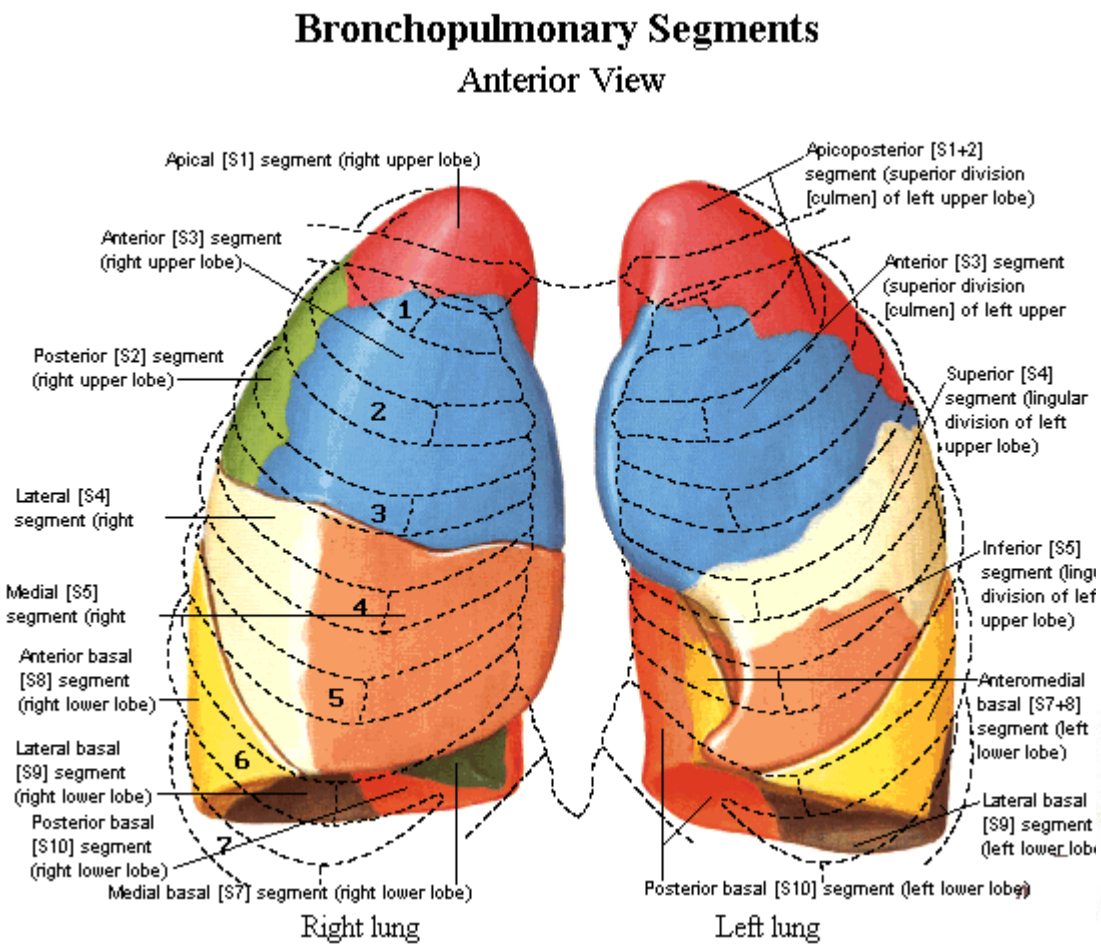
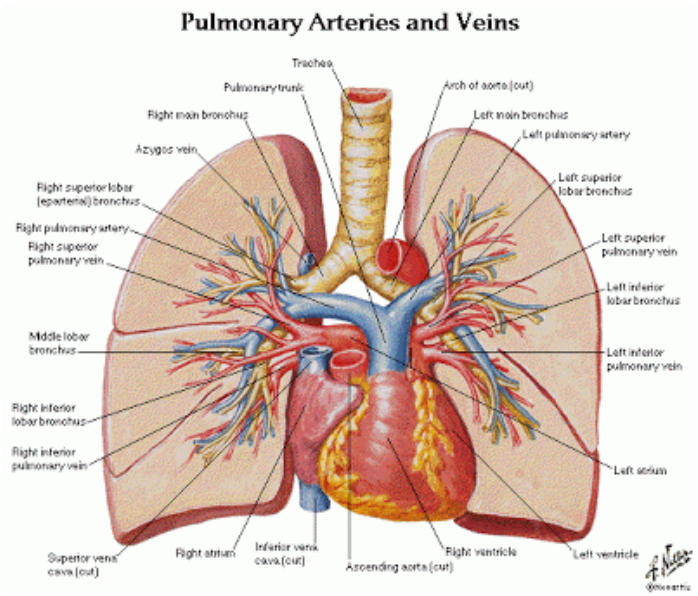
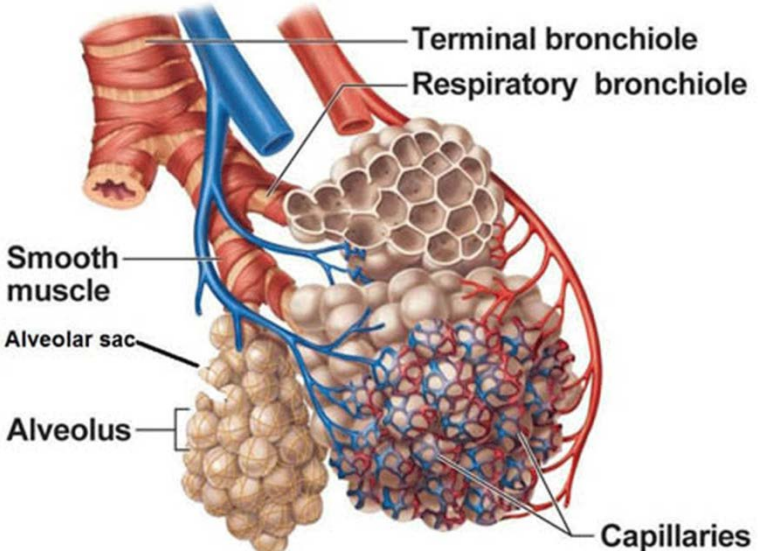
NUKLEARNA PULMOLOGIJA

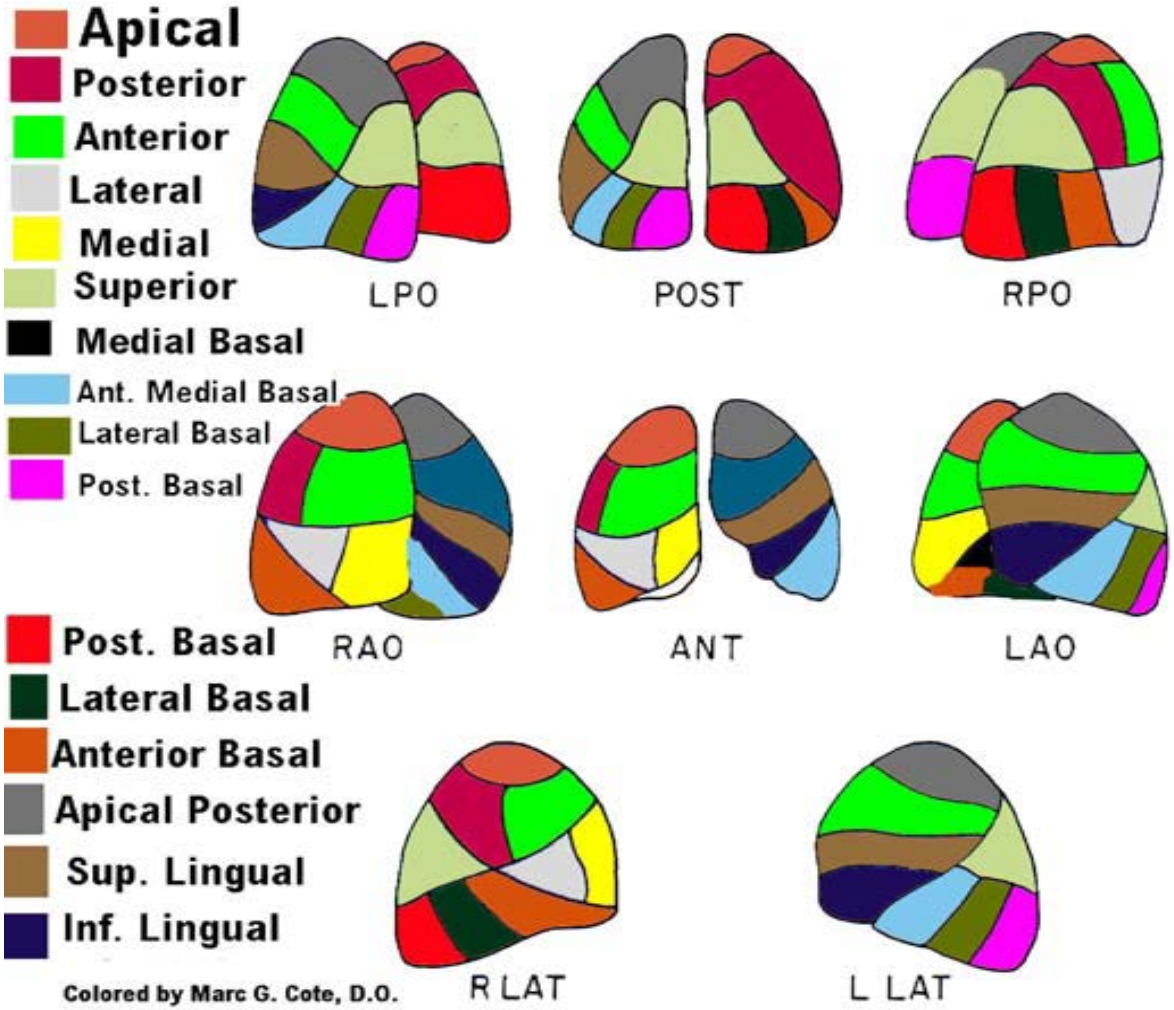
- **perfuziona**
- **ventilaciona scintigrafija pluća**

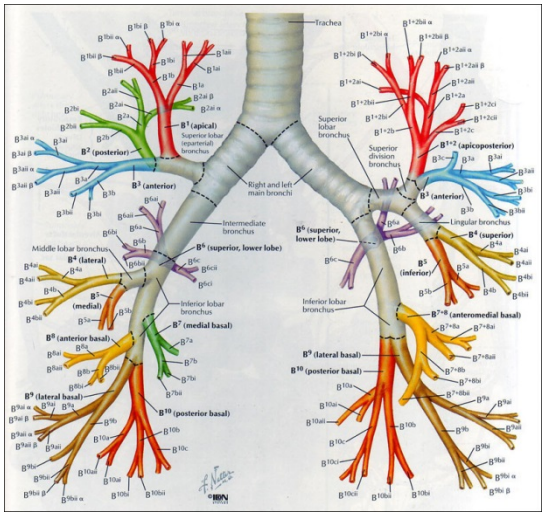
Anatomija pluća

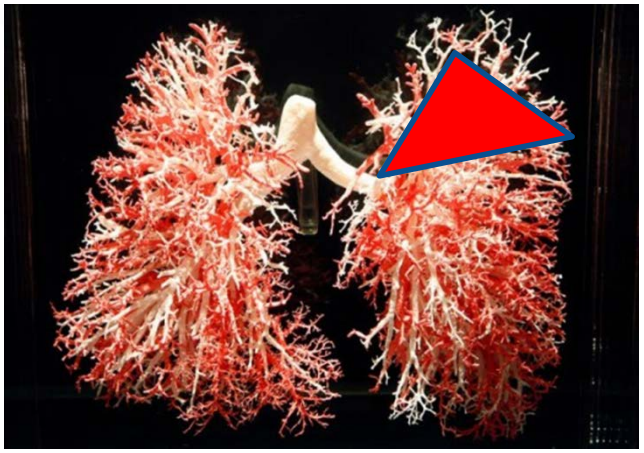








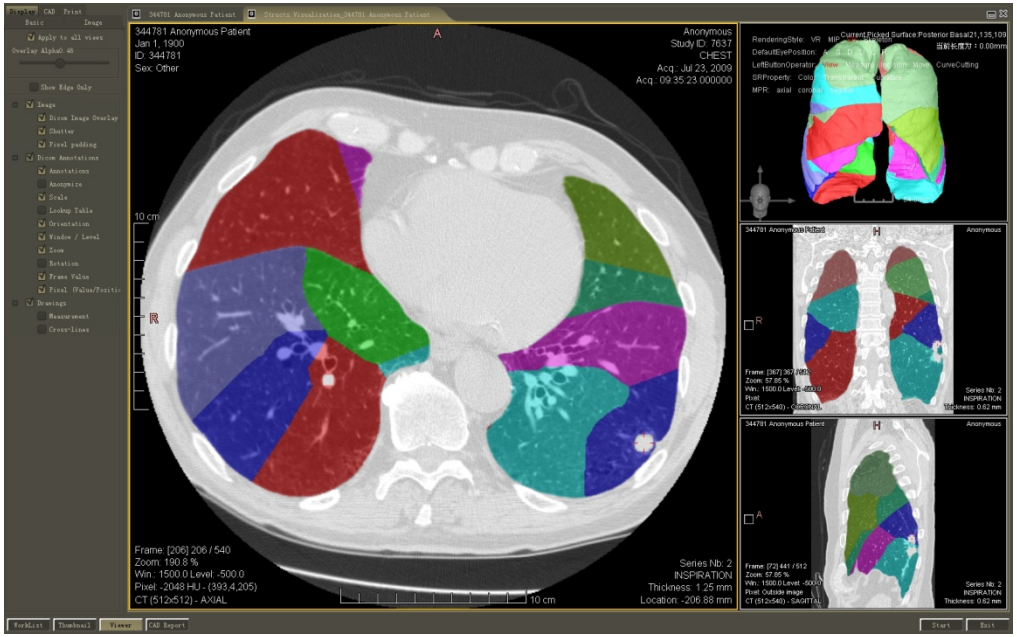




za **interpretaciju scintigrafskog nalaza** je važno poznavanje plućne

- **vaskularne segmentne anatomije** koja skoro u potpunosti prati
- **bronhopulmonalnu** segmentnu anatomiju osim u apikalnim delovima pluća

skraćenica za oznake segmenata pluća (i na engleskom)



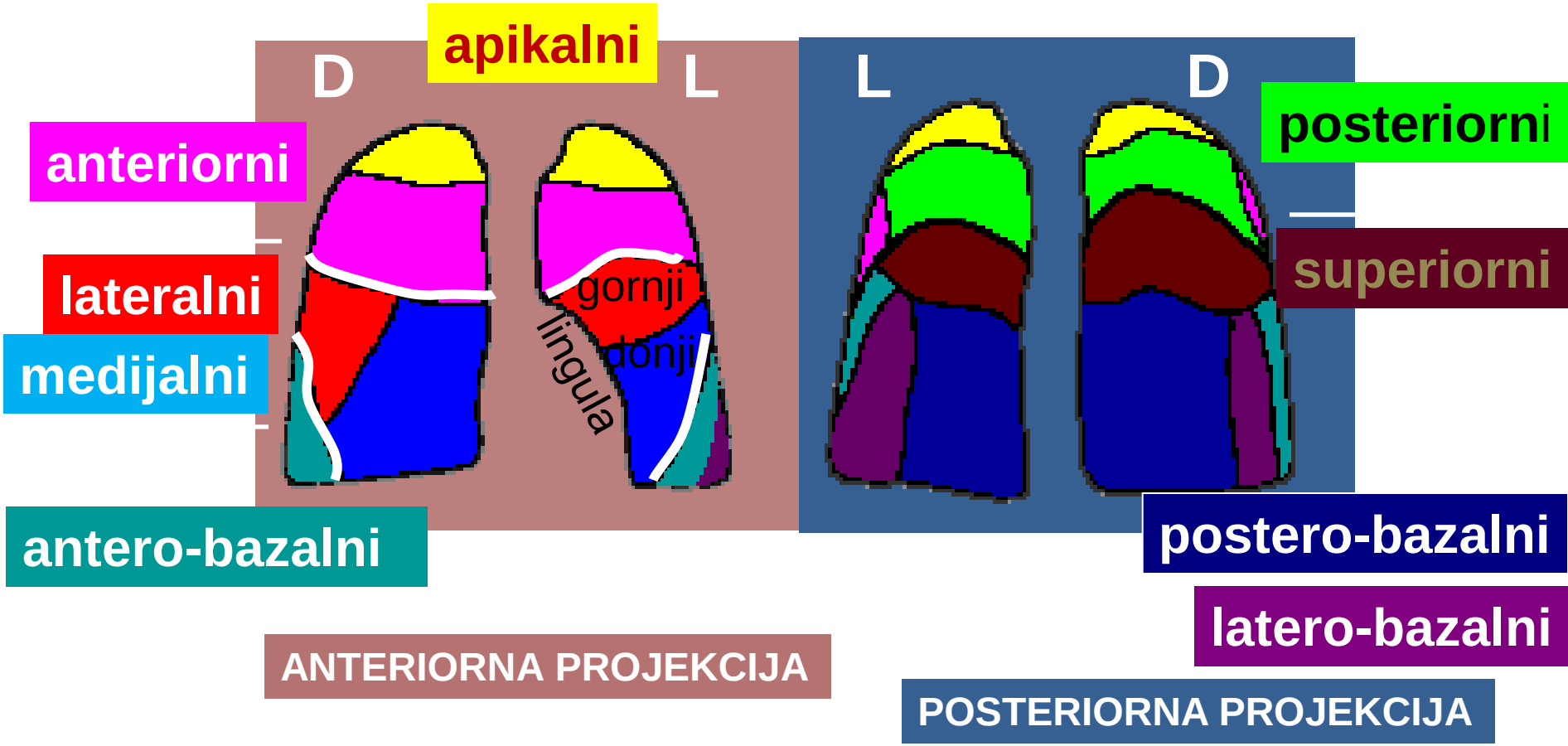
bronhopulmonalni segmenti na tomografskim presecima CT

AP- anteriorni ANT
PA-posteriorni POST
LPK – levi posteriorni kosi LPO
DPK – desni posteriorni kosi RPO
LAK – levi anterirni kosi LAO
DAK –desni anterirni kosi RAO
LB – levi bočni LL
DB –desni bični RL

Pluća se snabdevaju krvlju iz 2 sistema

- 95% od pulmonarnih arterija
- 5% od bronhijalnih arterija

SEGMENTI PLUĆA



ventilaciona scintigrafija pluća

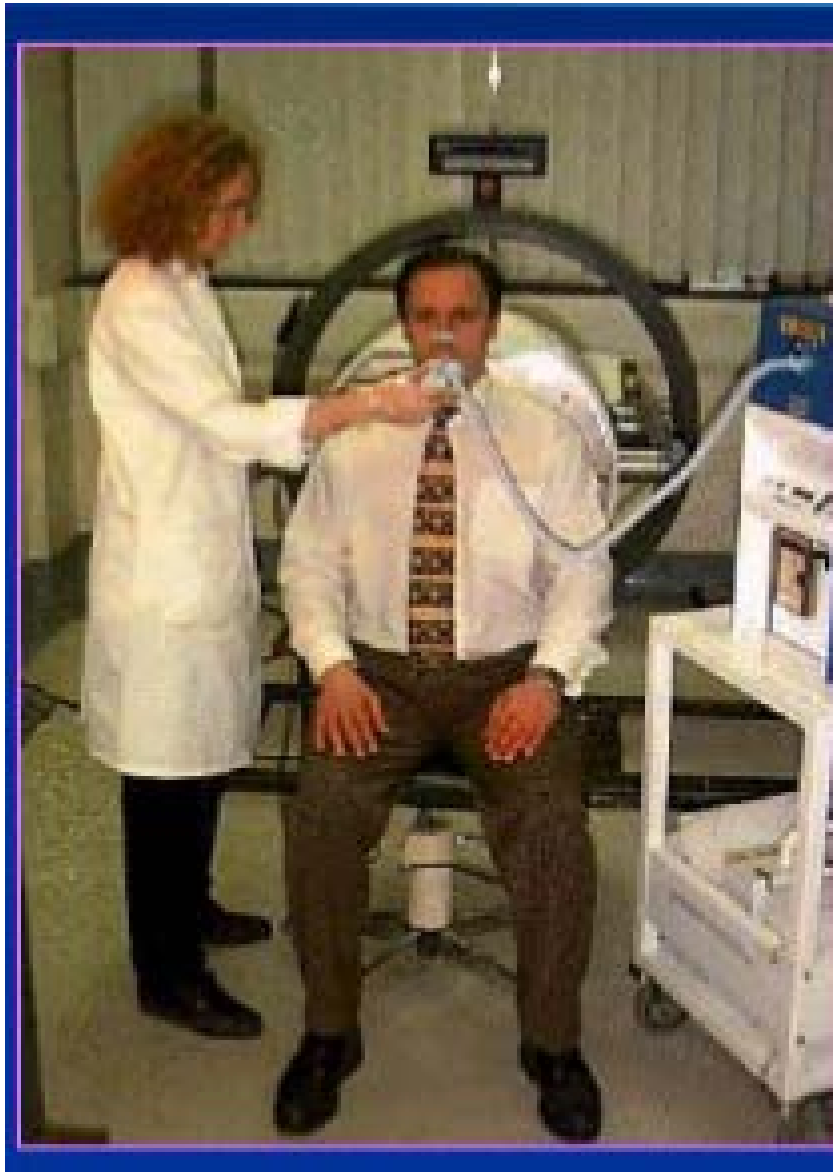
radiofarmak	Tc^{99m} DTPA aerosol ili Tc^{99m} ugljenik (čvrste čestice) tehnegas...pertehnegas	^{133}Xe	^{81m}Kr u ovlaženom vazduhu ili O_2
priprema pacijenta	familijarizacija sa sistemom za udisanje (moguće je suplementacija O_2)	familijarizacija sa sistemom za udisanje	familijarizacija sa maskom; dobro zaptivanje maske
aplikovana aktivnost	20 -40 MBq (1mCi)	37 MBq/l (1mCi)	6000 MBq (150 mCi) je gornja granica
kolimator	LEGP	LEGP	LEGP
snimanje , "akvizicija slika"	AP, PA, LKP, DKP, LKA, DKA. LB. DB (u skladu sa perfuzionim projekcijama); 200 000 impulsa	Obično jedna projekcija POSTERIORNA; ukupno vreme studije 600 s, wash-out počinje u 300 s; 100 x 6s sličice	AP, PA, LKP, DKP, LKA, DKA, LB, DB (u skladu sa perfuzionim projekcijama); 200 000 -300 000 impulsa
ekvivalentna doza	0.6 mSv (60 mrem)	0.3 mSv (30 mrem)	0.05-0.1 mSv (5-10 mrem)
doza koju primi osoblje	0.3-0.5 µSv (30-50 µrem)	0.1 µSv (10 µrem)	0.1 µSv (10 µrem)

radionuklidi za ventilacionu scintigrafiju

	^{133} **Xe**	^{81m} **Kr**	^{99m}**Tc DTPA aerosol/ tehnegas/ pertehnegas**
$T_{1/2}$	5.3 dana	13 s	6 h
E γ fotona	80 keV	190 keV	140 keV
agregatno stanje	gas	gas	(tečnost) aerosol/ **čvrsta čestica/čvrsta čestica**
cena	niska	visoka	**niska/visoka**
radi se u odnosu na **perfuzioni sken**	pre	posle	pre/**pre**

perfuziona scintigrafija pluća

radiofarmak	^{99m} Tc MAA (makroagregati albumina)
priprema pacijenta	leži ili je u polusedećem položaju
tehnika injiciranja RF	spora i.v. injekcija BEZ izvlačenja krvi
aplikovana aktivnost	80 MBq (2 mCi)
broj čestica	60 000 do 200 000
kolimator	LEGP
pozicije snimanja	AP, PA, LKP, DKP, LKA, DKA ili oba lateralna LB i DB
ekvivalentna doza	1 mSv (100 mrem)
doza za osoblje	1.5 µSv (150 mrem)

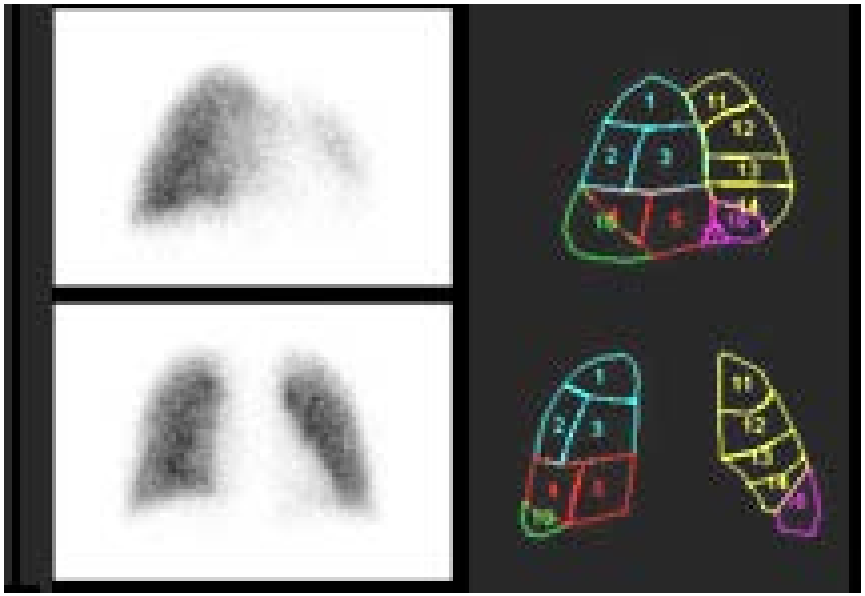


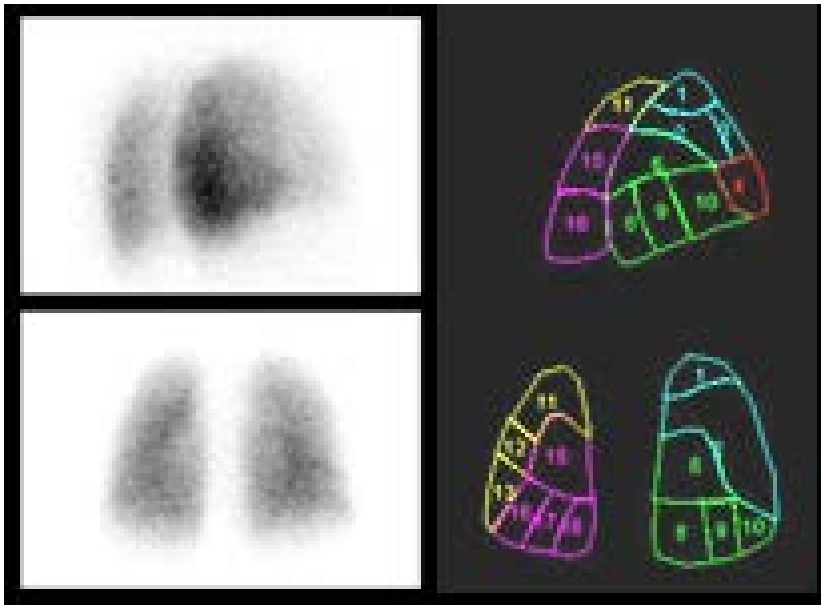


sistem za spravljanje TEHNEGASA/PERTEHNEGASA sa sistemom za udisanje















^{99m} Tc DTPA aerosol

- male čestice, 0.25 μ stvaraju se u “nebulizeru”
- problemi sa nagomilavanjem u centralnim disajnim putevima

slaganje ventilacije (V) i perfuzije (Q)

V... ventilacija - „ventilation“

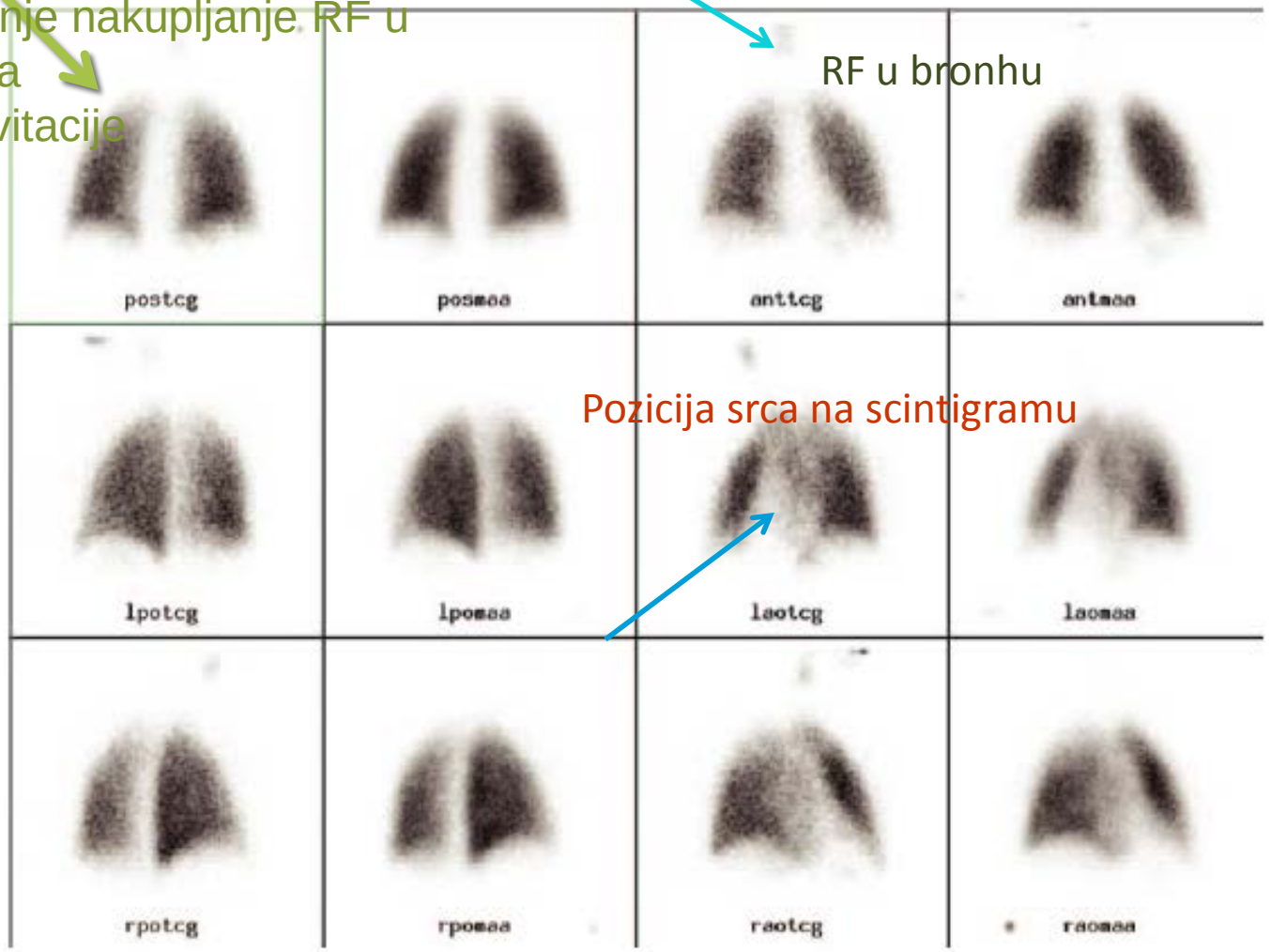
Q... „quellen“ - prskanje, istiskivanje, izvor

V/Q match (V/P podudarnost)....V/Q mismatch (V/P nepodudarnost)

- **desaturacija ili fizioloski šant** :
  - ako ventilacije nema onda je perfuzija refleksno zaustavljena i obrnuto, ako je perfuzija ugrožena onda ni ventilacije nema
  - to dovodi do smanjene koncentracije 0_2 u krvi....**desatruracija,** a krvotok ili ventilacija se preusmerava **(šant)** u funkcionalne segmente pluća
- hronicni bronhitis, astma, druge parenhimske bolesti pluca dovode do **regionalno smanjene ventilacije** koja uzrokuje **refleksnu vazikonstrkciju** pulmonarnih arteriola sto preusmerava krvotok u ventilisano područje. To omogućava da se ravnoteža tj. slaganje perfuzije i ventilacije odrzi sto je moguce bliže normalnom stanju **(v/p podudarnost**)

nešto manje nakupljanje RF u vrhu pluca zbog gravitacije

RF u bronhu



Pozicija srca na scintigramu

Figure 10.5. Normal category 6-view Technegas ventilation (left) and perfusion (right) scan of each pair performed sequentially. Count rate of perfusion was >5 times that of ventilation images.

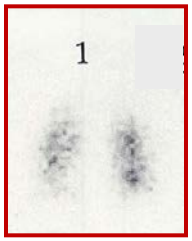
NORMALAN VENTILACIONI SCINTIGRAM PLUĆA

3 faze ventilacione scintigrafije pomoću gasa ^{133}Xe- **fiziološka distribiucija**

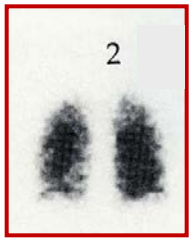
1. **Wash-in** (udisanje)
2. **Ekvilibrium**
3. **Wash-out** („ispiranje“)

posteriorna projekcija, dinamska studija

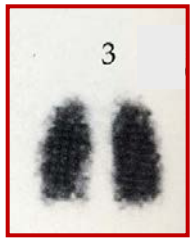
Xe je liposolubilan gas: incidentan nalaz nakupljanje RF u masnoj jetri



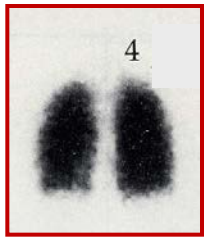
0 -15”



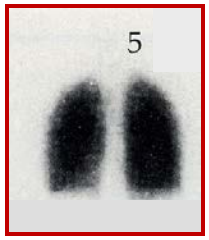
15 - 30”



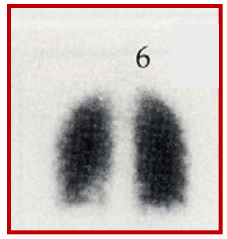
30 - 45”



45 - 60”



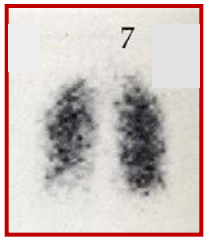
60 - 120”



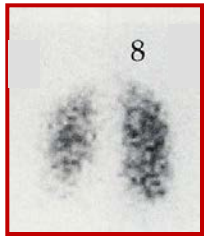
120 - 180”

WASH-IN

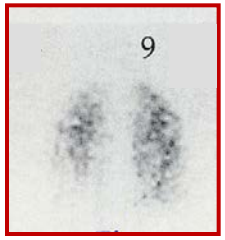
EKVILIBRIUM



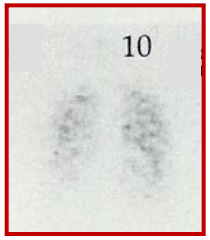
0 -10”



10 - 20”



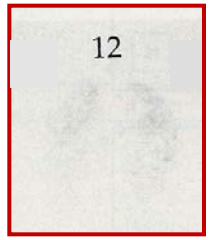
20 - 30”



30 - 45”



45 - 60”

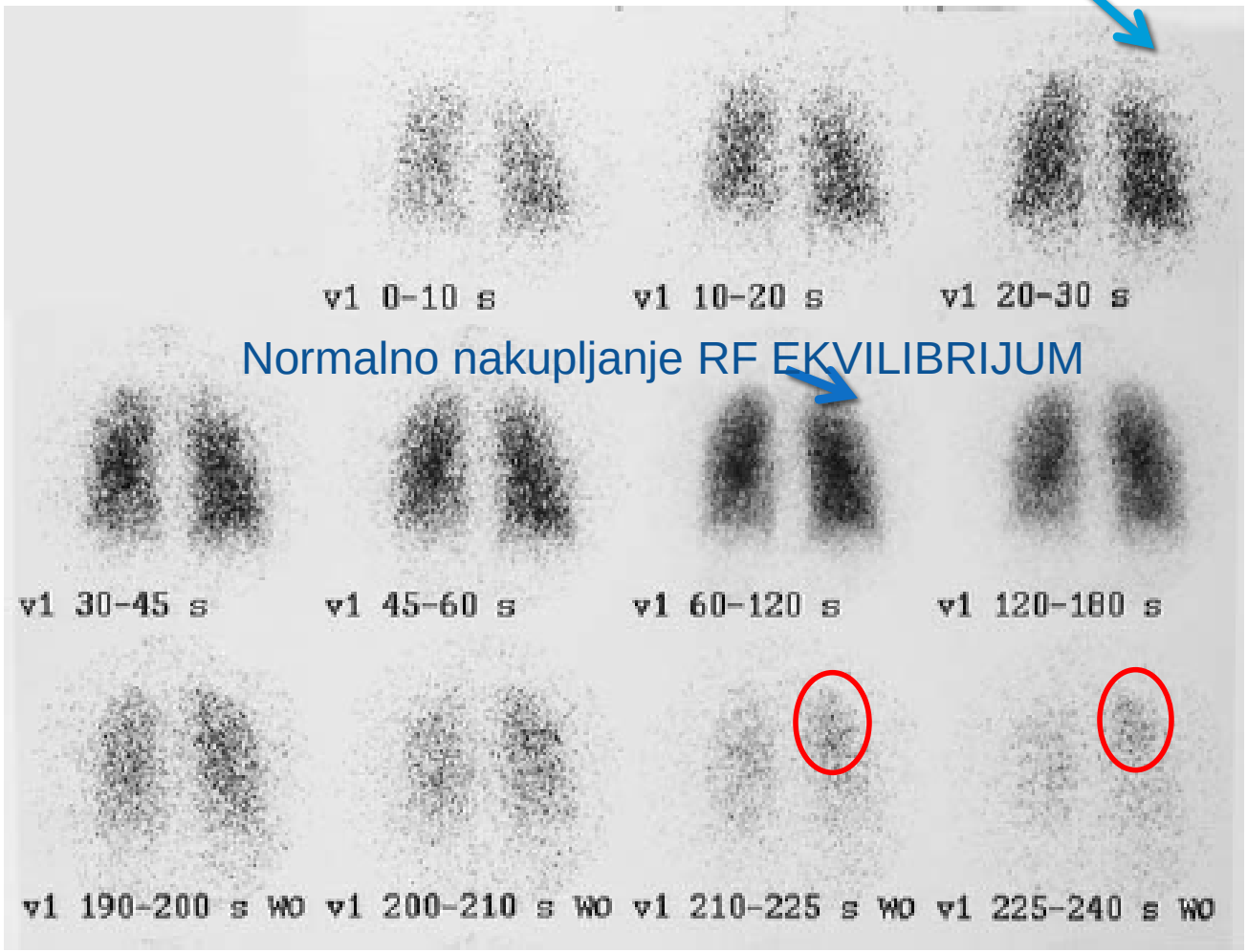


60 - 75”

WASH-OUT

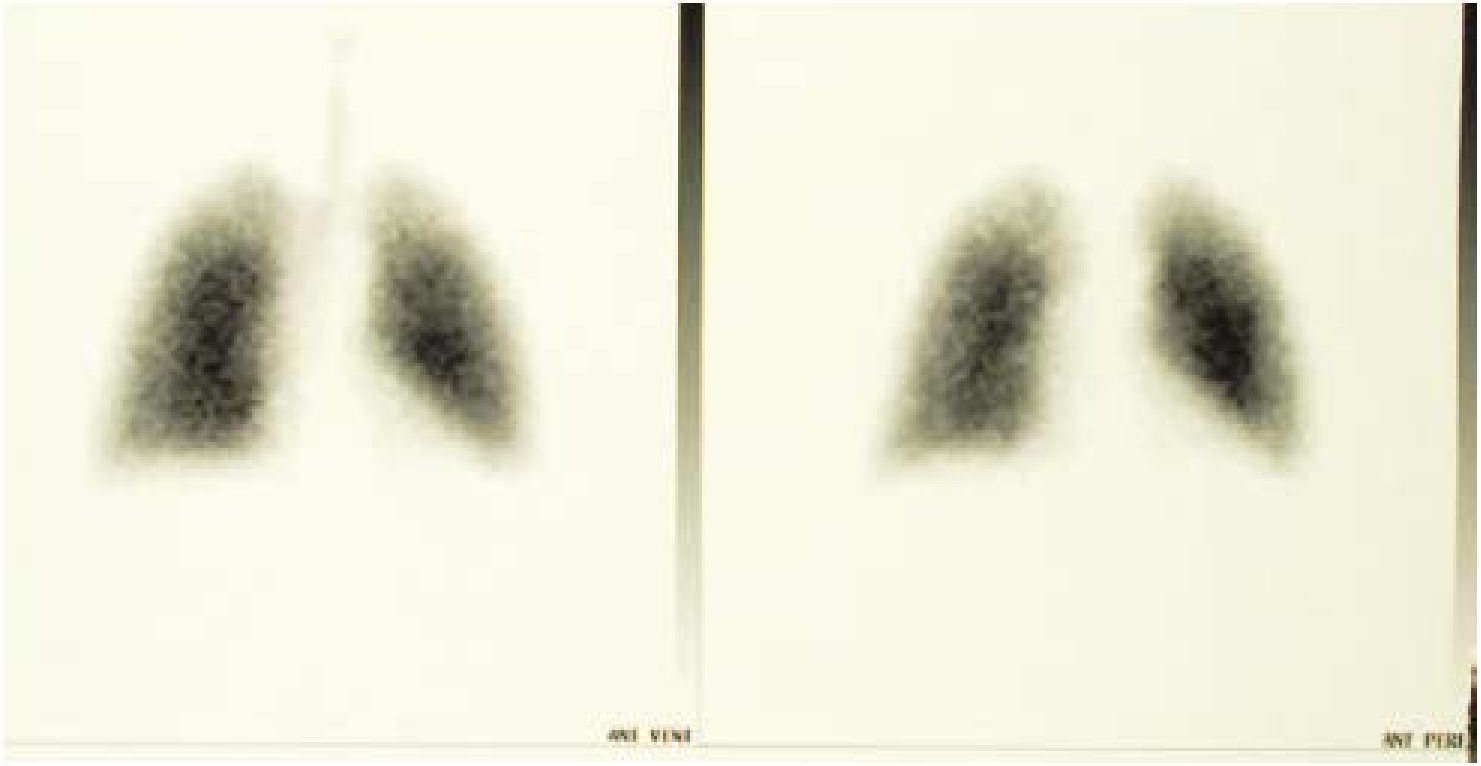
PA projekcija ^{133} Xe ventilacionog scintigrama

smanjeno nakupljanje RF u vrhu desnog pluća



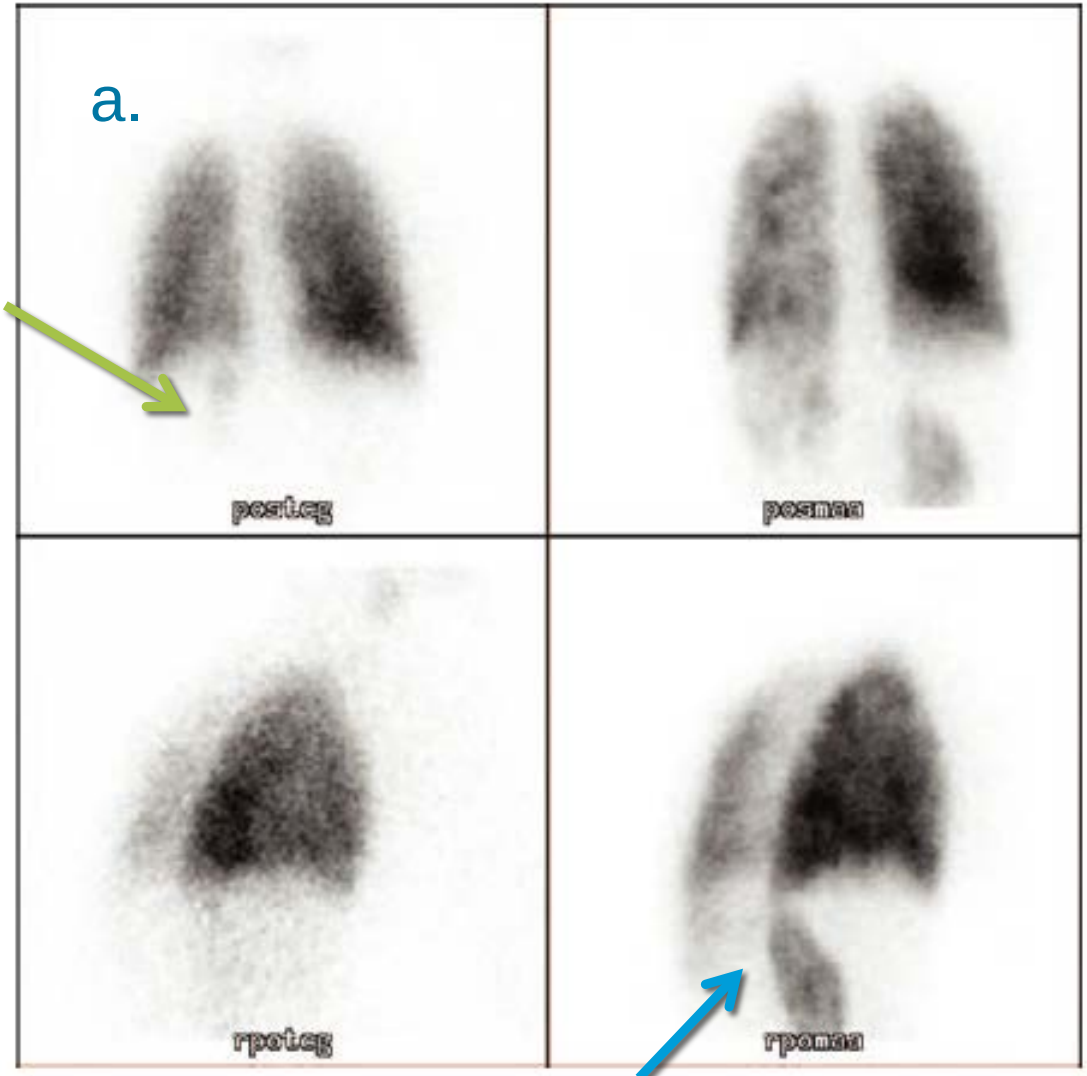
zadrzavanje RF u vrhu desnog pluća

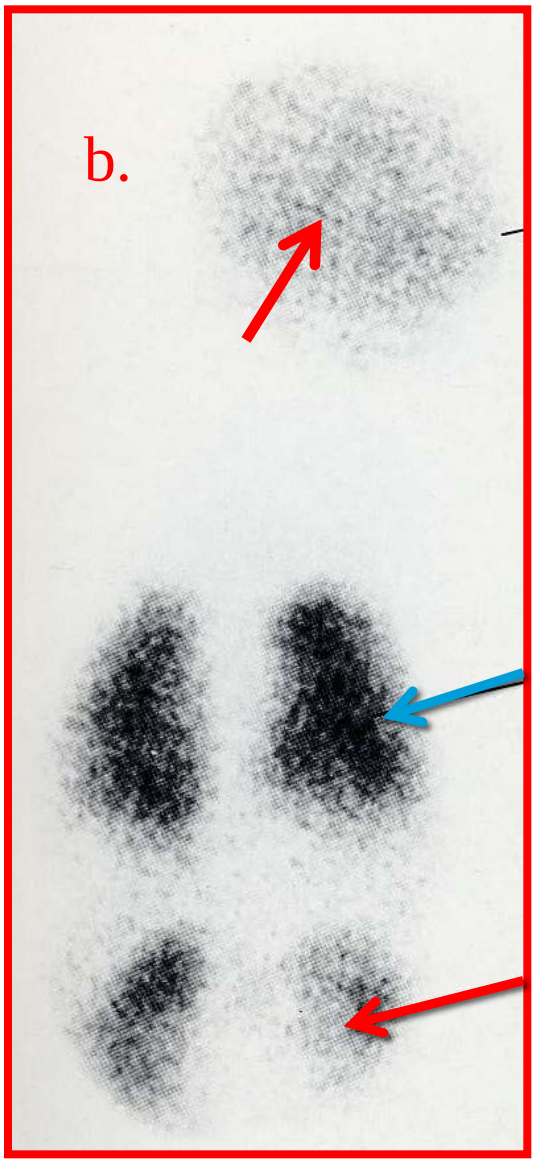
otežan *wash out* zbog spazma disajnog puta



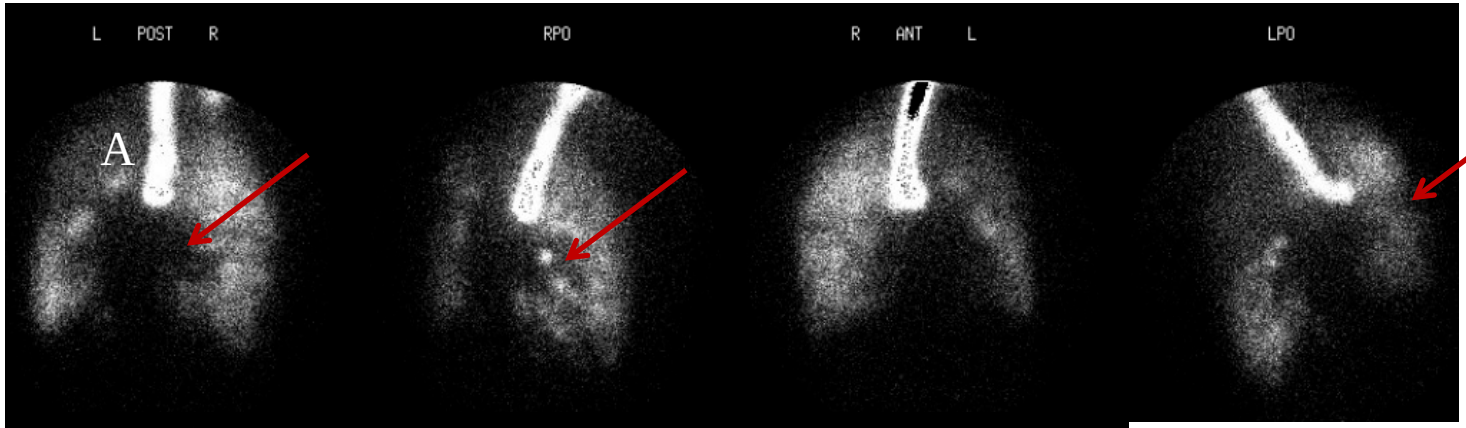
Normalan ventilaciono / perfuzioni scintigram
v/q match podudarnost (na oba scintigrama se prikazuje ravnomerna i intezivna akumulacija RF bez defekata u nakupljanju

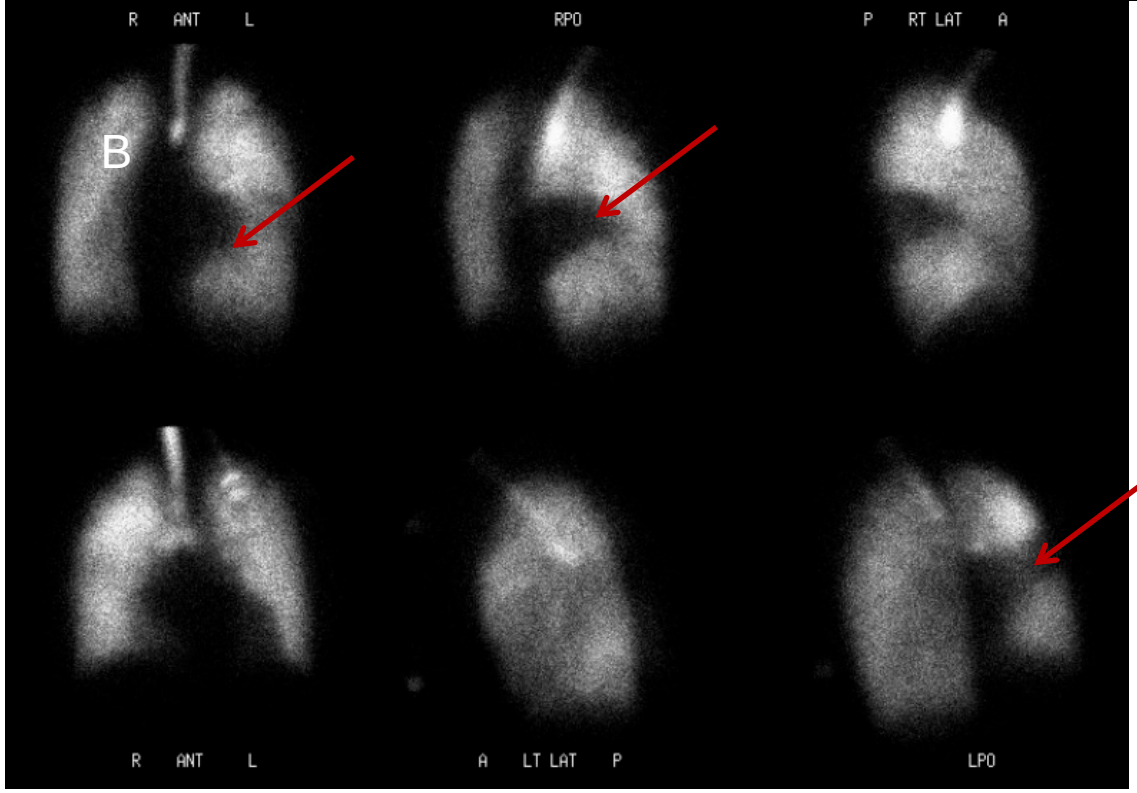
Ventilacioni scintigram Perfuzioni scintigram





na scintigramu se prikazuje nakupljanje RF u (a) bubregu bubrezima i mozgu (b) zbog postojanja desno-levog šanta

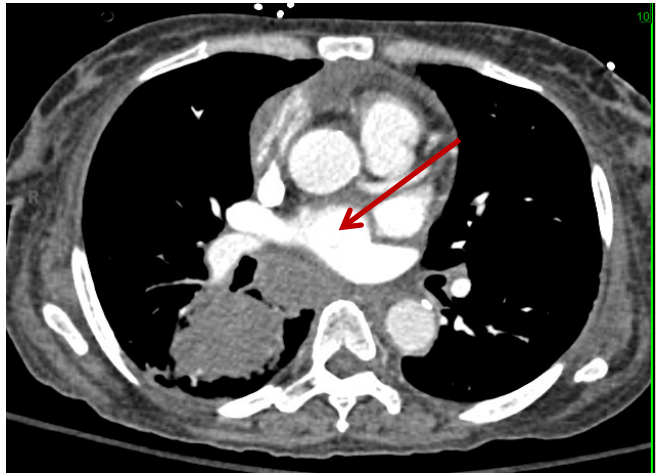






zašto je perfuzioni defekt veći od ventilacionog

^{99m} Tc DTPA aerosol ventilaciona scintigrafija (A)
Perfuziona scintigrafija (B)
V/Q match
superiorni segment donjeg desnog režnja; **defekt** izgleda veći na perfuzionom scintigramu



tumor pluća vidljiv na CT kao infrahilarna senka

optimalan broj čestica ^{99m}Tc MAA za perfuzionu scitigrafiju pluća je **100 000 – 200 000**

★ Smanjen broj čestica (do 60 000) se daje kod

- **dece**
- dokazanog ili kod sumnje na **D-L šant**
- teške **plućne hipertenzije**
- prethodne **pneumonektomije**
- **transplantacije** jednog plućnog krila

indikacije za V/P scintigrafiju pluća

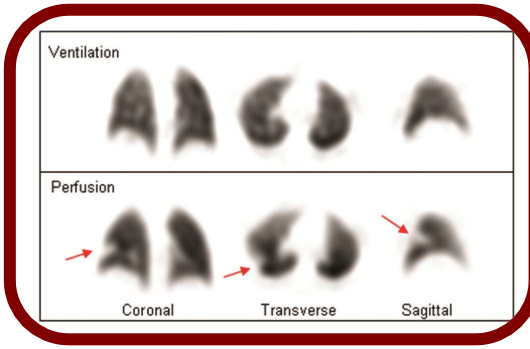
- akutna plućna embolija
- plućna hipertenzija
- preoperativna toraklana evaluacija
- desno-levi šant

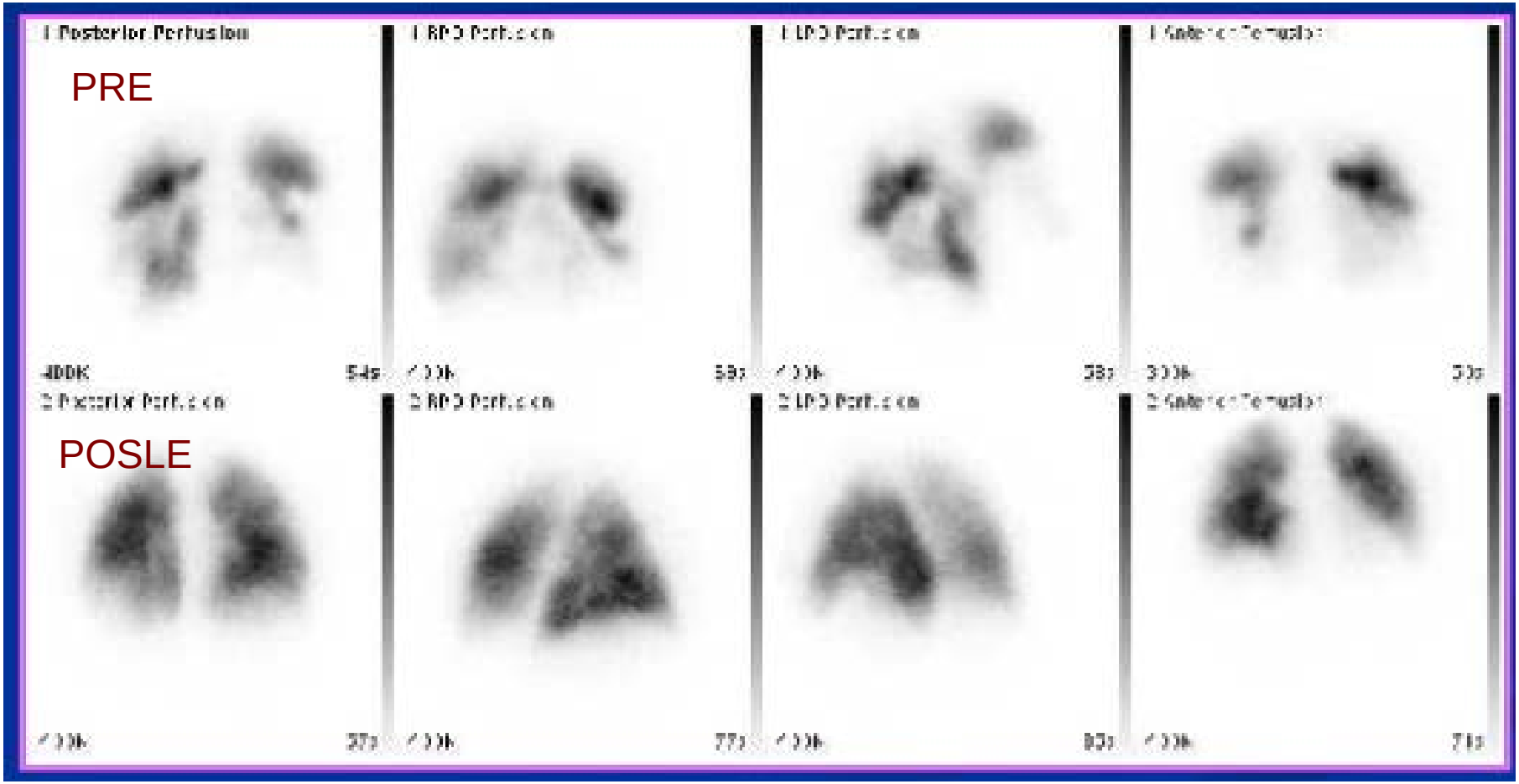
DIJAGNOZA PLUĆNE EMBOLIJE

- klinička (neprecizna): **dispnea**, **bol u grudima**, **hemoptiza**
- biohemijska: ↑ **D-dimer**
- gasovi u a. krvi: **hipoksemija**
- EKG: klasičan $S_1Q_3T_3$ nalaz
- Rtg nalaz: normalan ili blaga abnormalnost



- **V/P nepodudarnost**
- arteriopulmografija pod kontrolom CT
- **angiopulmografija zlatni standard**
- MR





perfuzioni scintigram PRE i POSLE antikoagulantne terapije kod bolesnika sa PLUĆNOM EMBOLIJOM

INTERPRETACIJA AKUTNE PLUĆNE EMBOLIJE

PIOPED kriterijumi

The **P**rospective **I**nvestigation of **P**ulmonary **E**mbolism **D**iagnosis

Verovatnoća da scintigram **(V/P nepodudarnost)** ukazuje na PE

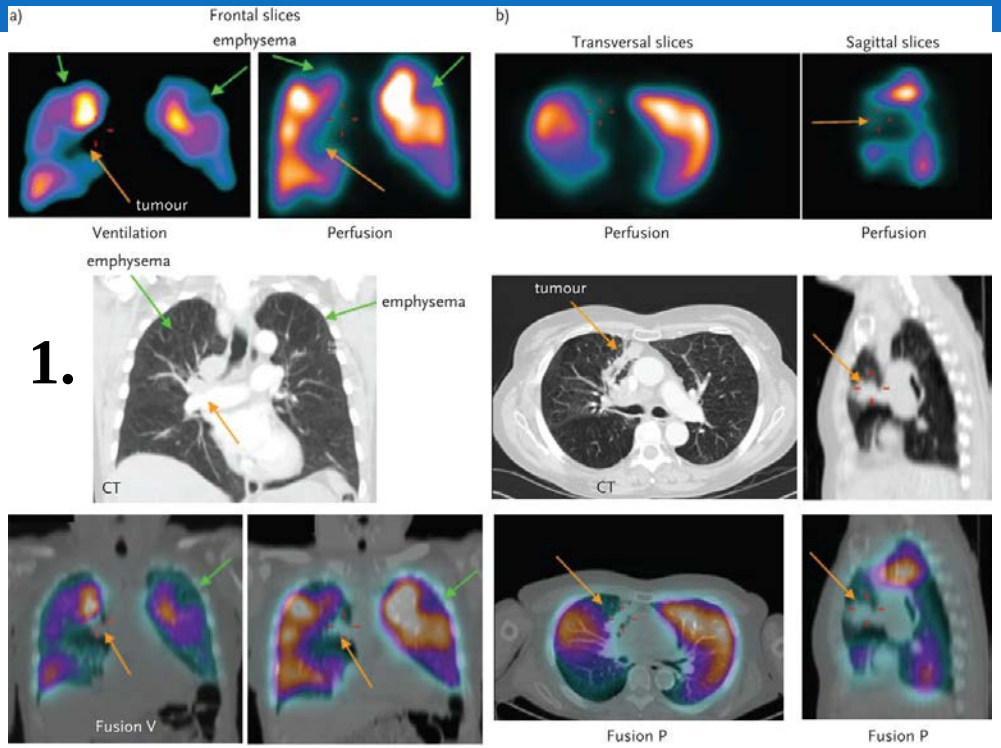
visoka : perfuzioni defekt preko 80% -najmanje 2 velike segmentne zone V/P nepodudarnosti uz normalan Rtg nalaz

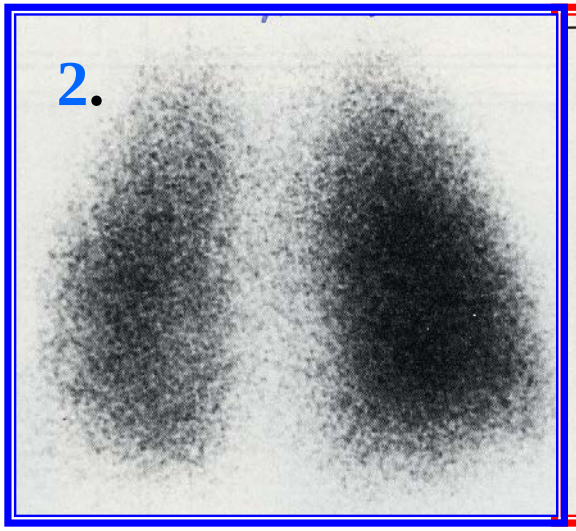
intermedijarna: p.d. 20-80%

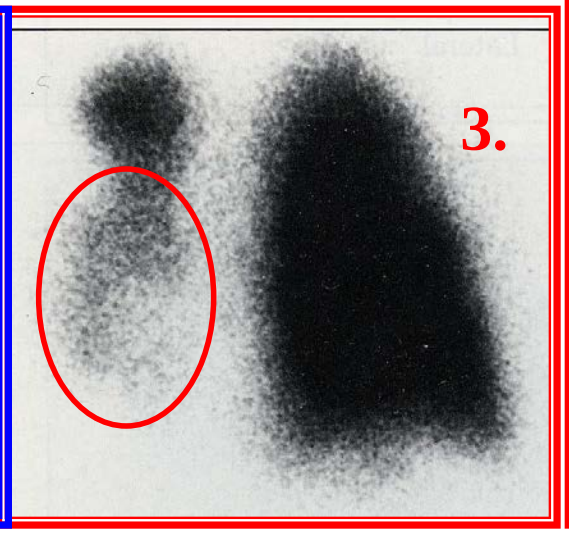
niska: p.d. manji od 20%

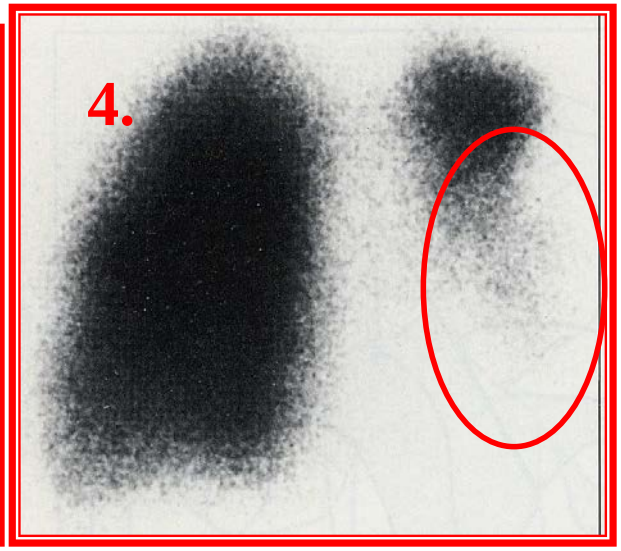
veoma niska: p.d. manji od 10 %

1. **SPET/CT V/Q u emfizemu**
2. **Ventilacioni sc. PA: smanjena ali prisutna ventilacija u LEVOM pl.krilu**
3. **PA: masivni perfuzioni defekt u LEVOM pl.k**
4. **AP: masivni perfuzioni defekt u LEVOM pl.k**







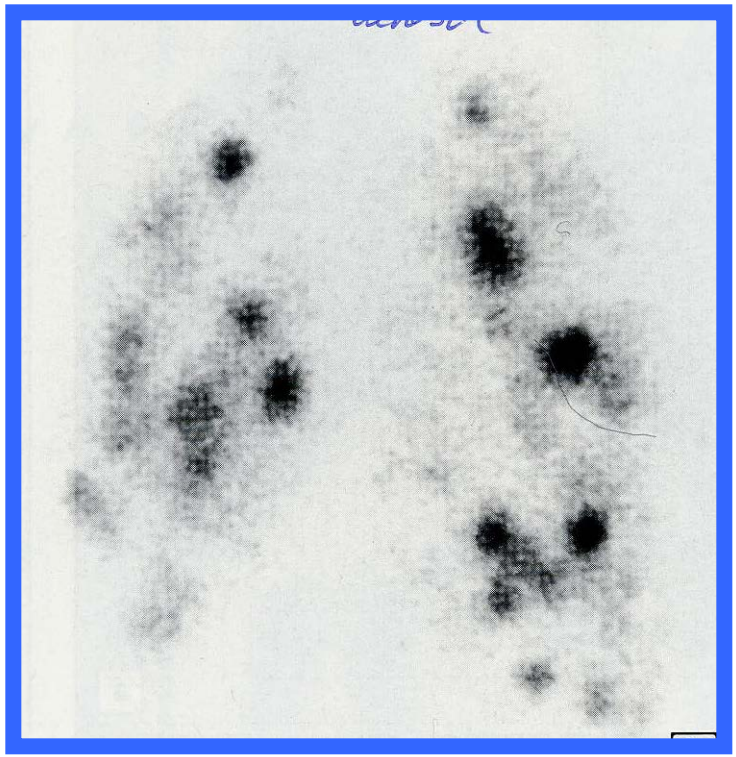


teška parenhimska bolest pluća

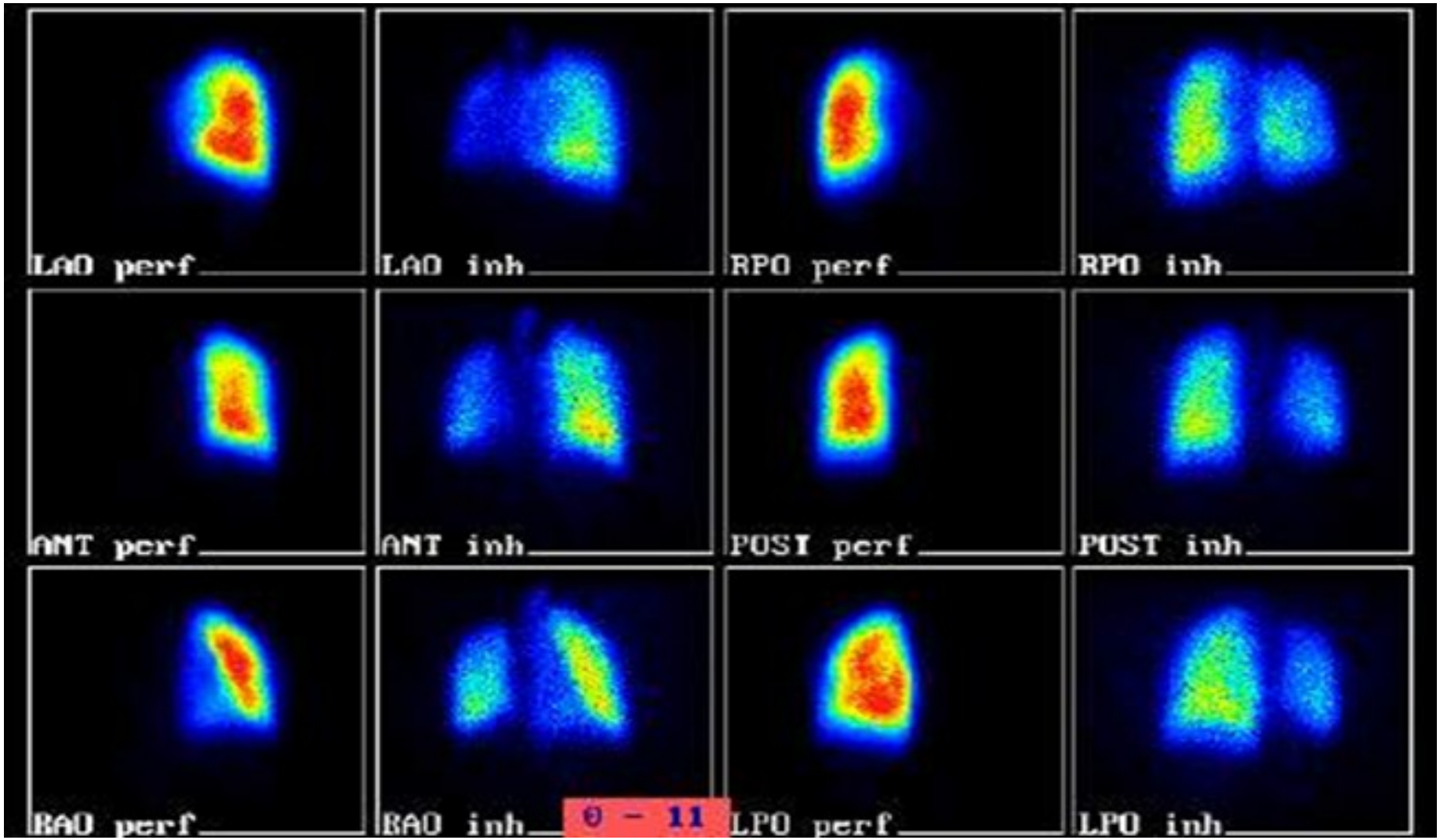
V/P podudarnost



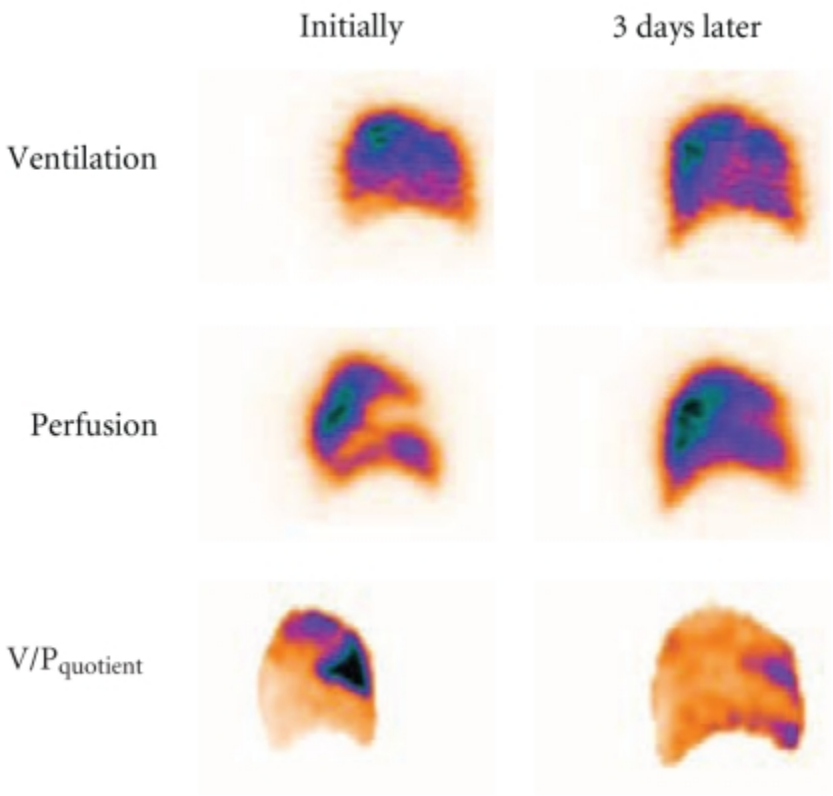
perfuzioni sc. ^{99m} Tc MAA



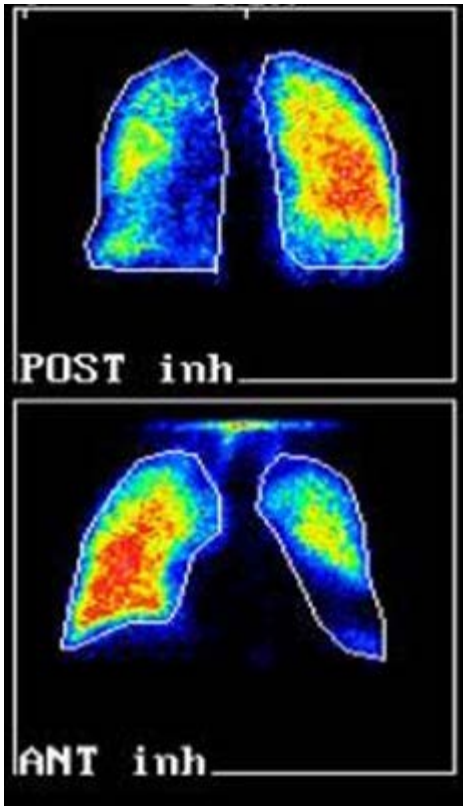
ventilacioni ^{99m} Tc DTPA aerosol

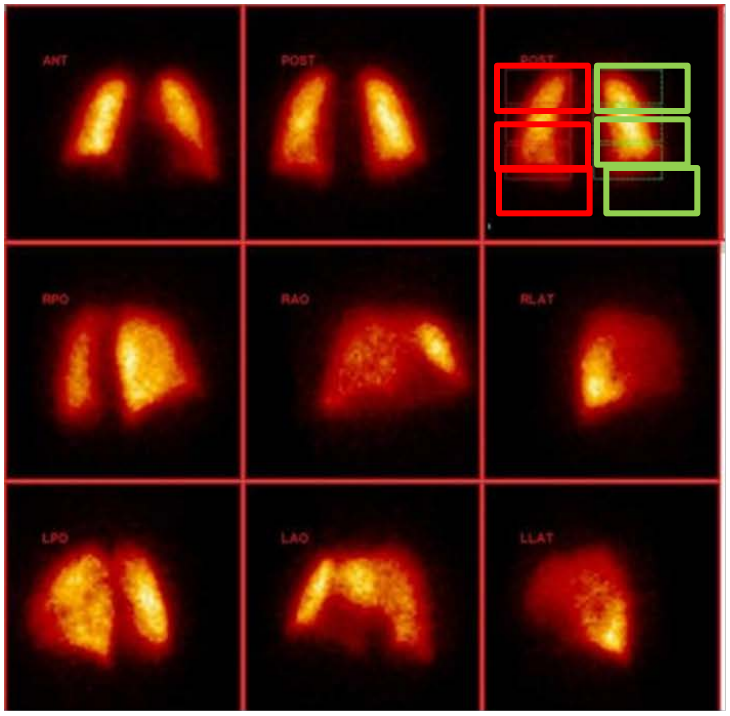


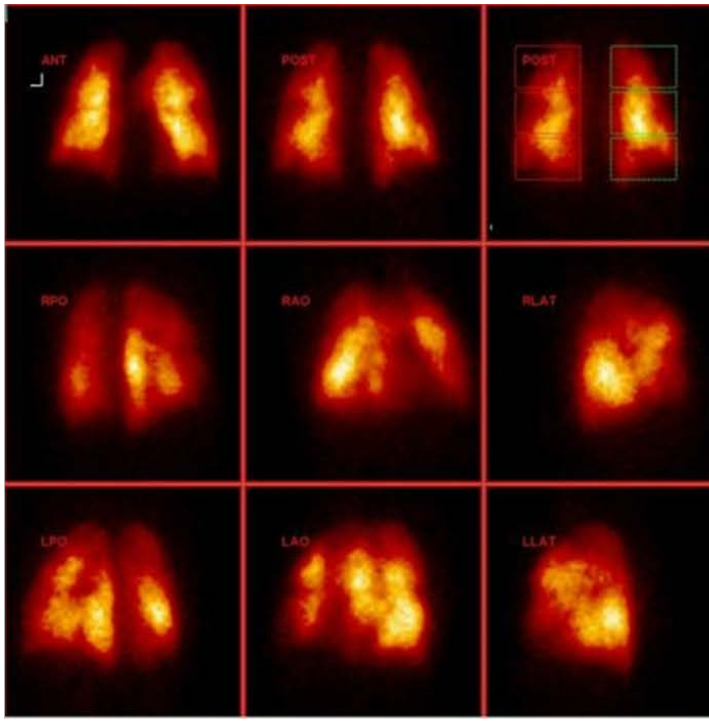
agenezija pulmonarne arterije
V/P nepodudarnost



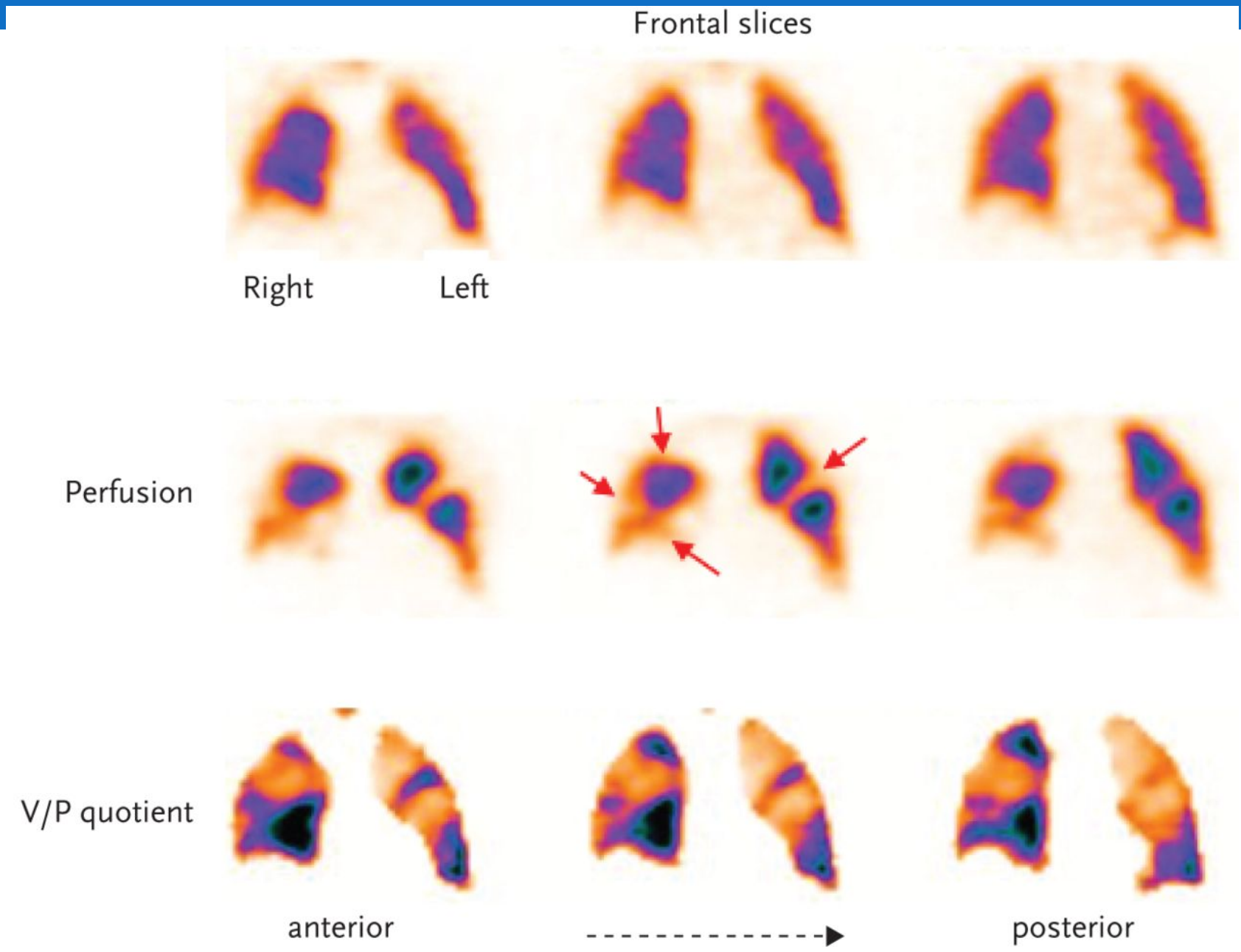
SAGITALNI PRESECI KOD PE: jasan perfuzioni defekt V/P nepodudarnost koja se popravila posle 3 dana i trombolitičke terapije

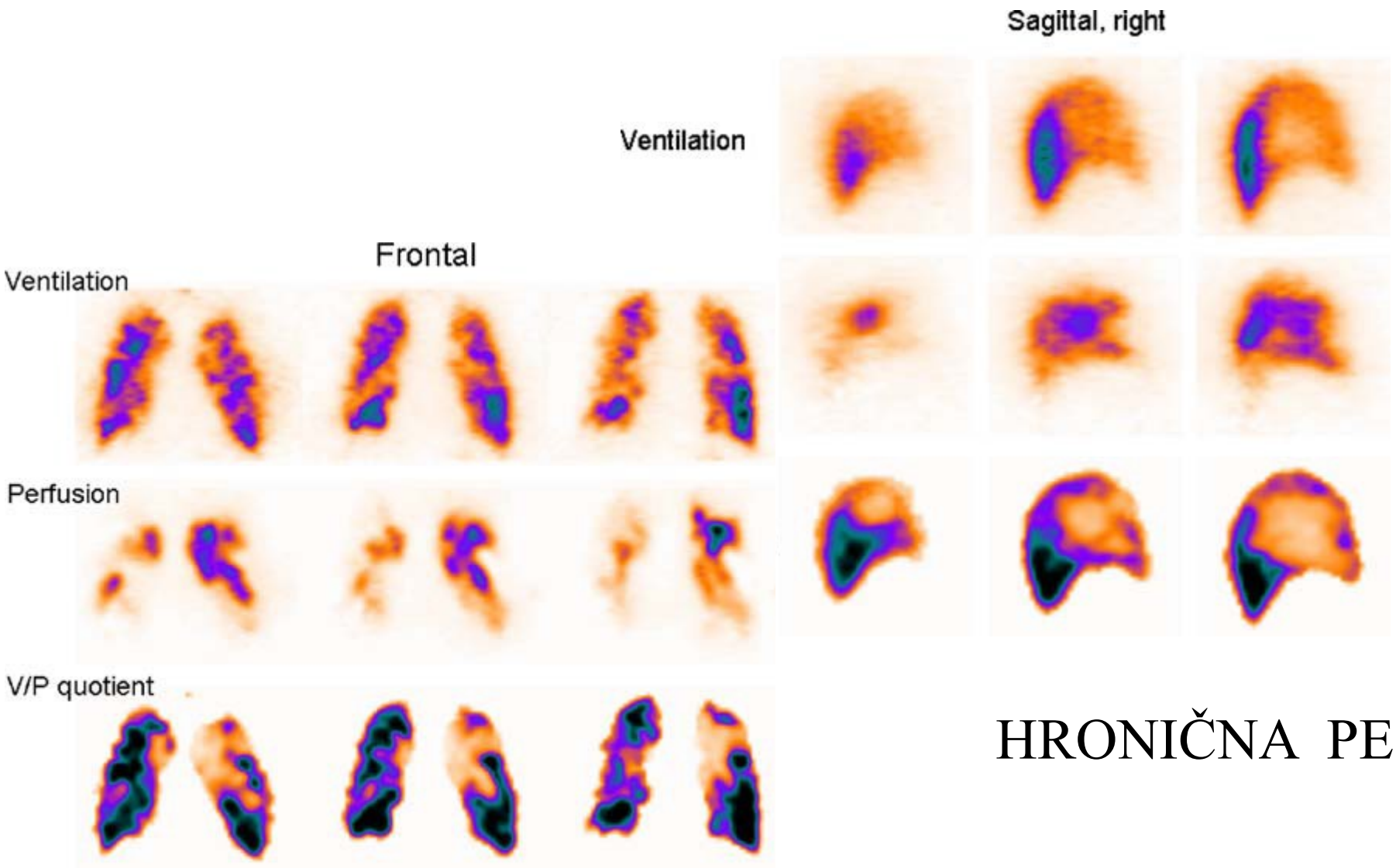






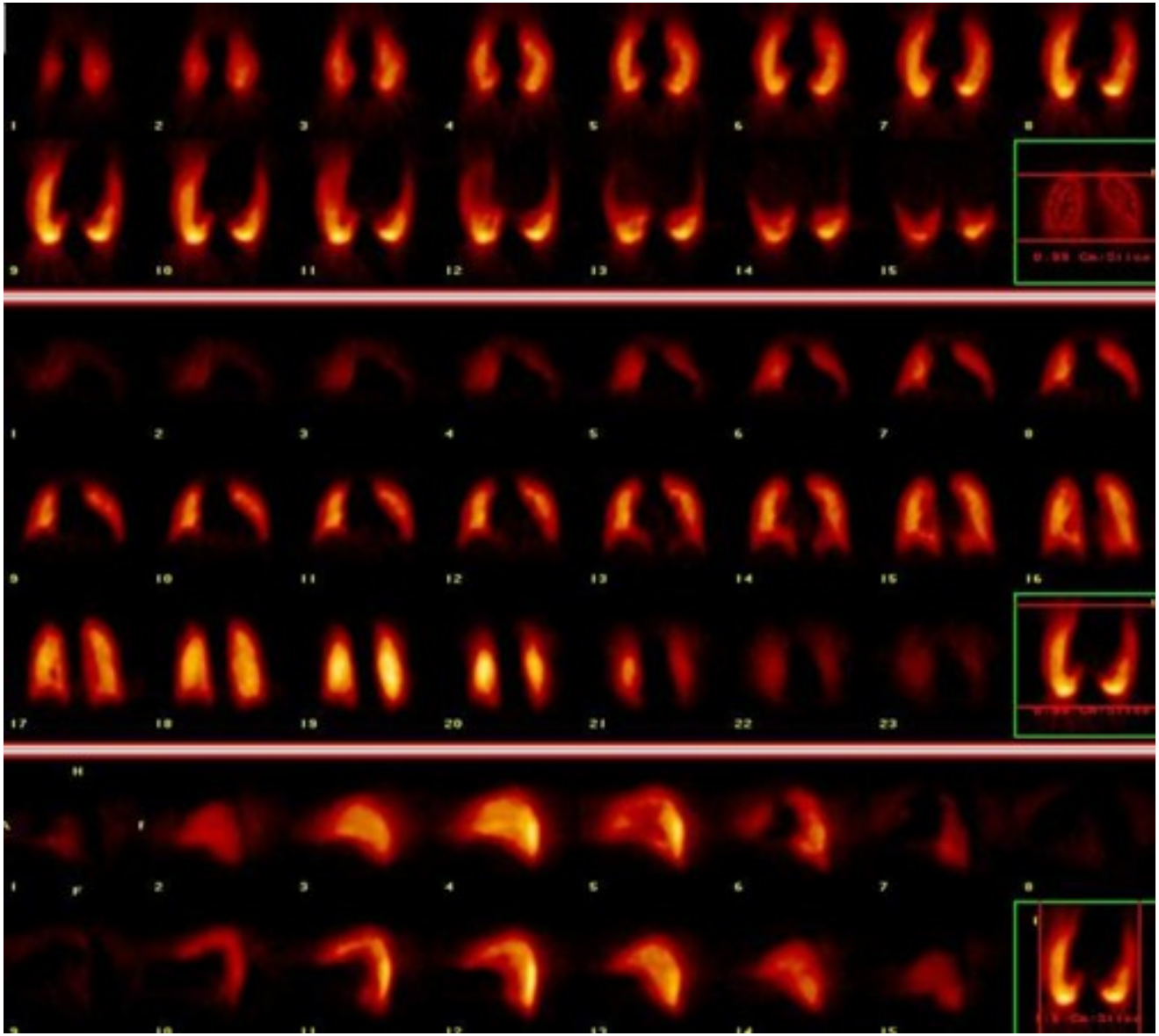
Određivanje odnosa nakupljanja RF u plućima pre pre pulmonektomije ocrtavanjem ROI (pravougaonici ili se ocrta silueta celog PK)


Frontal slices
Right
Left
Perfusion
V/P quotient
anterior
posterior



HRONIČNA PE

hronična opstruktivna bolest pluća



SPECT perfuziona scintigrafija