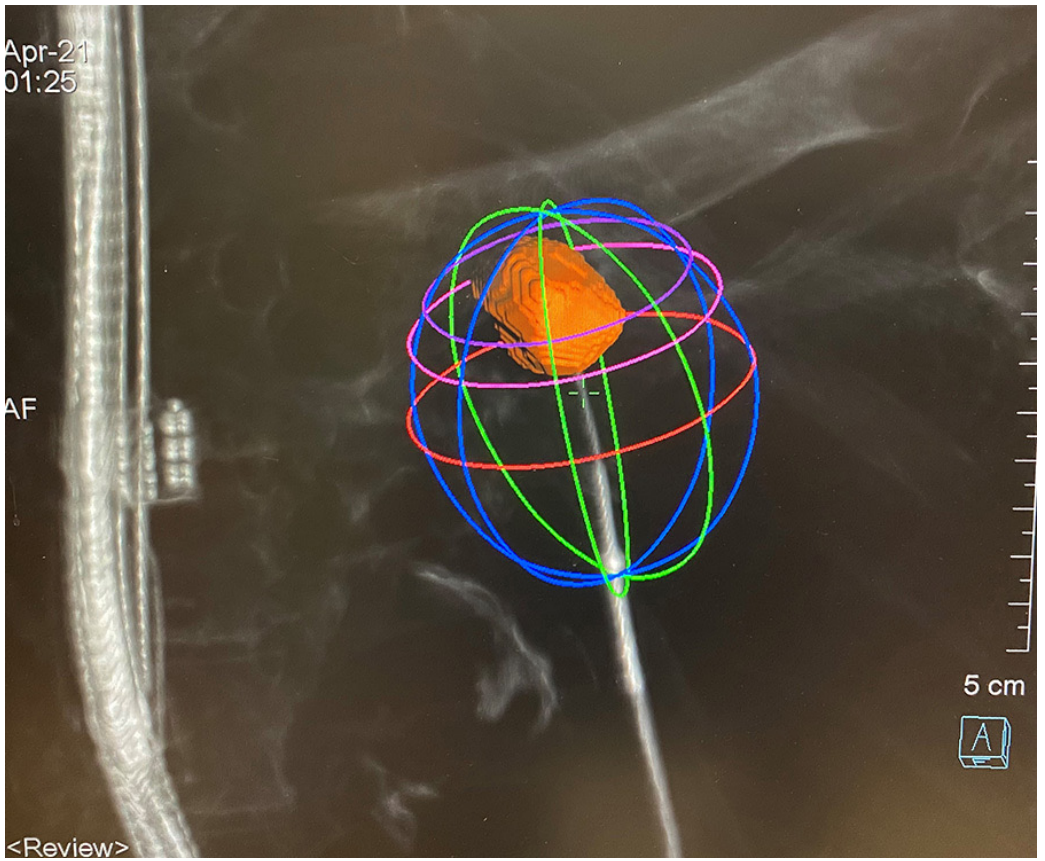
Transbronchial microbølgeablation af lungecancere/lungemetastaser





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https://www.youtube.com/watch?v=yc9-2BuuIPQ&t=160s

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