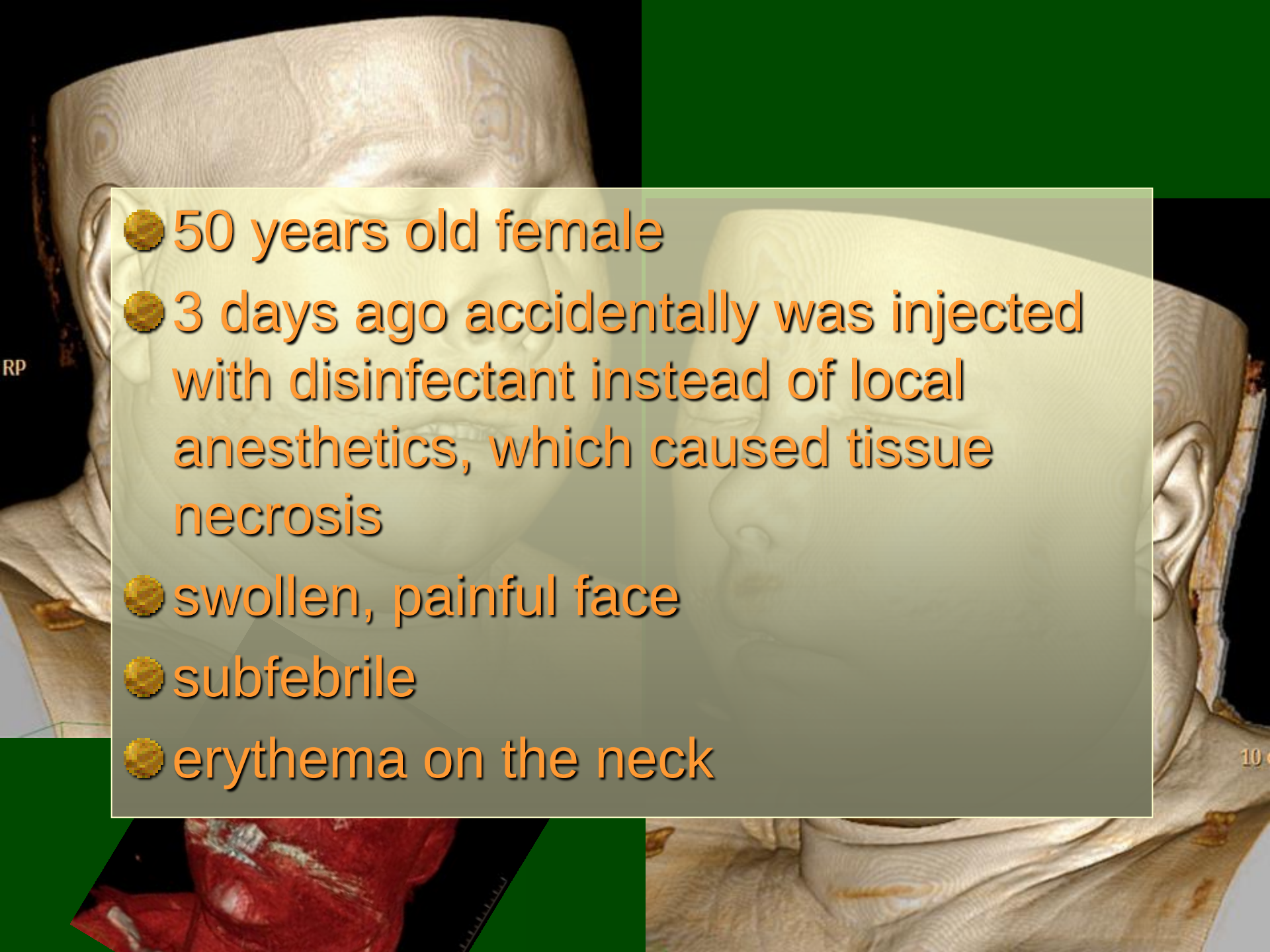
SEMMELWEIS EGYETEM
Department of Radiology

Role of modern imaging methods in maxillofacial diagnostics

Department of Diagnostic Imaging
Semmelweis University, Budapest

FOK V.
09/04/2018.



- 50 years old female
- 3 days ago accidentally was injected with disinfectant instead of local anesthetics, which caused tissue necrosis
- swollen, painful face
- subfebrile
- erythema on the neck

Which diagnostic method would help here???

Questions that could be considered?

- Extent of inflammation?
- State of the organs in the region?
- Crepitation- fluctuation?
- Abscess formation?

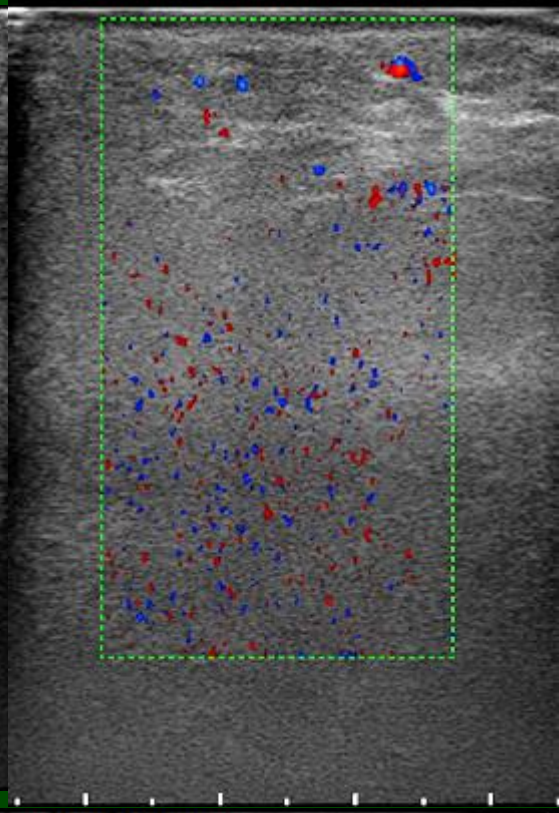
Most important: is there any Abscess?
If so = surgery

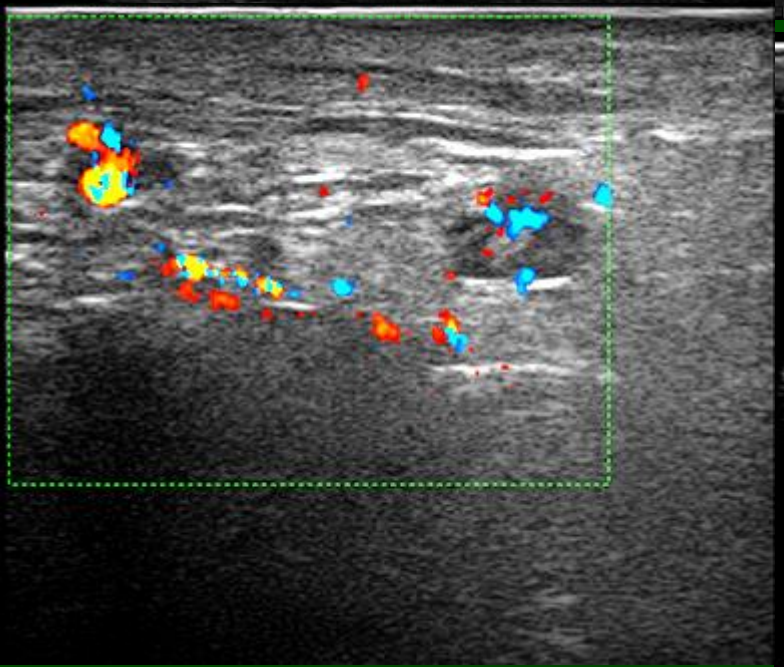
Specific examinations
Definite question – calls for a straight answer

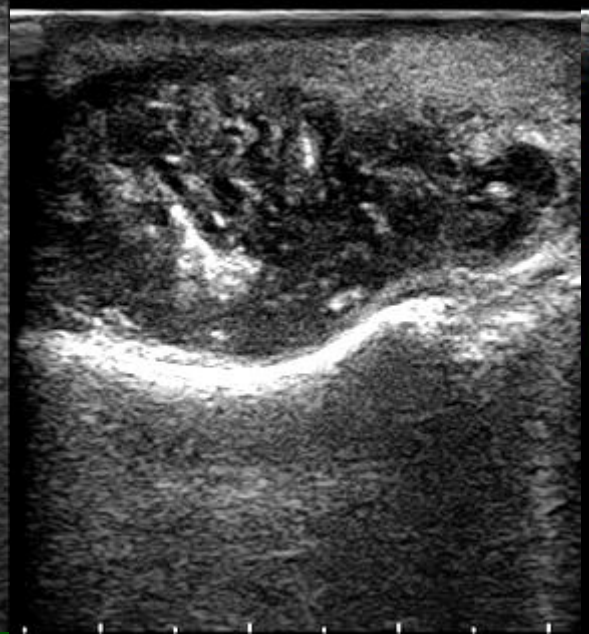
- Step 1:
  Ultrasound examination of he neck
- Step 2:
  crossectional imaging method – non contrast and contrast enhanced CT

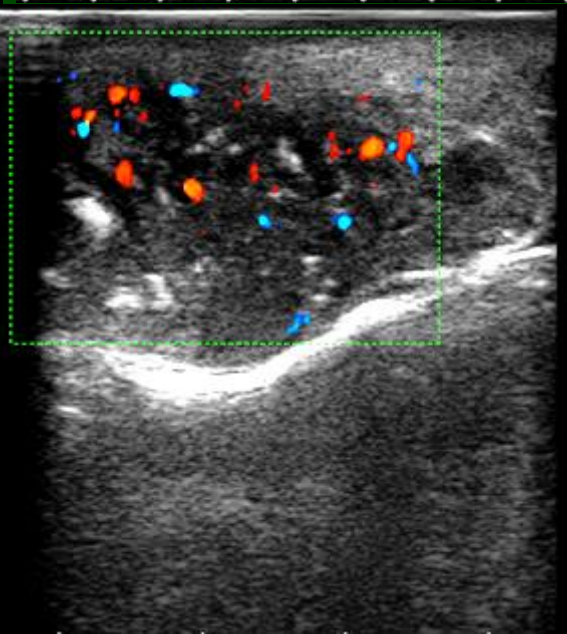
- Abscess?

US

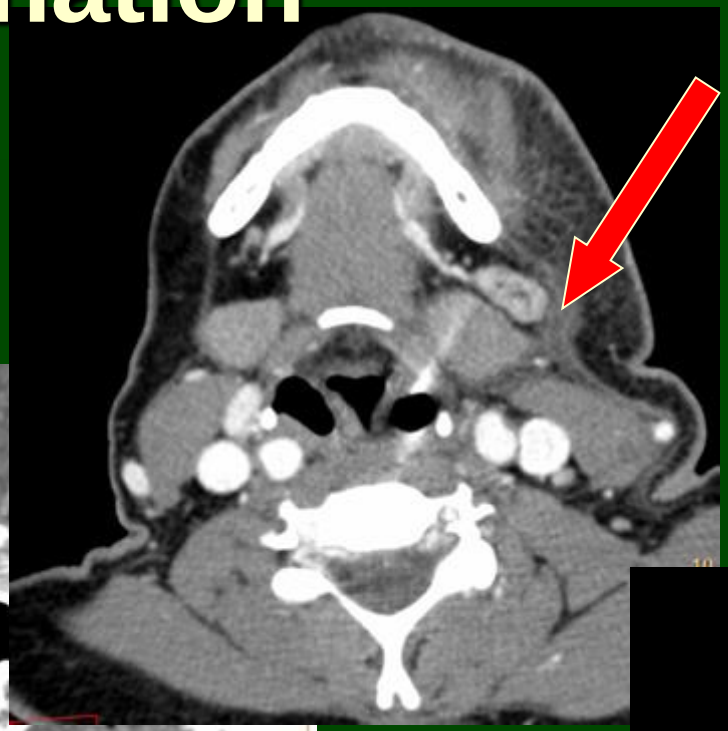


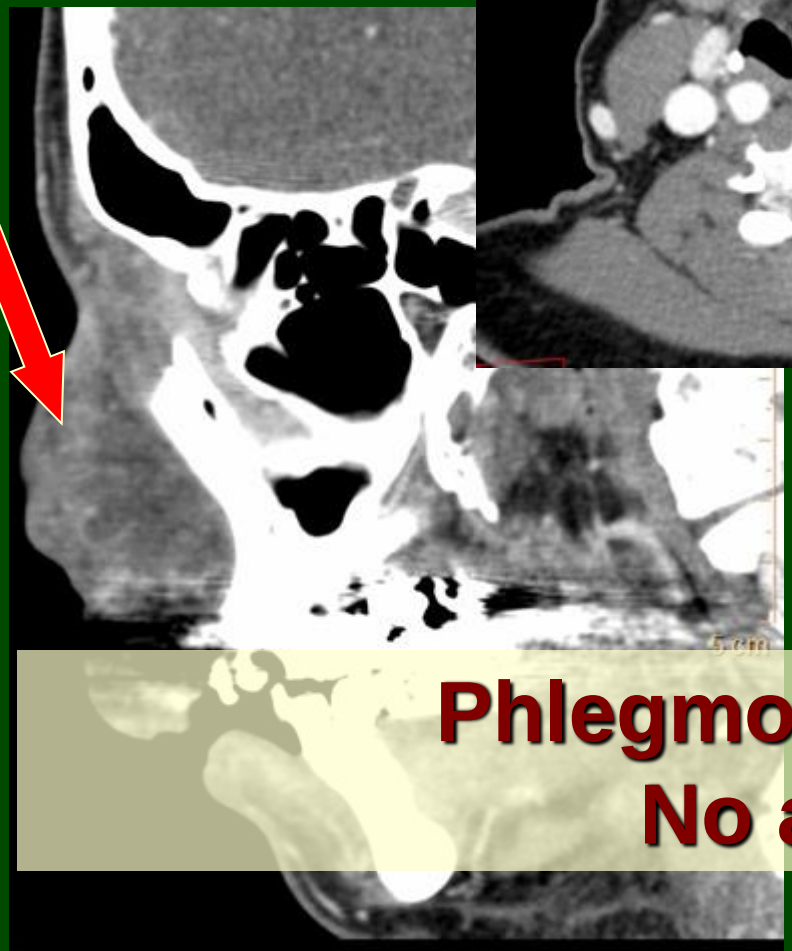






CT examination





Phlegmone (cellulitis).
No abscess.

Diagnostioc Imaging methods

- Ultrasound
- Conventional X-ray (+ fluoroscopy)
  - Non-contrast
  - Contrast enhanced
- CT (Multislice, cone-beam) / MR
- Angiography
  - DSA
  - CT-, MR-Angiography
- Molecular medicine
  - scintigraphy
  - SPECT (single photon emission computed tomography)
  - PET (positron emission tomography), PET-CT

US

- Image is based on soundwave reflections
- Bones and gases cannot be examined
- solid ↔ cystic DD -excellent
- Lower depth ↔ higher resolution
- Flow related measurements (Doppler)
  - Direction, speed → stenosis,
  - vascularization → inflammation, tumor
- biopsy guidance (FNAB, core)

US

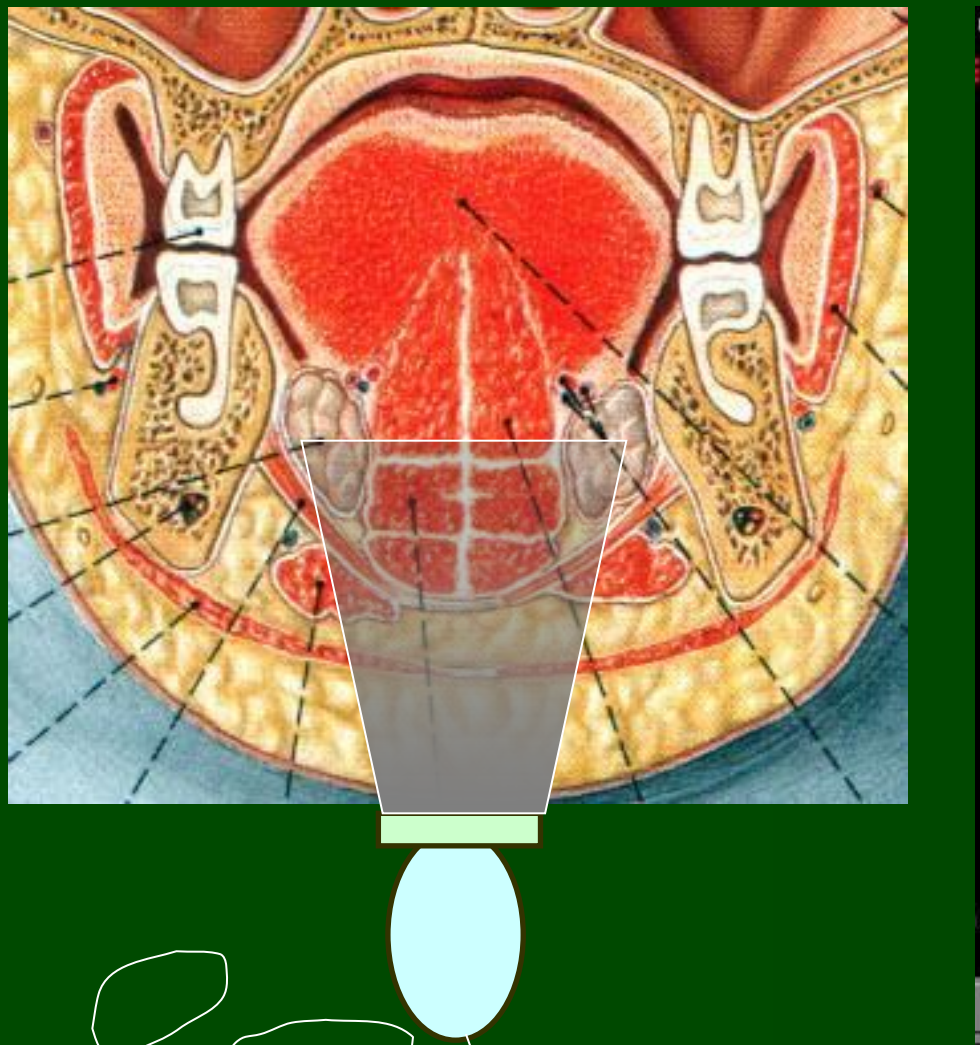
Indications

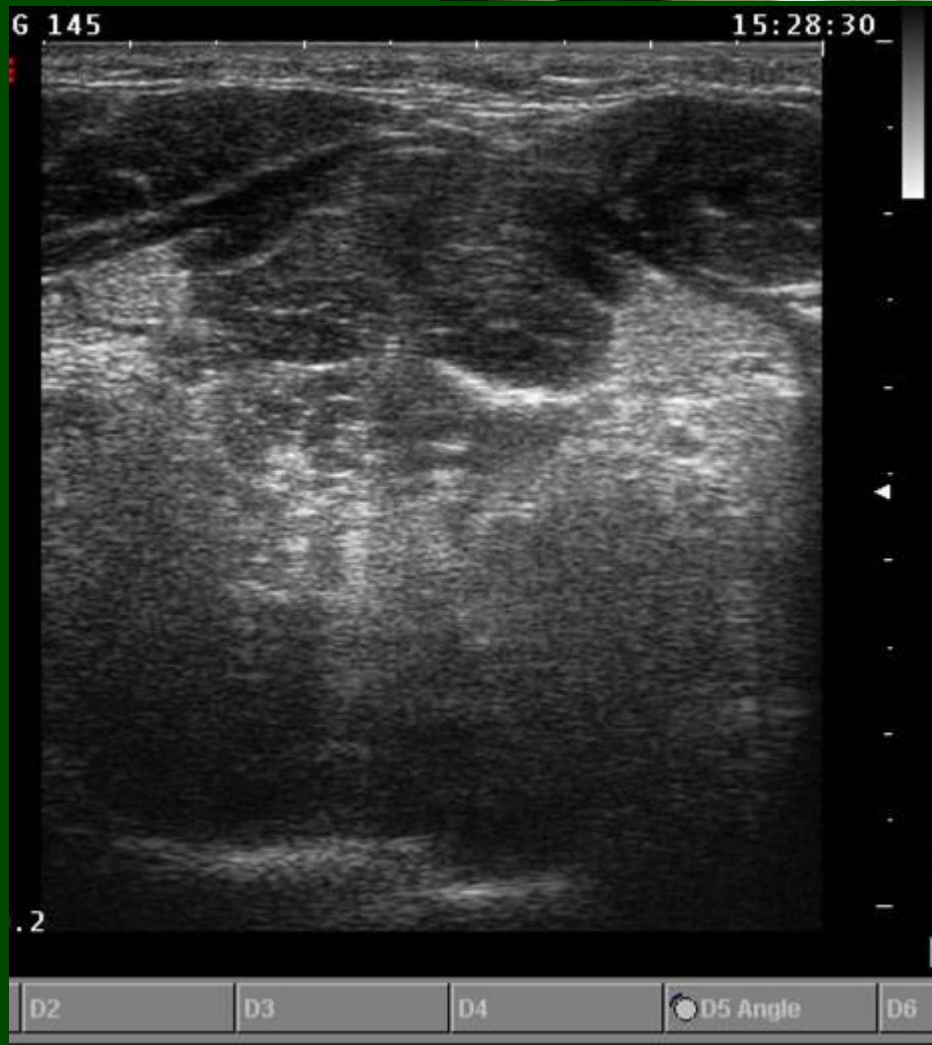
- face
- Floor of the mouth
- Superficial layers of the neck
- Above bones
- Main lymph node regions

Preparation

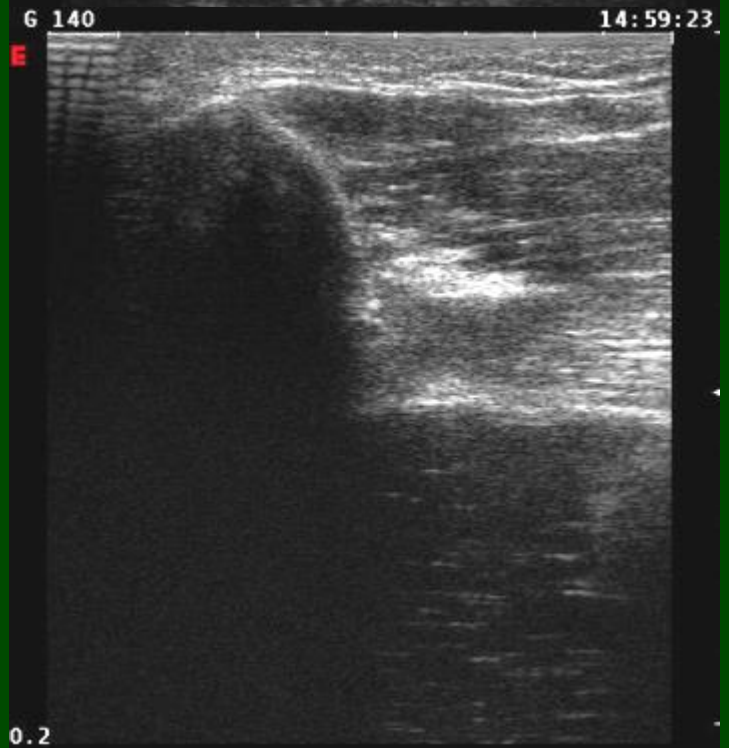
- Jewelry needs to be taken off
- Bandage removal
- tracheostomy line if possible removed
- Consent in case of contrast enhanced examinations or biopsies

Extraoral



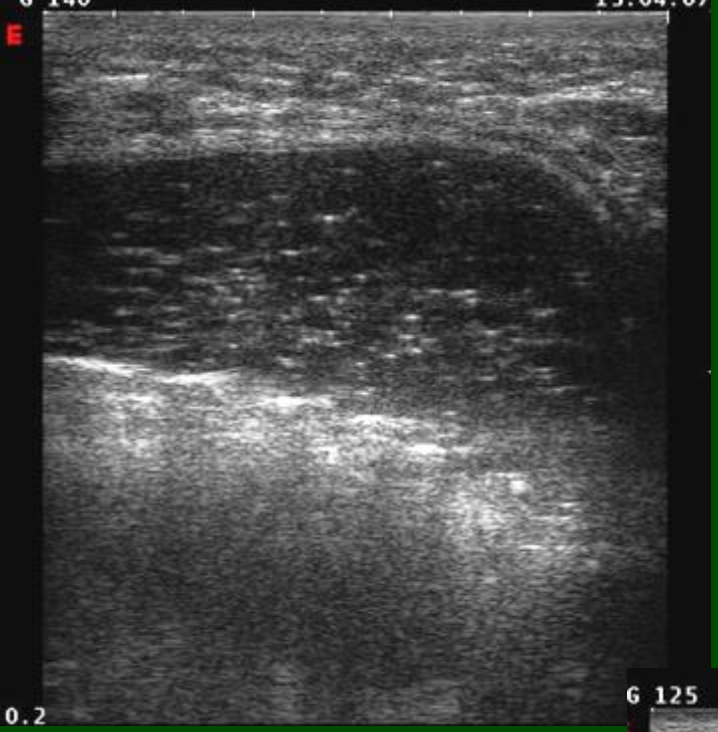


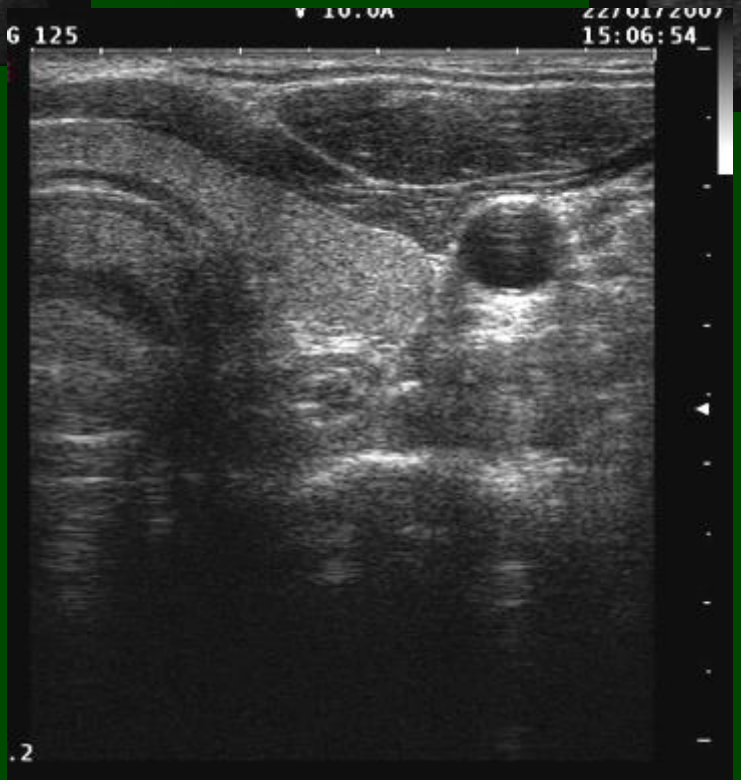

G 130
14:58:01


G 140
14:59:23
0.2

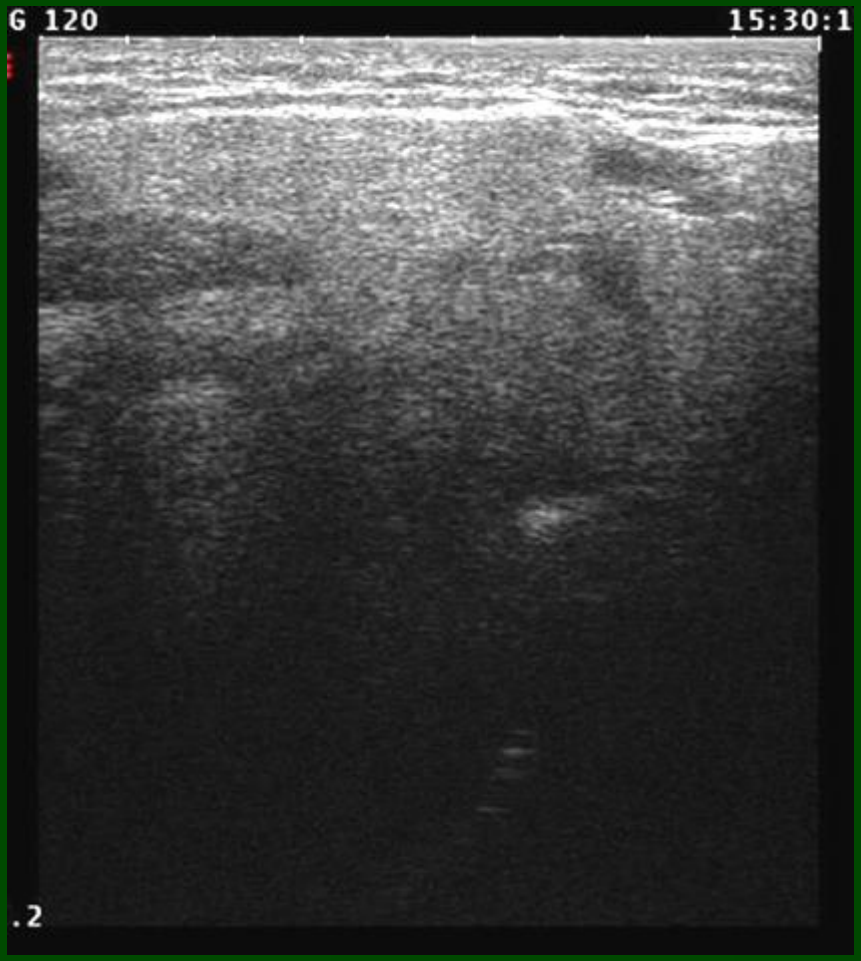

G 140
15:01:32
0.2

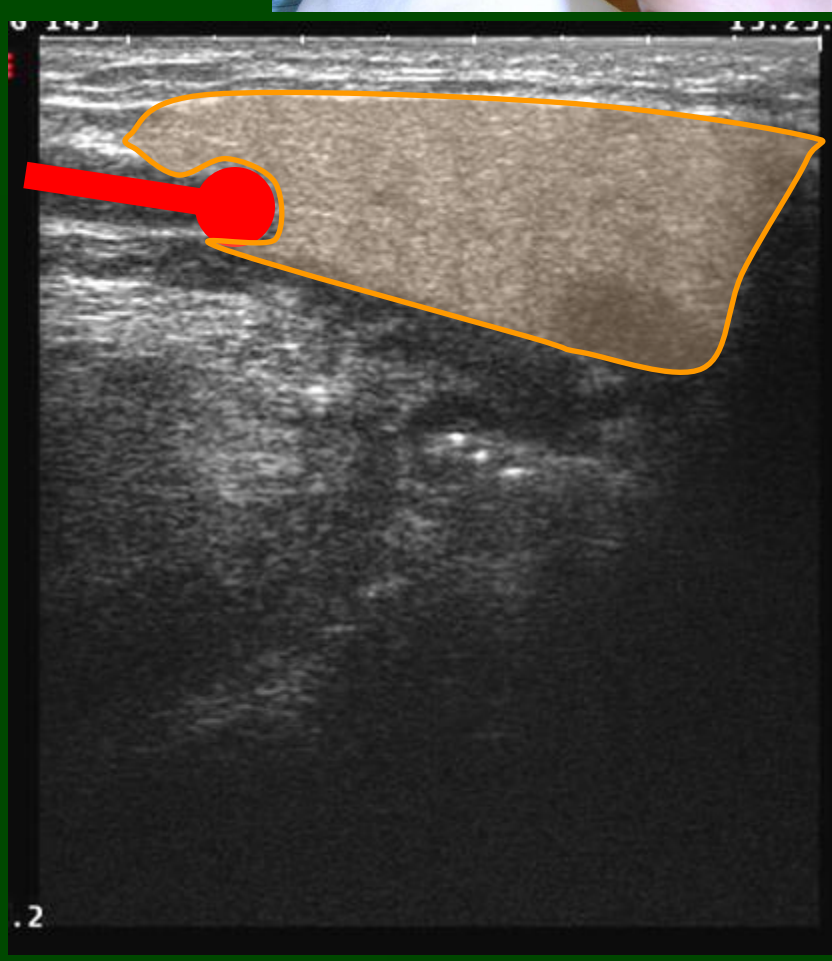
Bucca



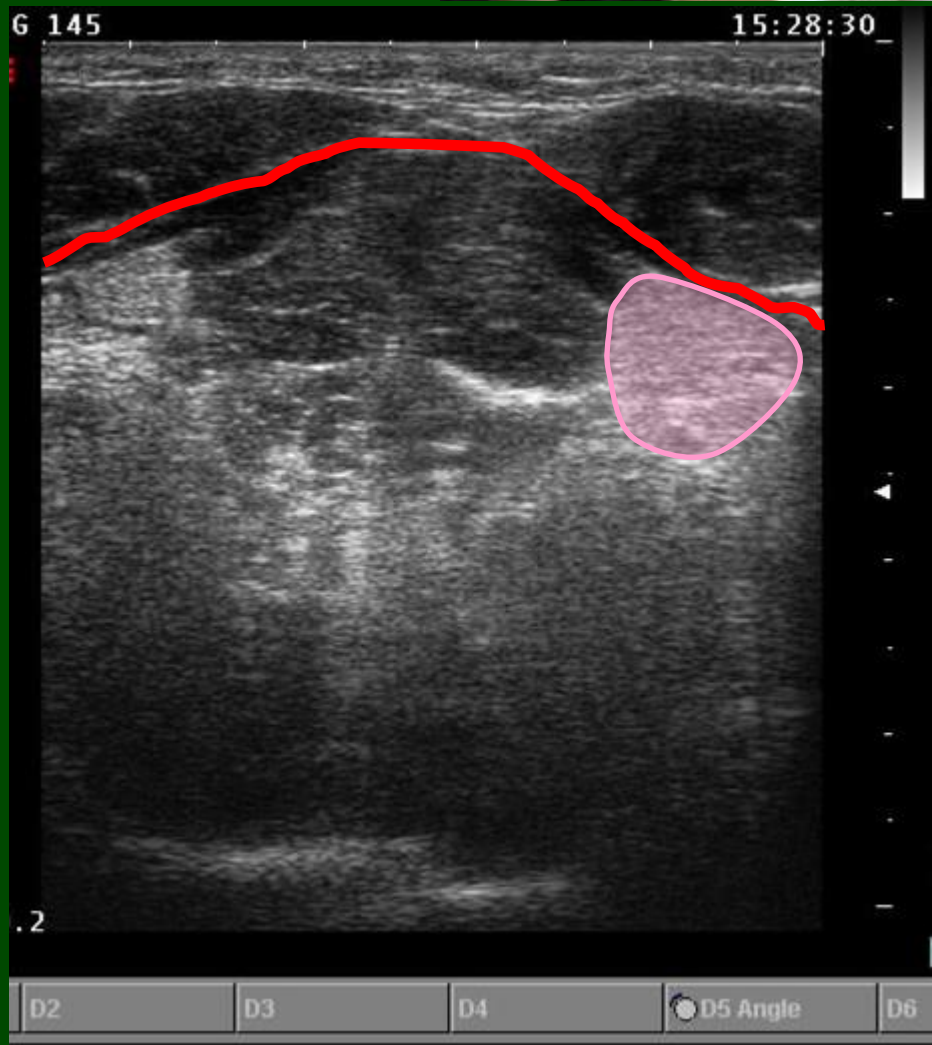


Submandibular region





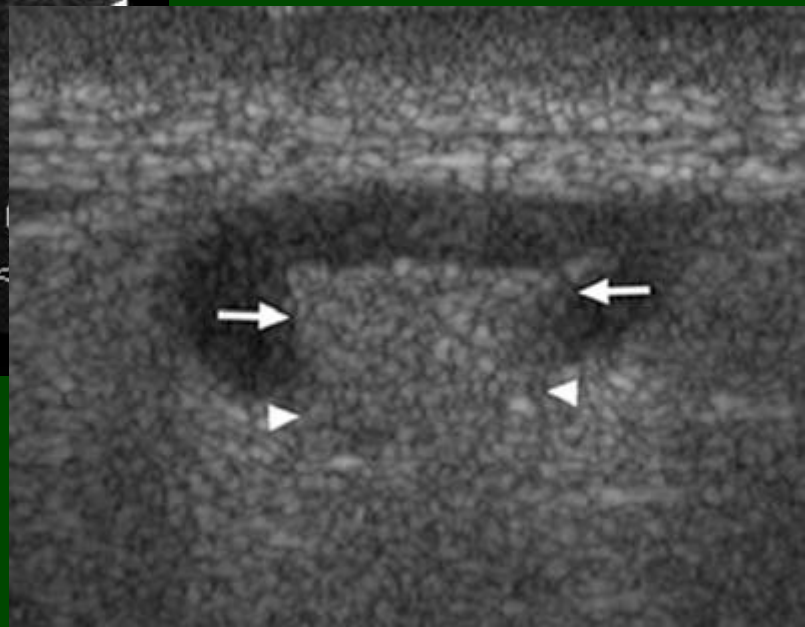
Floor of the mouth



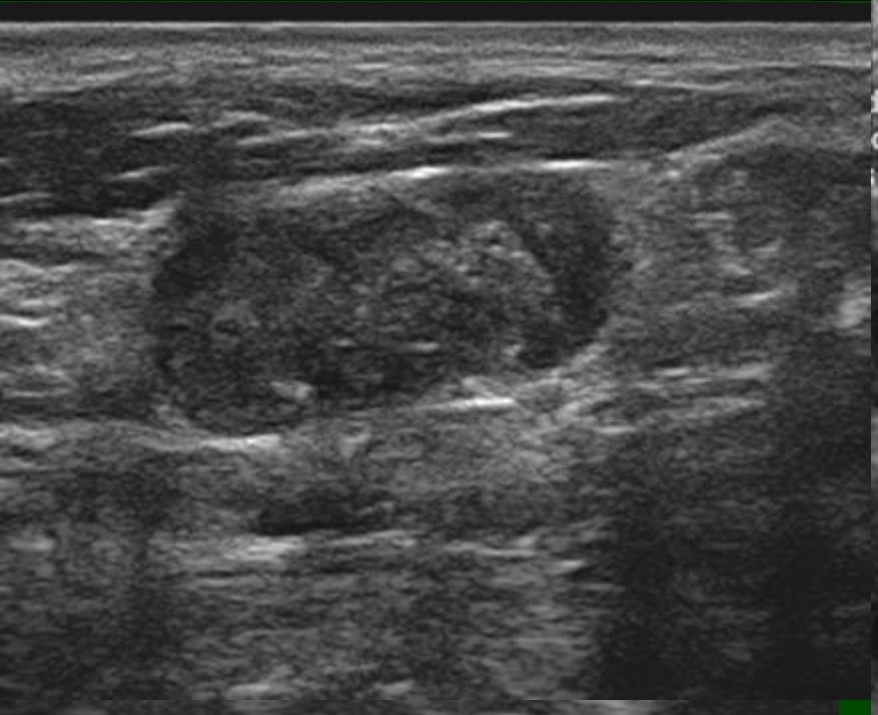
Thyroid left lobe

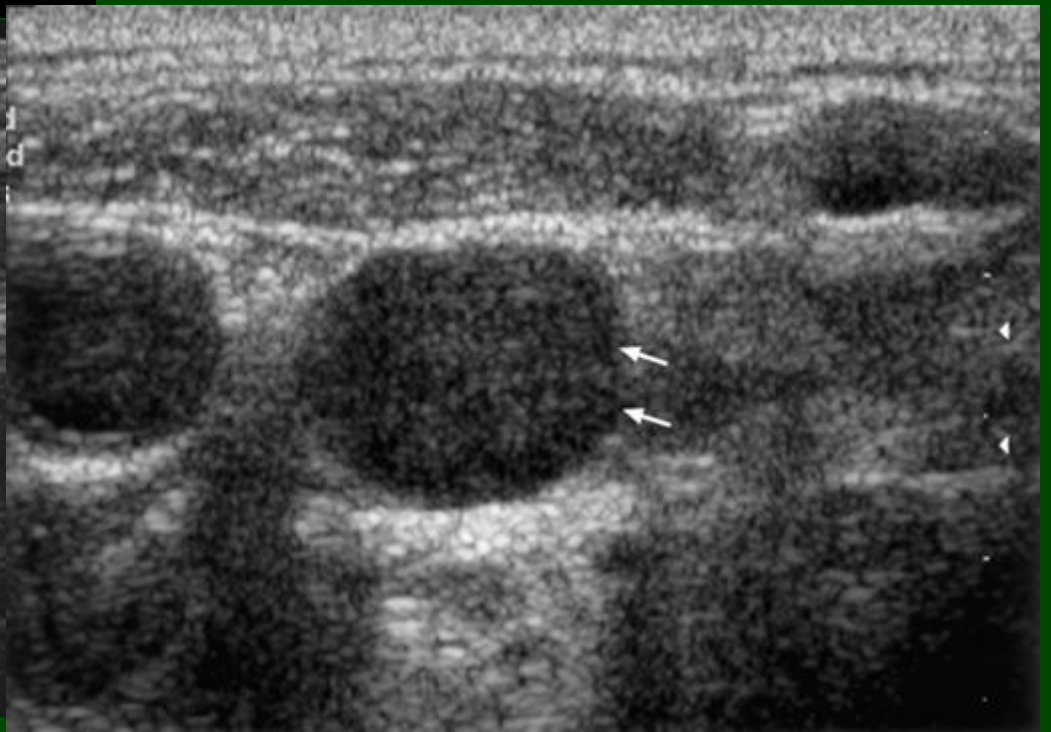
Lgl

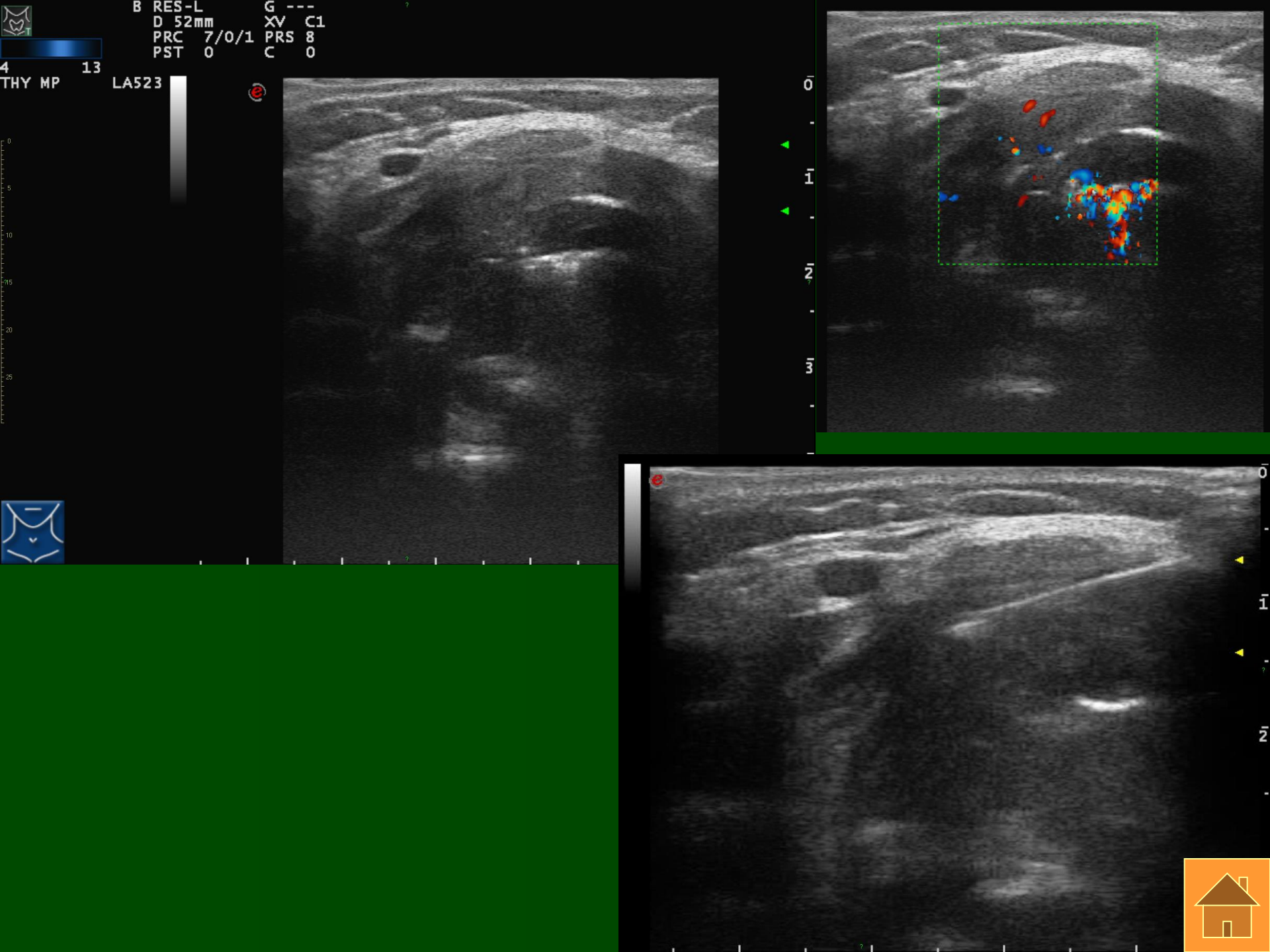

B:12.5/ DPT 41 mm / G 125
11:36:44
D 1: 8.3 mm
D 2: 23.8 mm
D: 8.0 mm
-1.4dB MI 0.7 TIS 0.2

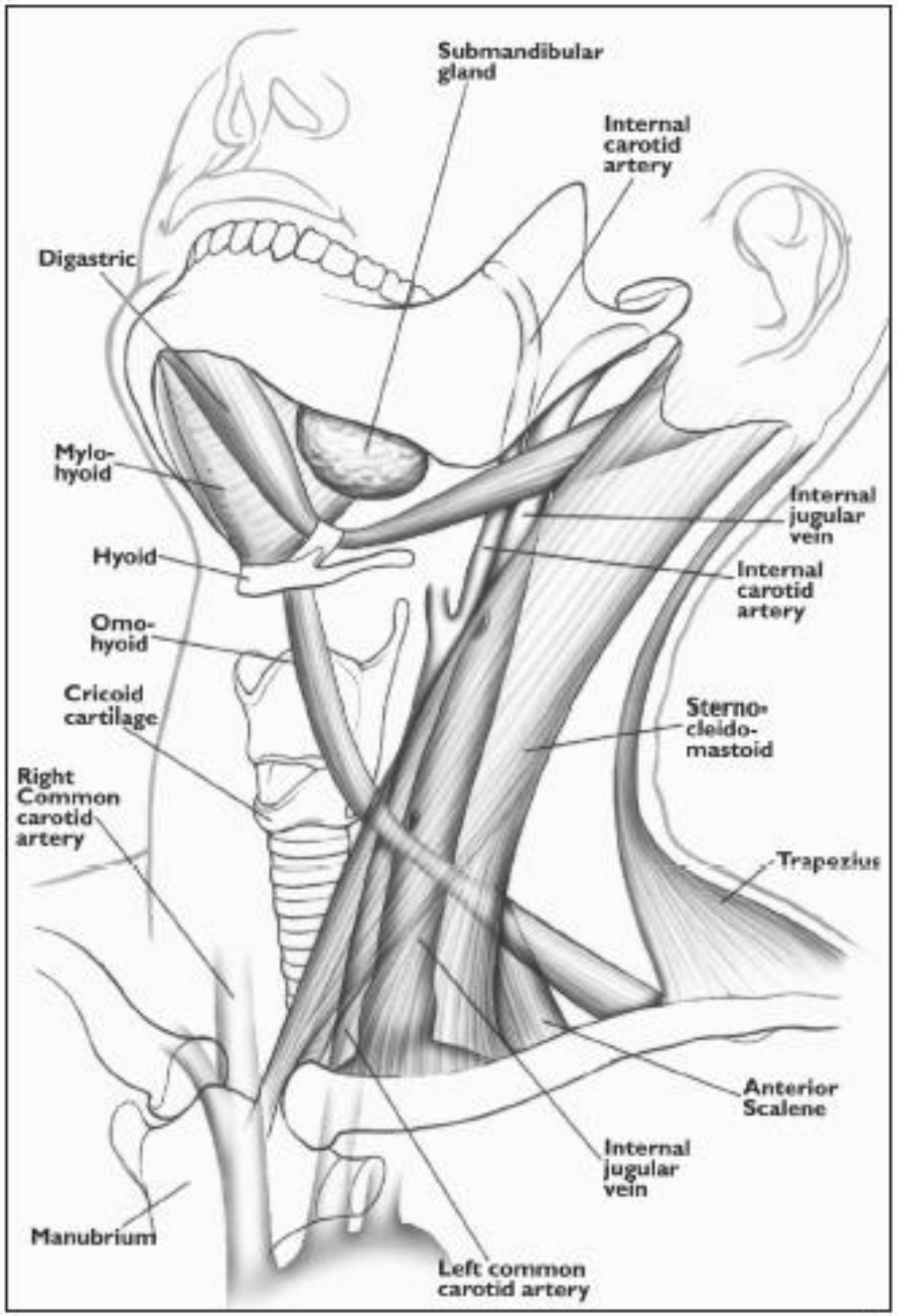


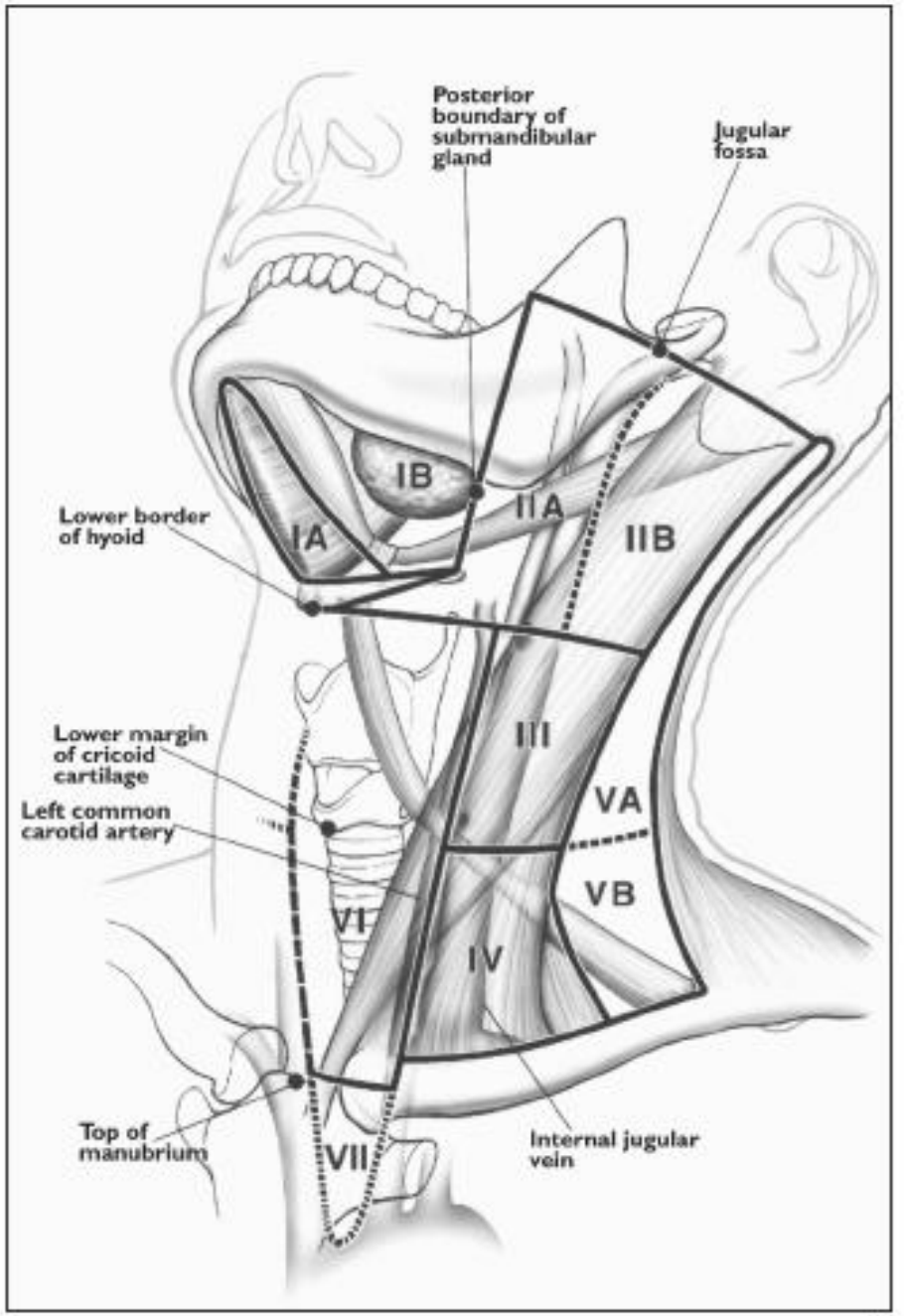

G 115
11:29:55





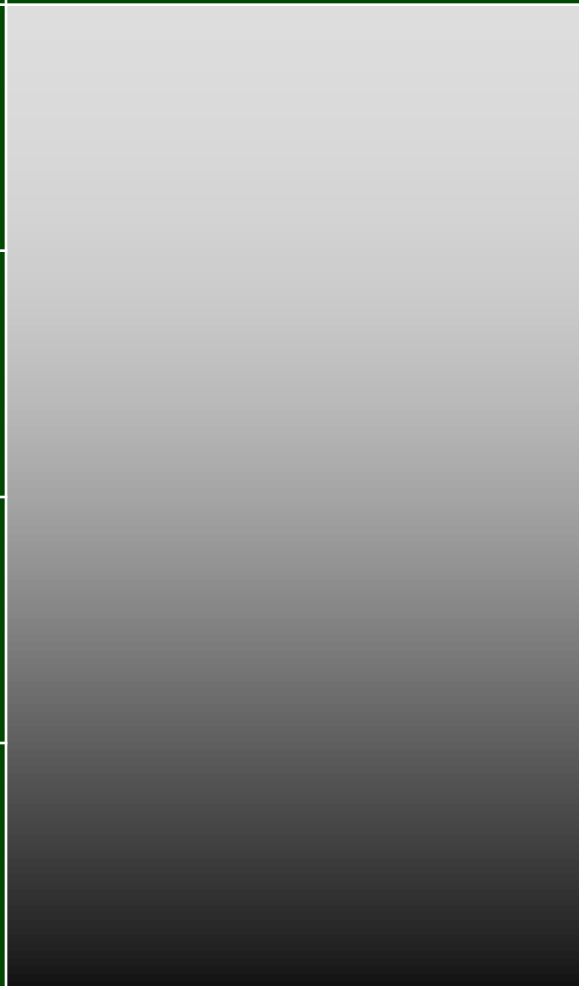

B RES-L
D 52mm
PRC 7/0/1
PST 0
G ---
XV C1
PRS 8
C 0
4 13
THY MP
LA523

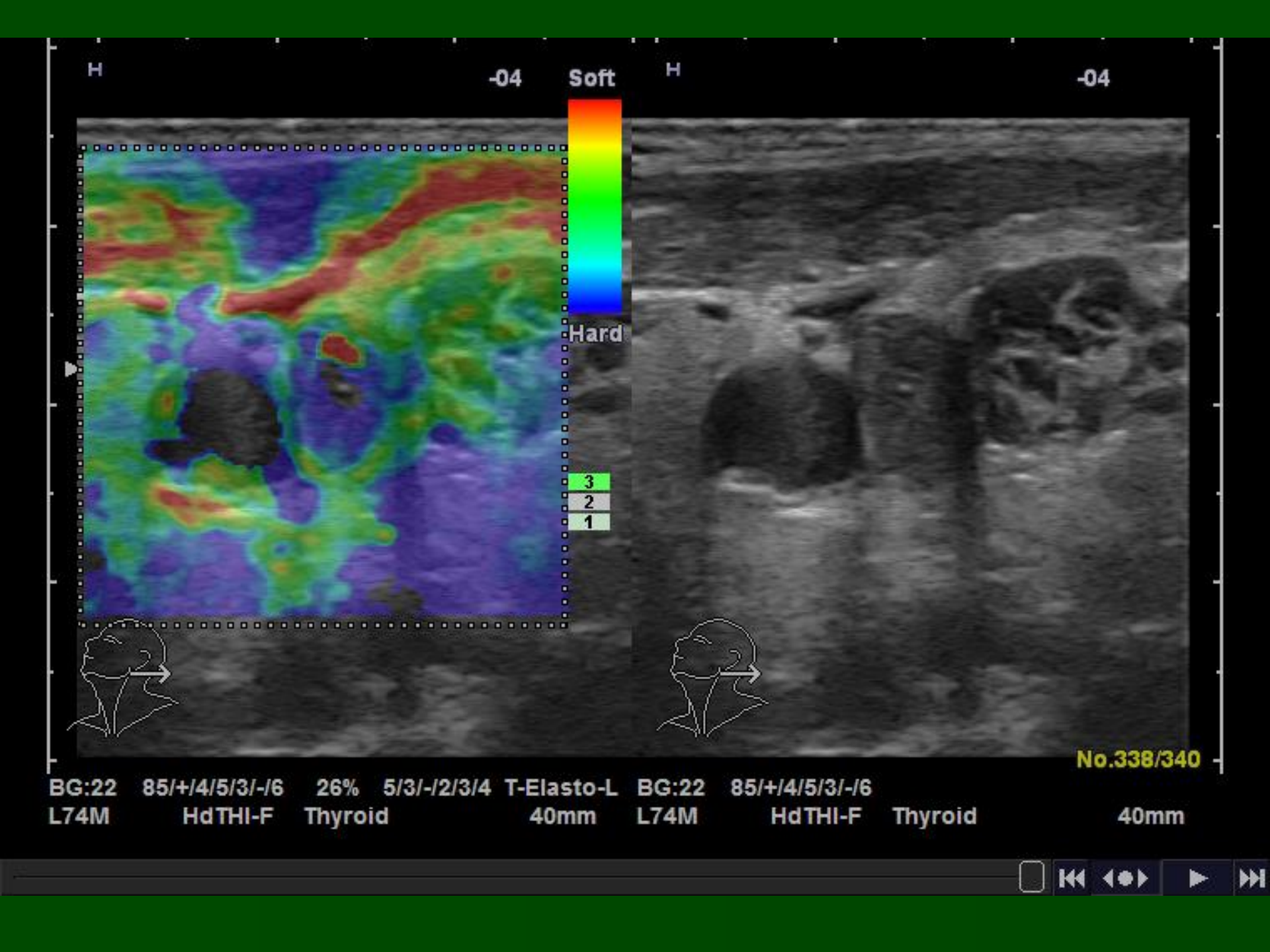

Submandibular gland
Internal carotid artery
Digastric
Mylo-hyoid
Internal jugular vein
Hyoid
Internal carotid artery
Omo-hyoid
Cricoid cartilage
Sterno-cleido-mastoid
Right Common carotid artery
Trapezius
Anterior Scalene
Internal jugular vein
Manubrium
Left common carotid artery
A

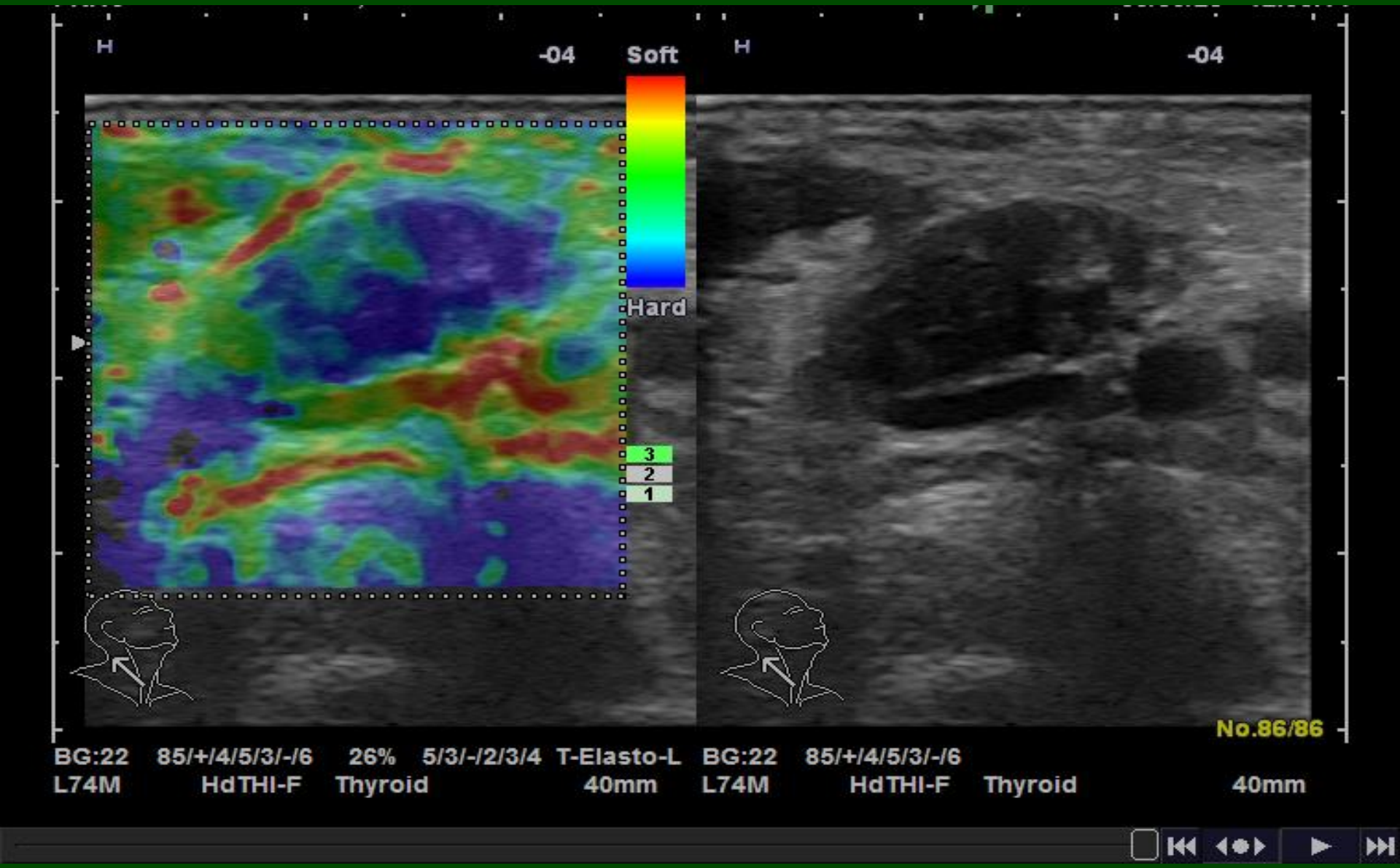

Posterior boundary of submandibular gland
Jugular fossa
IB
IIA
IIB
IA
Lower border of hyoid
III
Lower margin of cricoid cartilage
VA
Left common carotid artery
VB
VI
IV
Top of manubrium
VII
Internal jugular vein
B

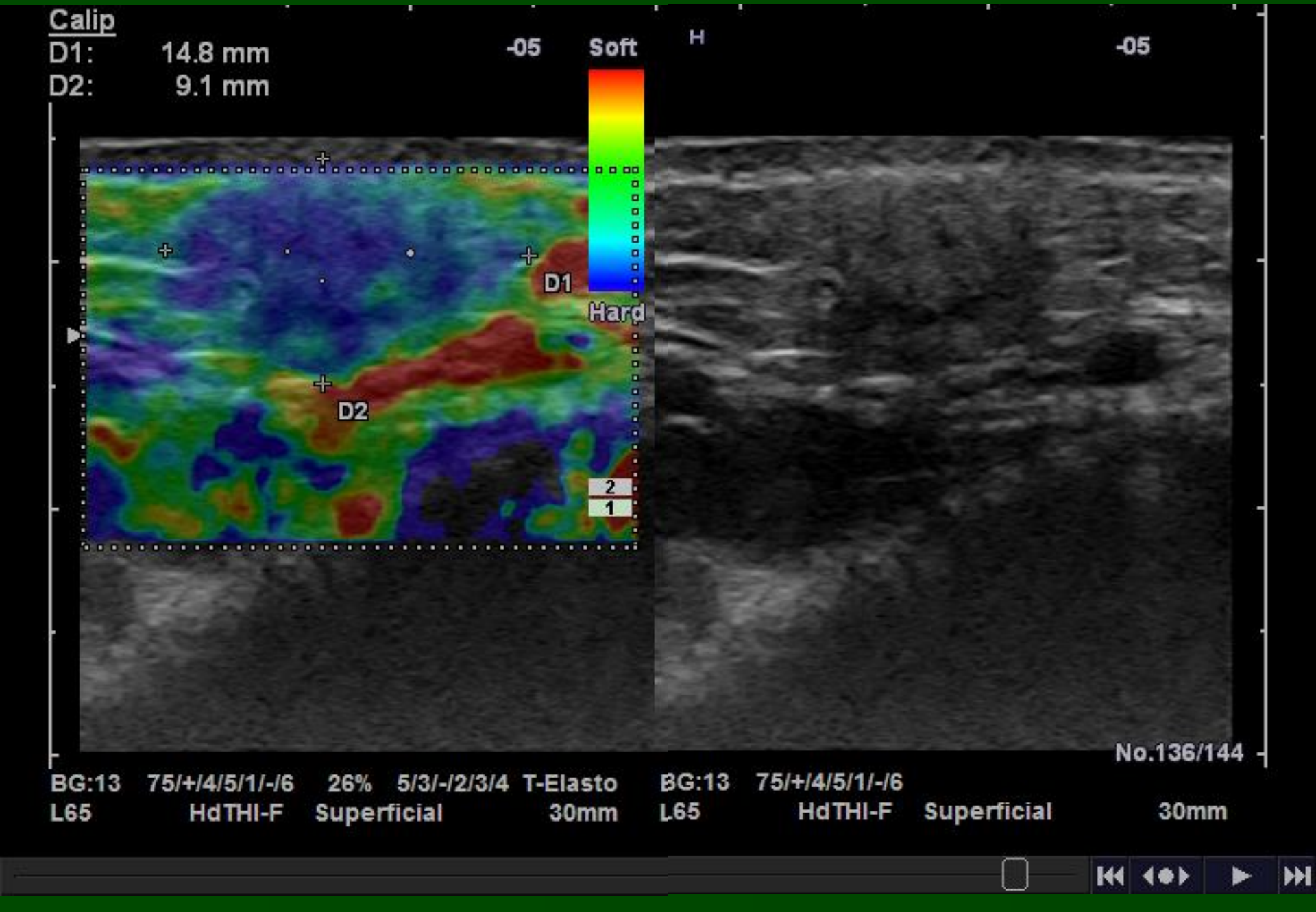
Elastography

- Qunatitatiove measurement of tissue characteristics:
  - Inner stimulus or external compression the tissues move
  - Elastic vs. Tough tissue
- Tumors are tougher: less elastic
- Color code

Color	Tissue	Greyscale
	Soft, elastic	
	…	
	…	
	tough	


H
-04
Soft
Hard
3
2
1
H
-04
No.338/340
BG:22 85/+/4/5/3/-/6 26% 5/3/-/2/3/4 T-Elasto-L
L74M HdTHI-F Thyroid 40mm
BG:22 85/+/4/5/3/-/6
L74M HdTHI-F Thyroid 40mm

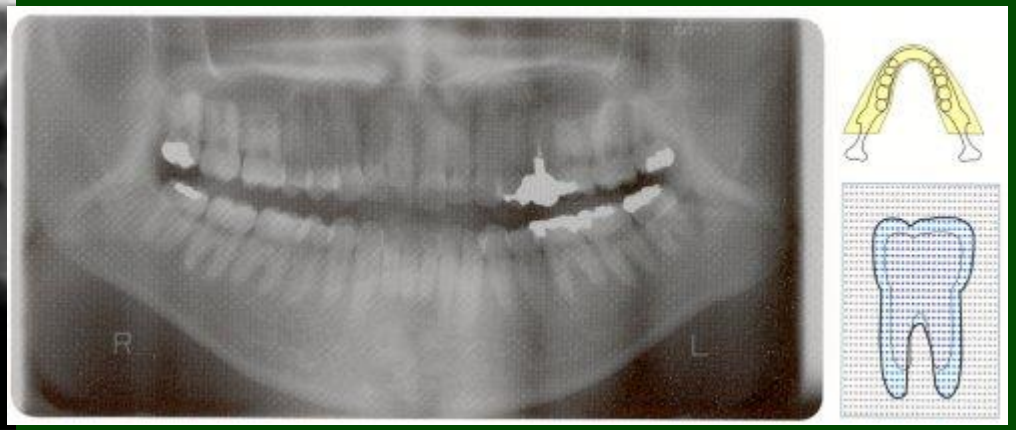

H
-04
Soft
Hard
3
2
1
H
-04
No.86/86
BG:22 85/+/4/5/3/-/6 26% 5/3/-/2/3/4 T-Elasto-L
L74M HdTHI-F Thyroid 40mm
BG:22 85/+/4/5/3/-/6
L74M HdTHI-F Thyroid 40mm

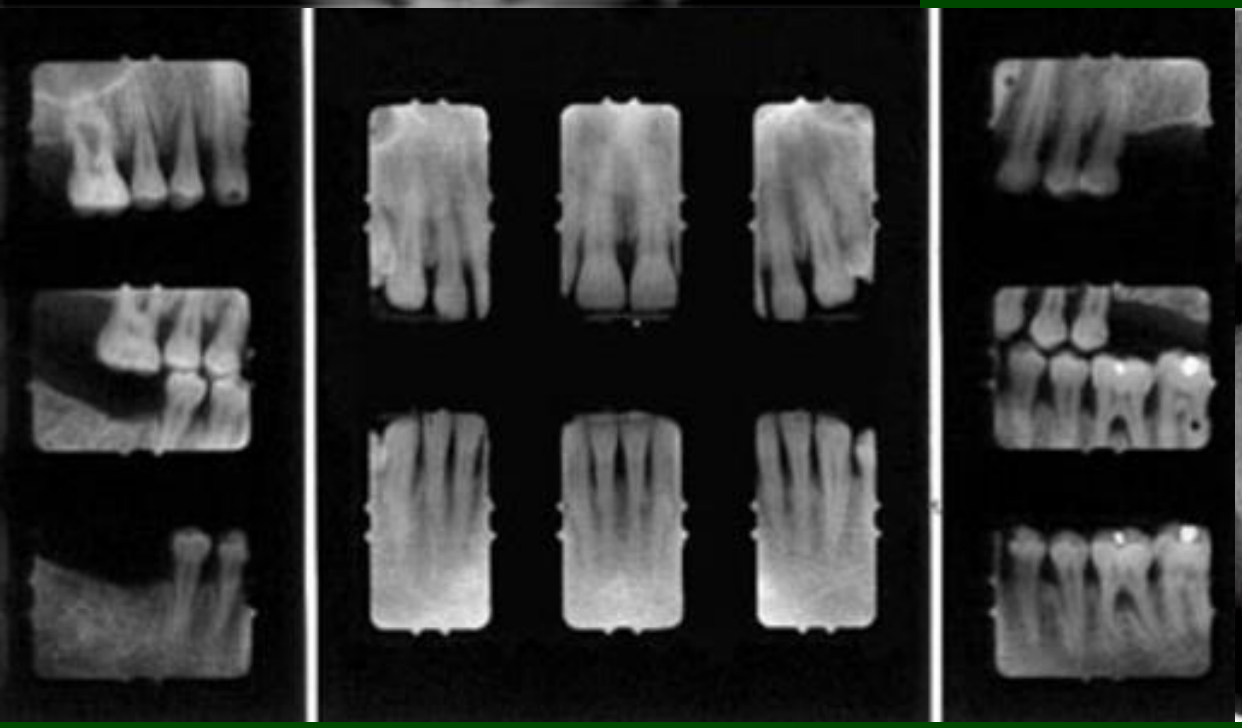

Calip
D1: 14.8 mm
D2: 9.1 mm
-05
Soft
Hard
D1
D2
2
1
H
-05
No.136/144
BG:13 75/+/4/5/1/-/6 26% 5/3/-/2/3/4 T-Elasto
L65 HdTHI-F Superficial 30mm
BG:13 75/+/4/5/1/-/6
L65 HdTHI-F Superficial 30mm

Conventional X-ray

- indications: panoramic X-ray and dental X-ray
- less valuable since CT: face bones, orbit, temporal bone, sinuses
- Preparation

Dental





Conventional X-ray w/ contrast

- Swallow
- Sialography (sialolithiasis)
- Still valuable

Conventional X-ray Contrast enhanced

Indications

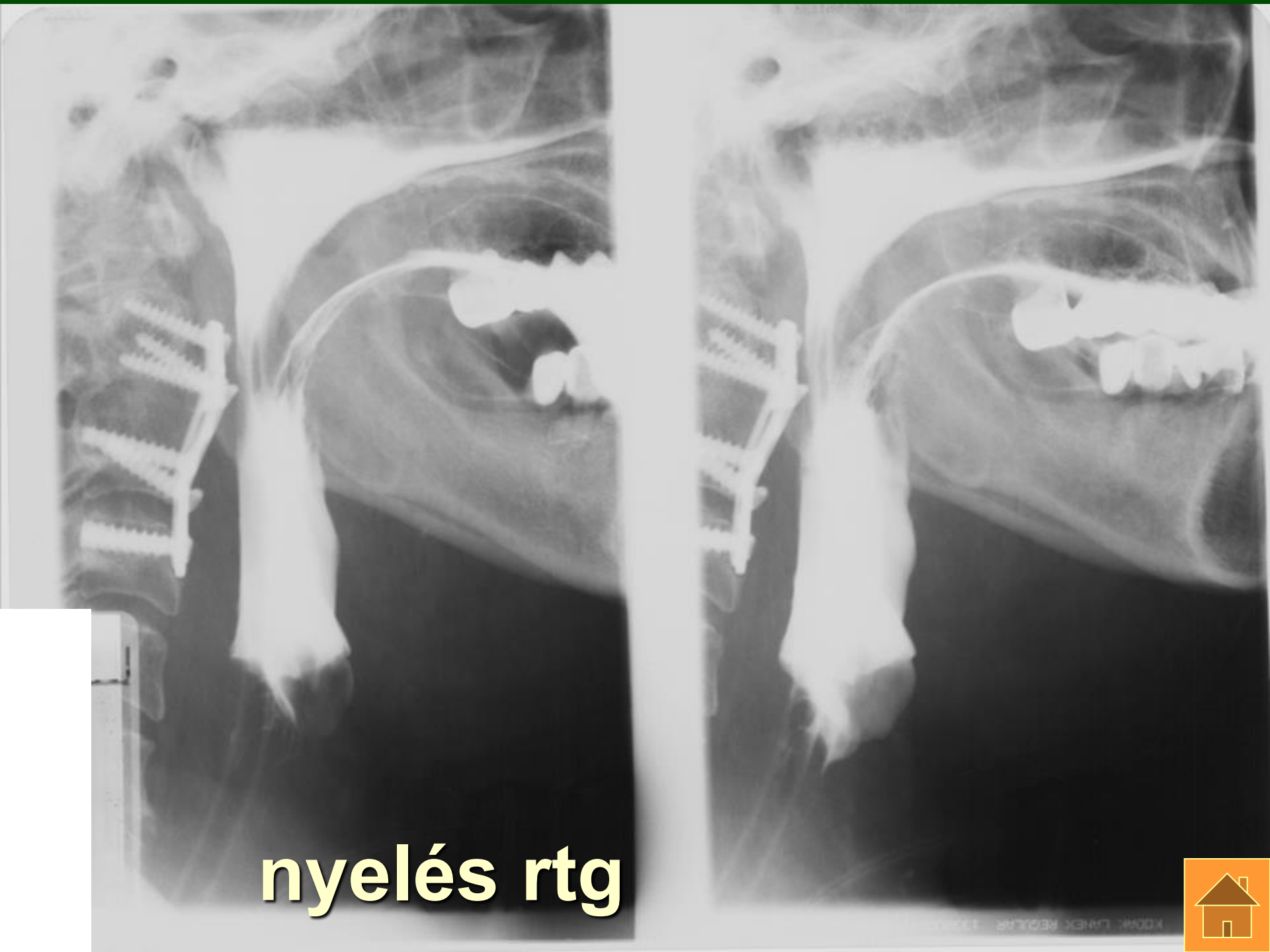
- FB -obstruction
- Perforation
- diverticulum
- Sclerotic lesions
- tumor – stenosis

Preparations

- jewelry
- empty stomach
- cooperation

Swallow x-ray

sialography

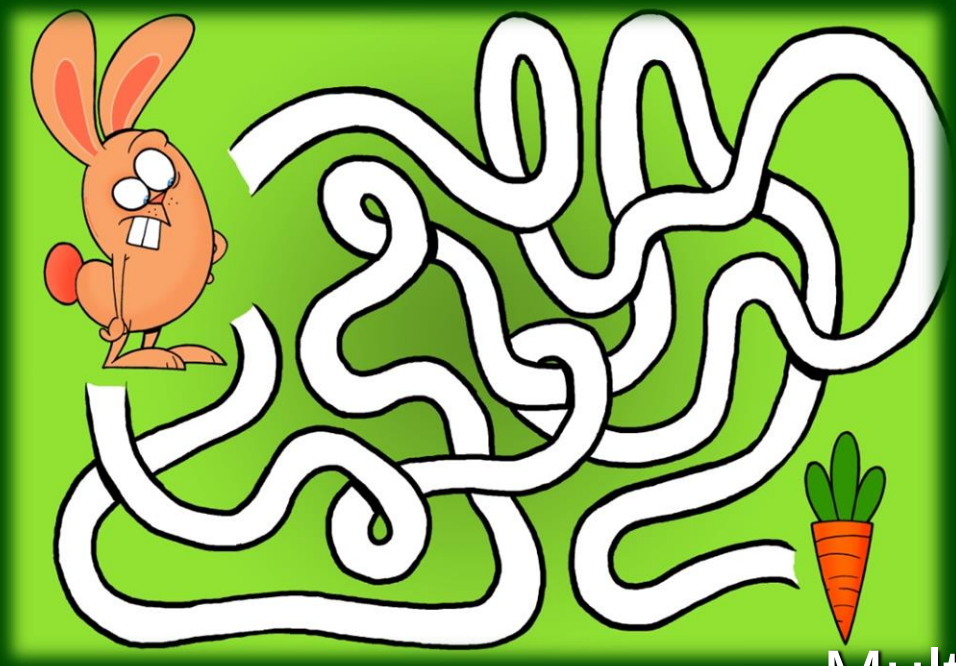

nyelés rtg

CT concepts

CT concepts

DVT digital volumenography

CBCT cone beam CT



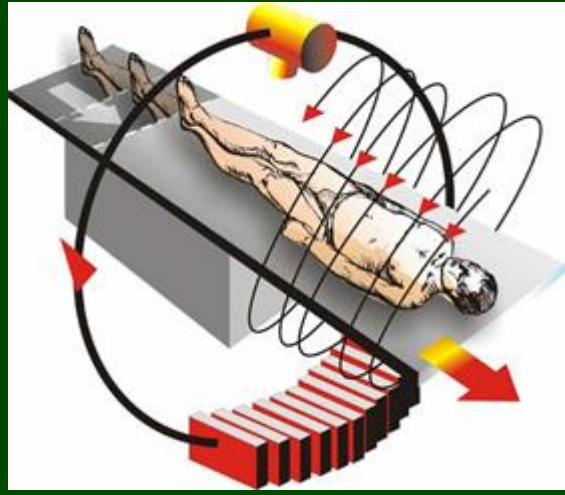
MSCT multislice CT

DSCT dual source CT

MDCT Multidetector row CT

HRCT high-resolution CT

Non-contrast and contrast enhanced CT



- Uses X-ray
- NC and CE + multiple rows of detectors
  - CTA – option
  - Better soft tissue resolution than X-ray, but lower spatial resolution /512x512 px/
  - High dose of ionizing radiation

Non-contrast and contrast enhanced CT

Indications

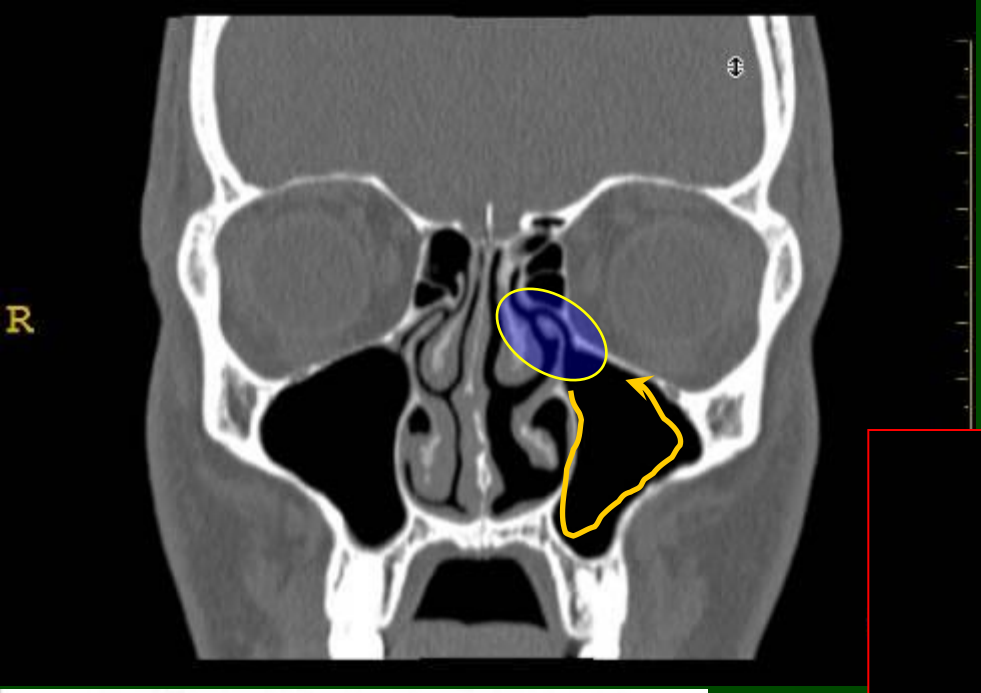
- tumor TNM
- Deep spaces of the HN region
- Bones (fractures, paranasal sinuses)
- Suprahyoid regions - MR is more useful
- Inrahyoid neck – very good;

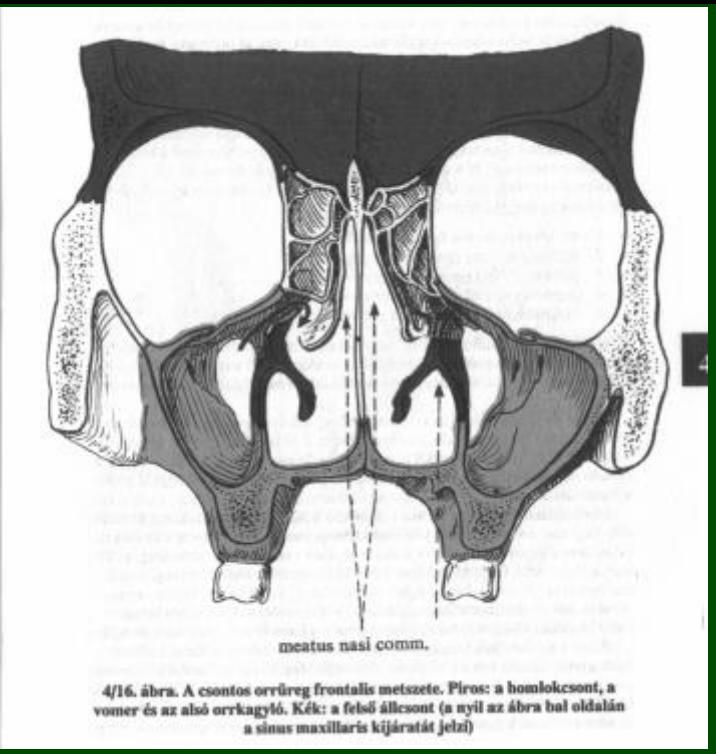
Preparation

- Remove metal pieces
- Consent
- Kidney function
- iv. contrast– DM (metformin)

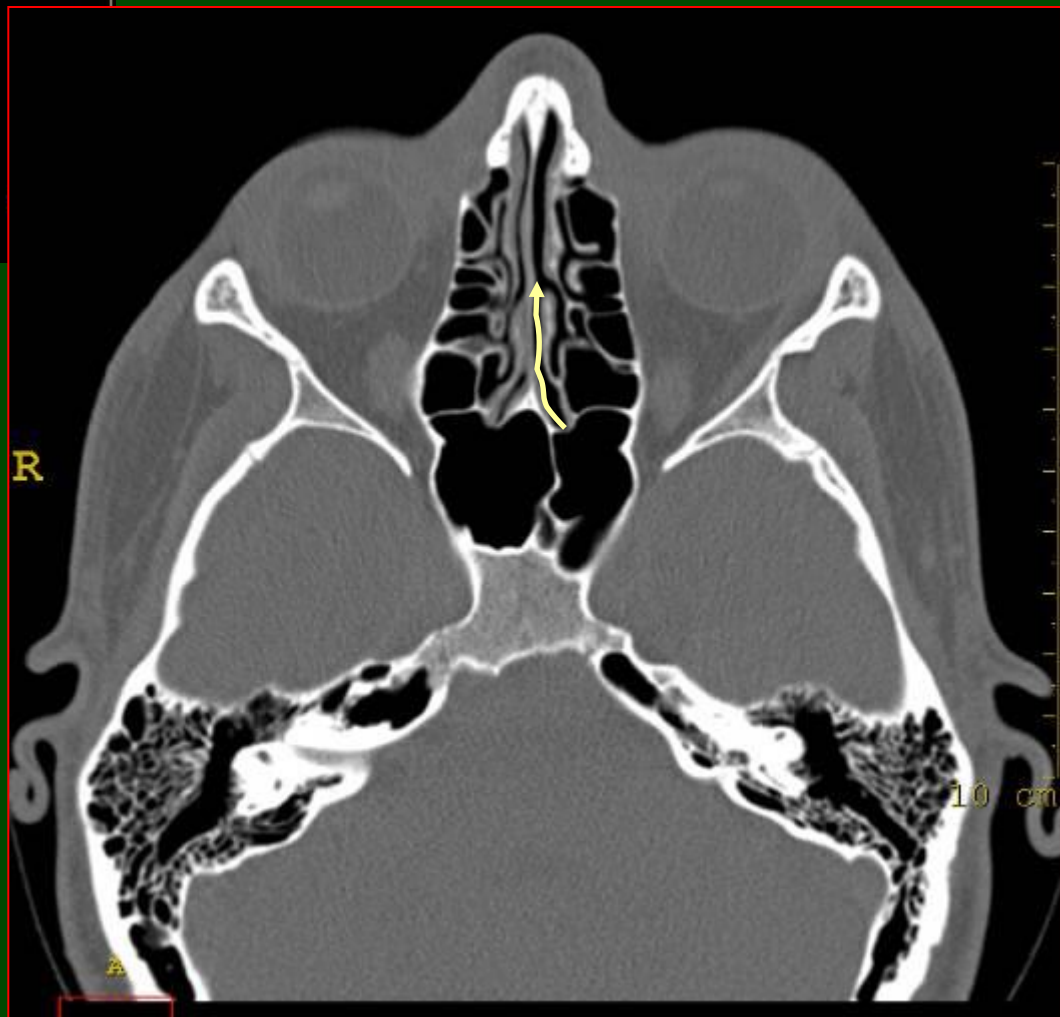

R


R
A





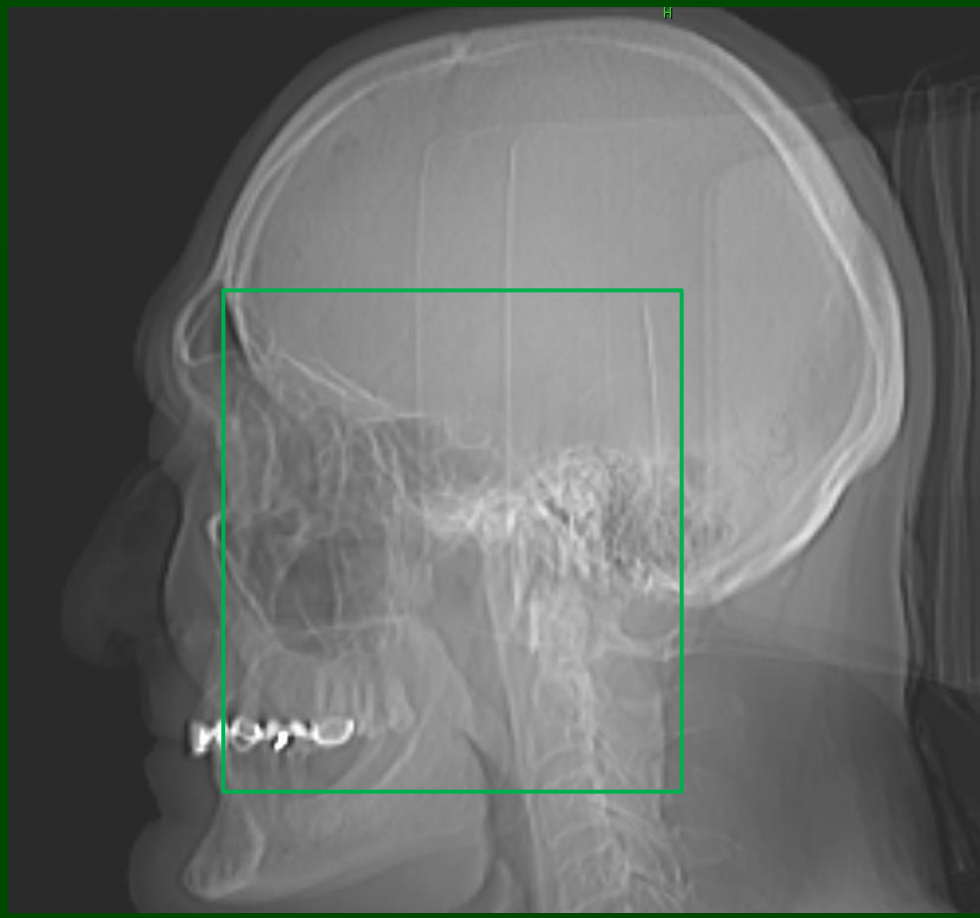
4/16. ábra. A csontos orrüreg frontalis metszete. Piros: a homlokcsont, a vomer és az alsó orrkagyló. Kék: a felső állcsont (a nyíl az ábra bal oldalán a sinus maxillaris kijáratát jelzi)



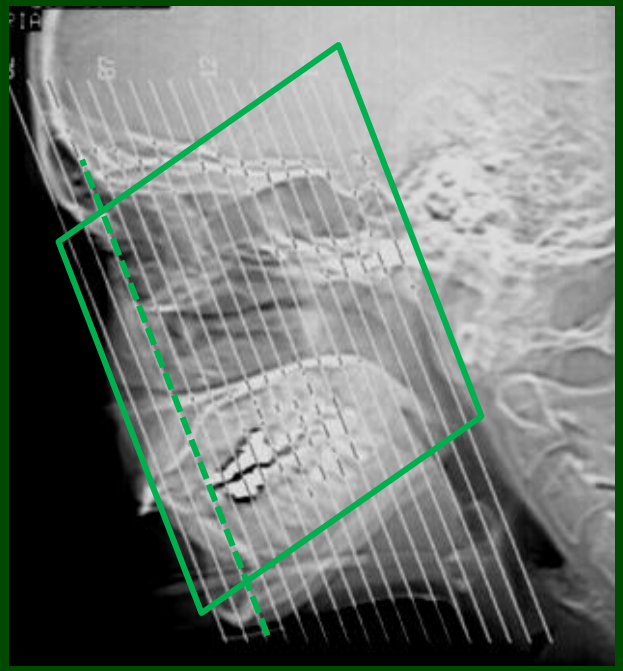
Face CT

MDCT

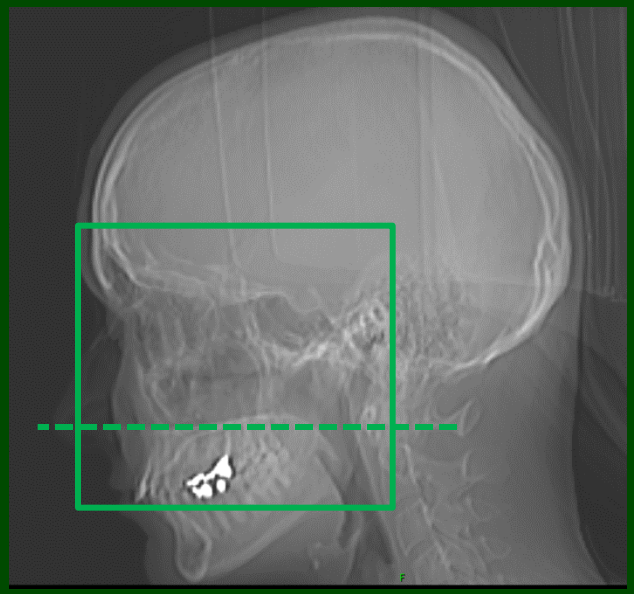
Helical	
Resolution	High
Collimation	16 x 0.75
Pitch	0.438
Rot.	0.75
FOV	200 / 150/ 100 mm
Filter	D (bone)
kV	120
mAs	250
Sliceth/ rec	2mm/ 1mm
WC; WW	200/ 2000 HU
matrix	512



MDCT primary planes

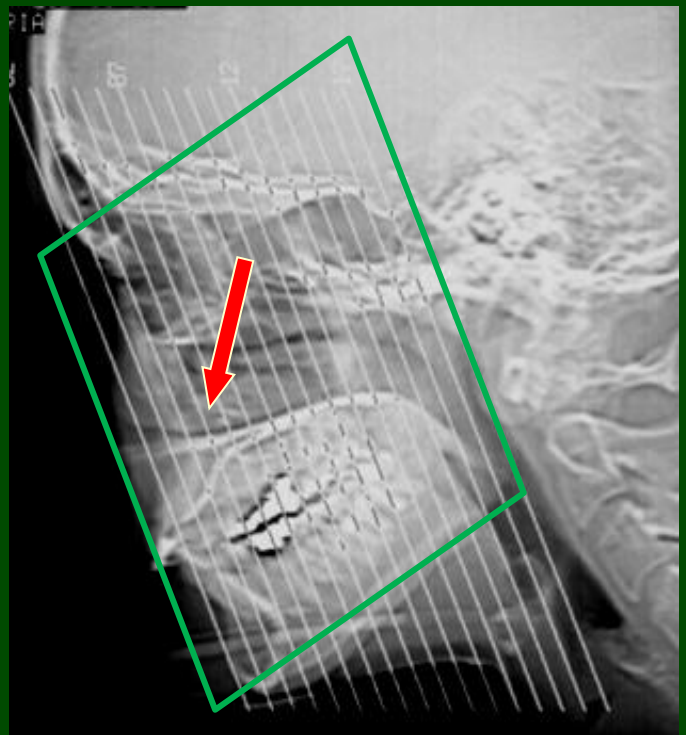


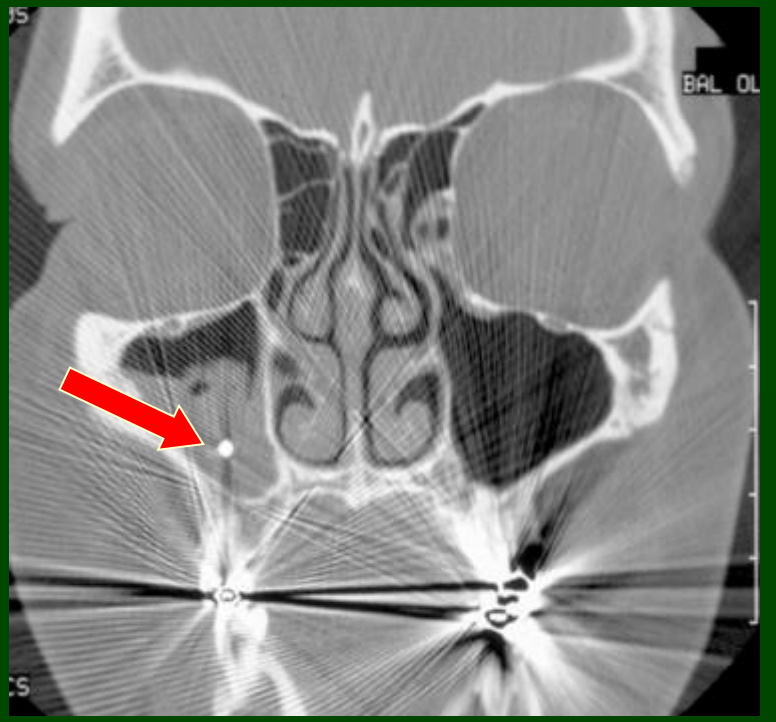
coronal



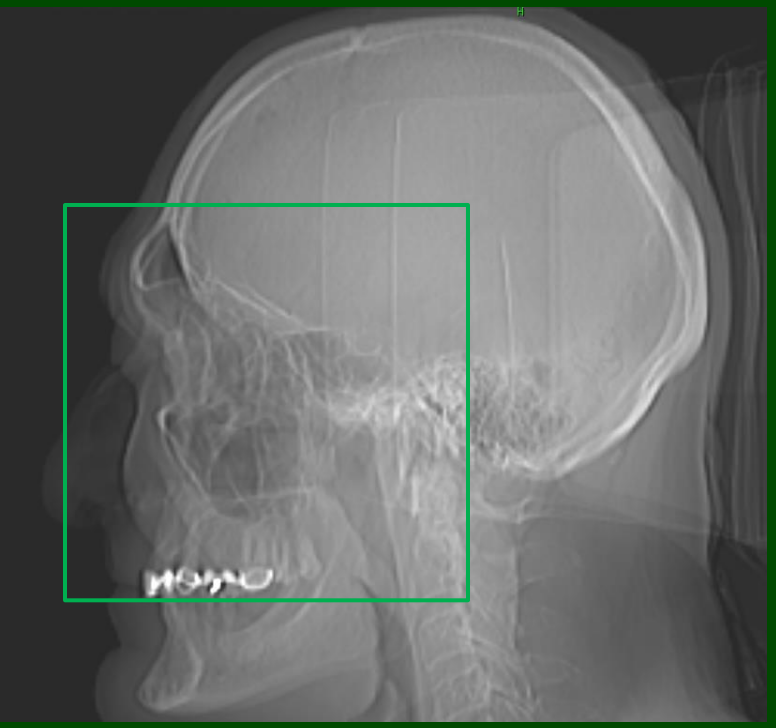
axial

coronal

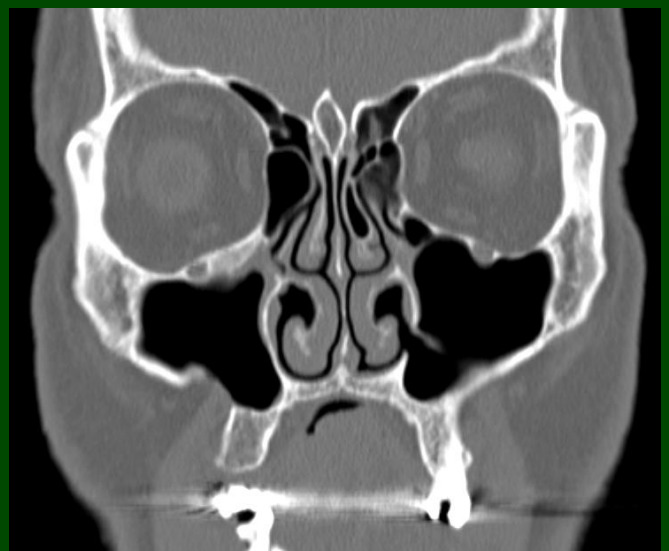




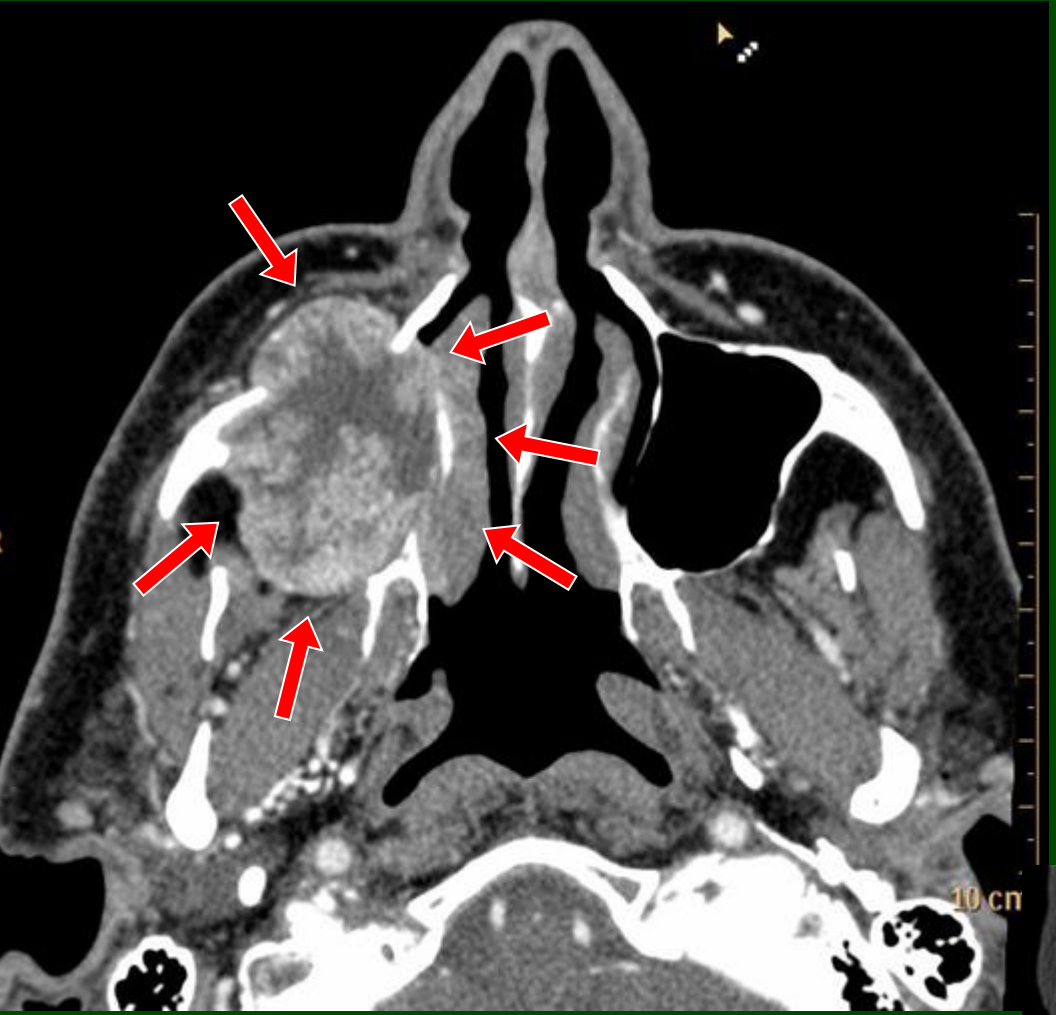
Axial



Soft tissue window

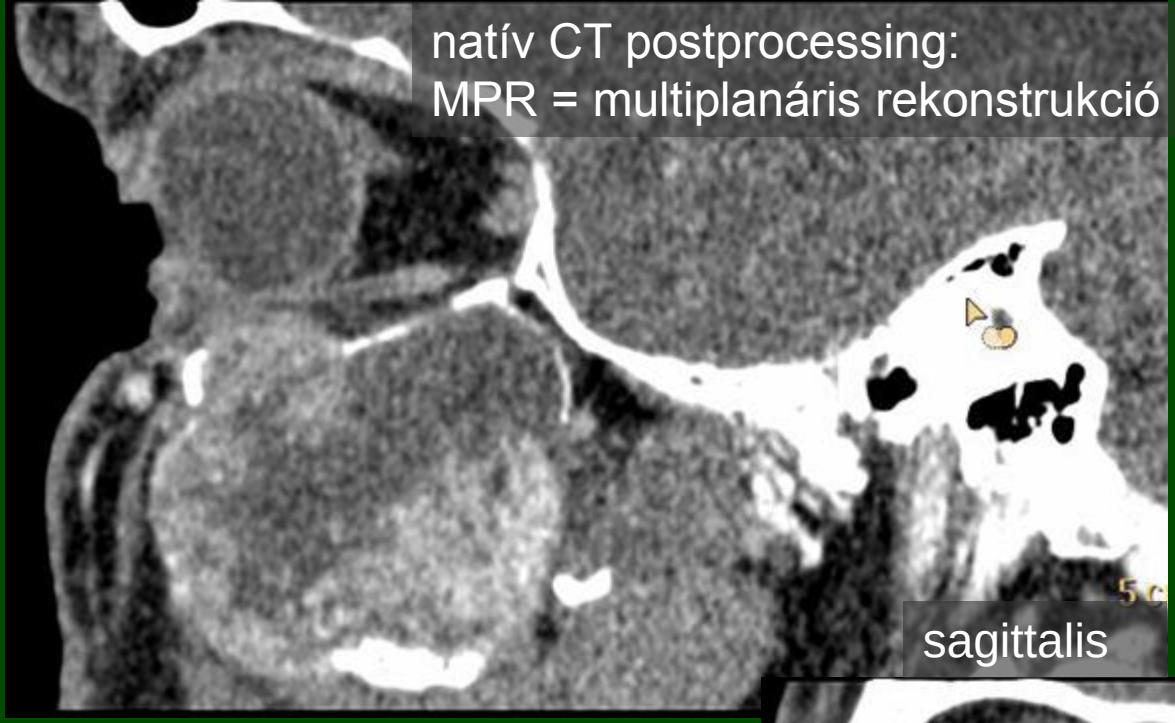


coronal „MPR”

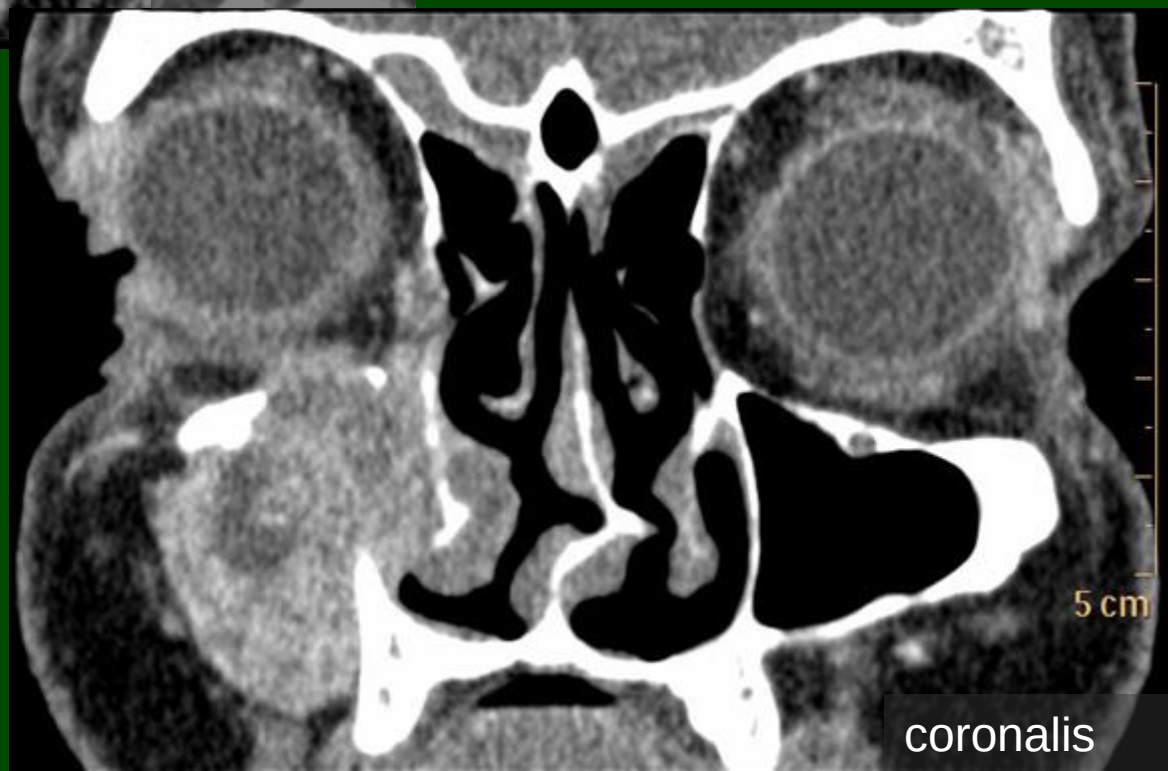

10 cm


R
5 cm

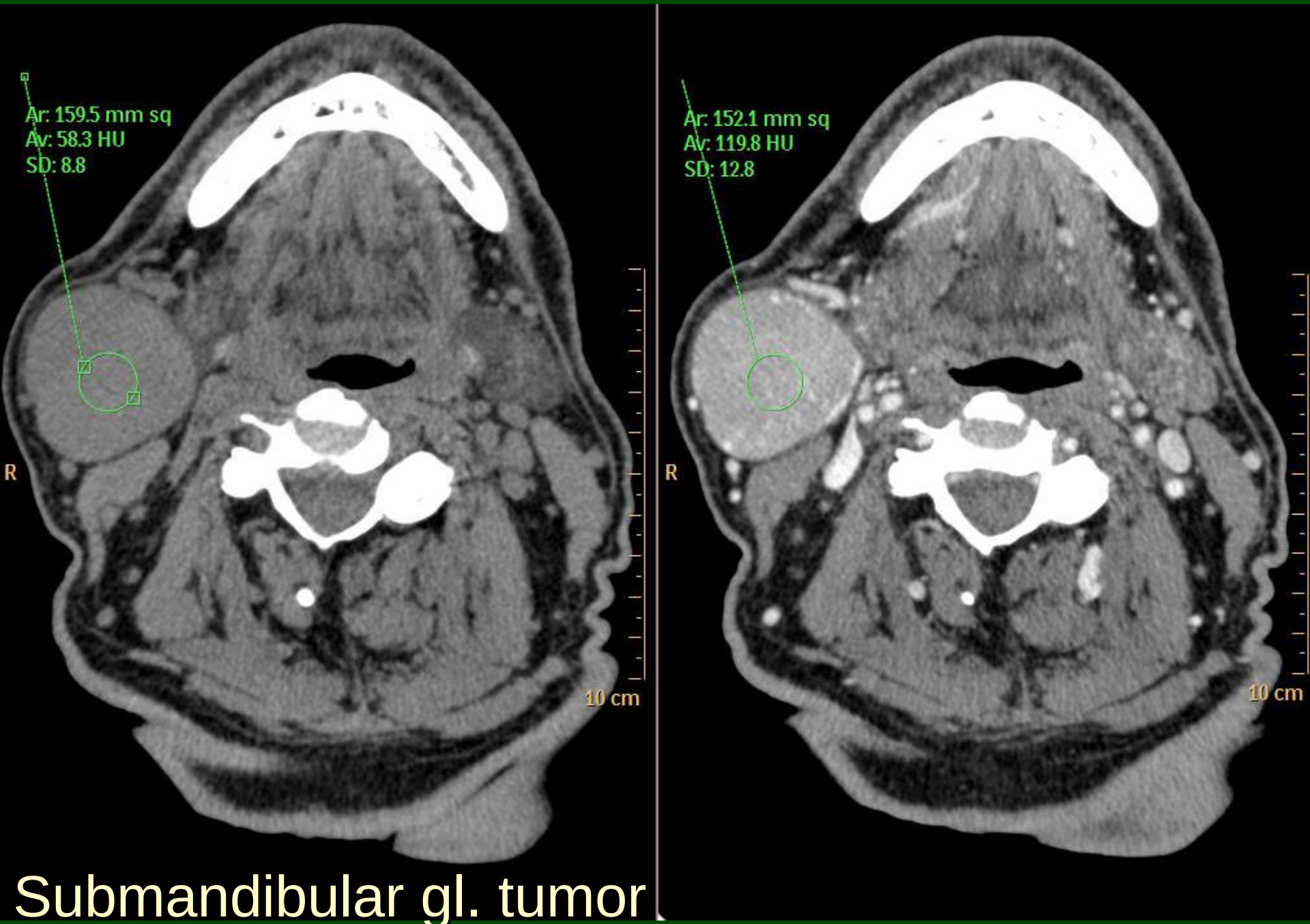
natív CT postprocessing:
MPR = multiplanáris rekonstrukció



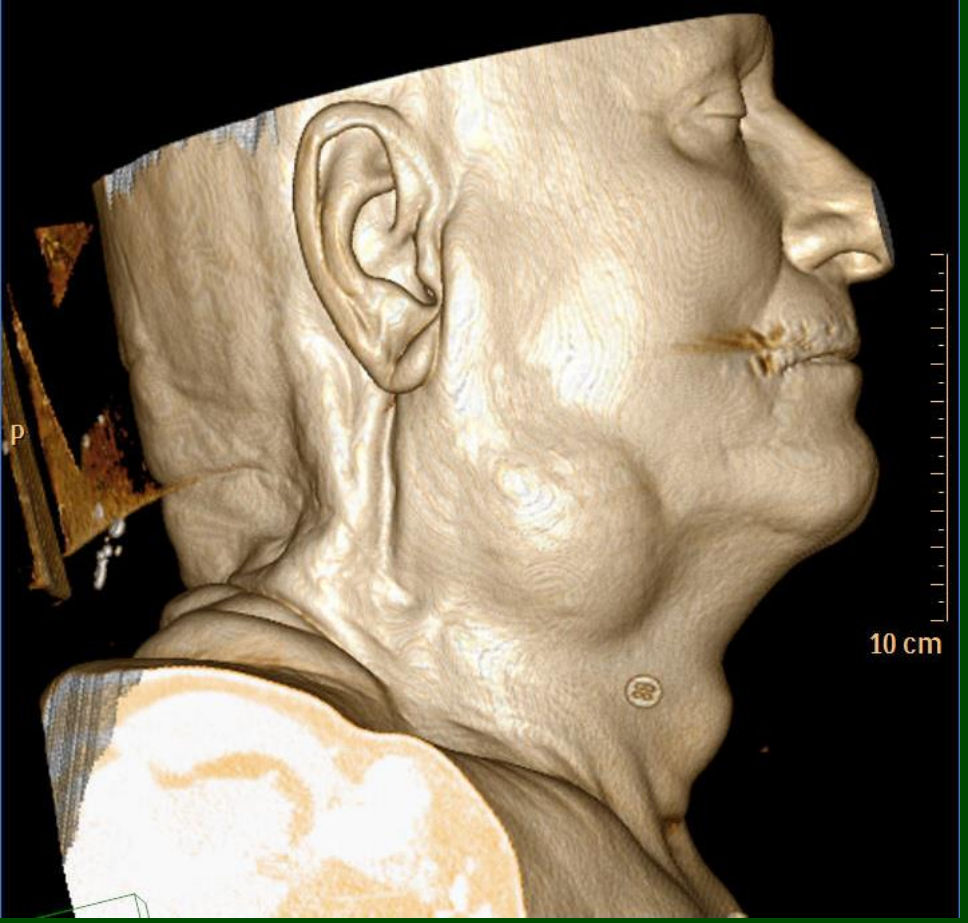
sagittalis



coronalis

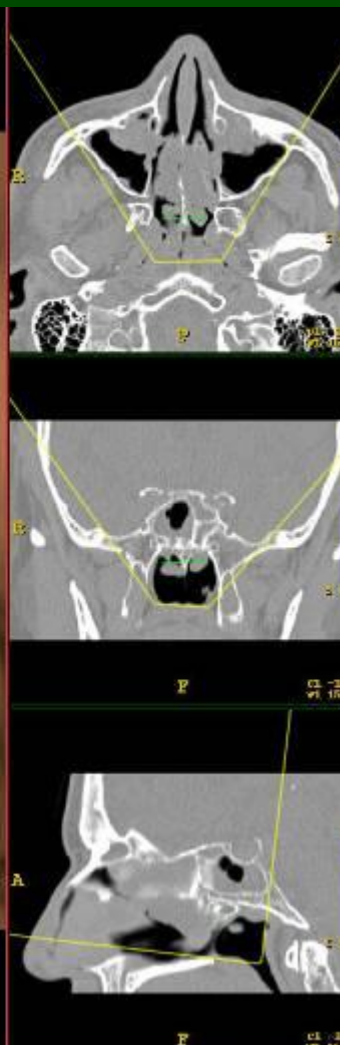


Submandibular gl. tumor

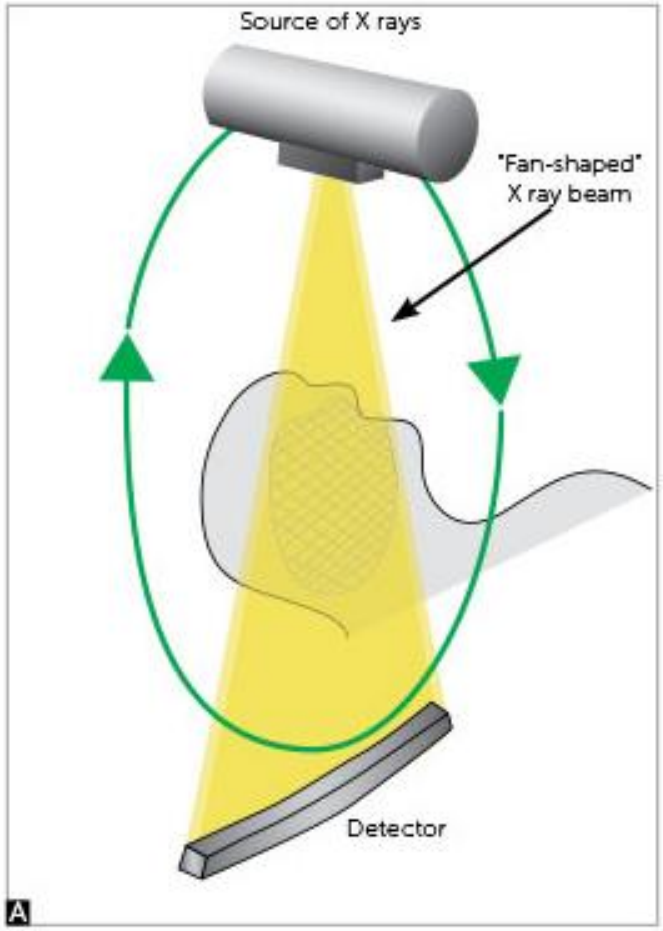

P
10 cm


P
10 cm

sinonasal polyposis



MD- vs. CBCT



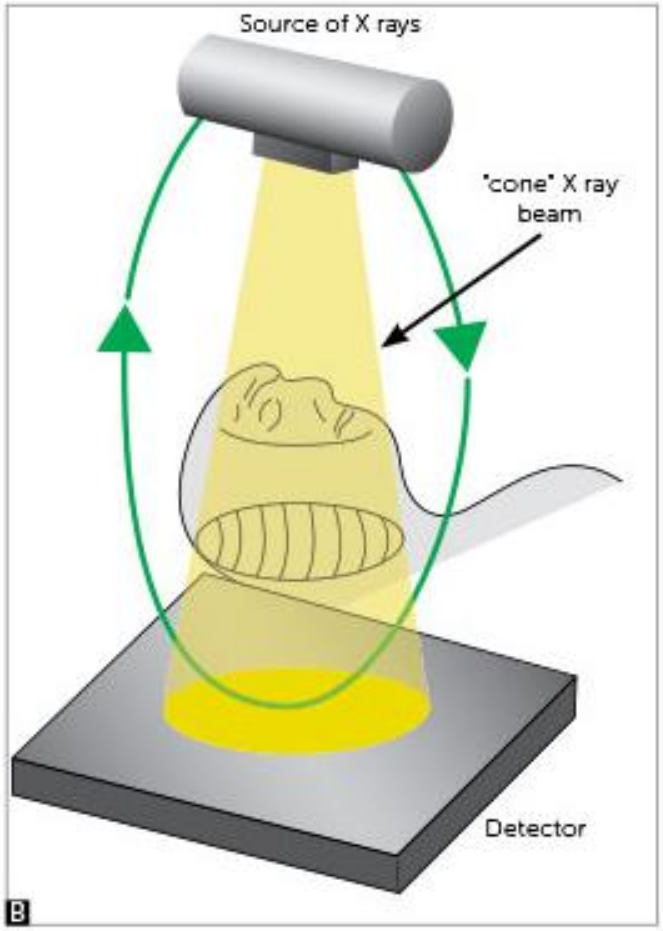


Figure 4 - Draft of projection of X-rays showing the differences on the obtention of image between a simple detector (A) and the cone beam (B). Source: Sukovic,[27] 2003.

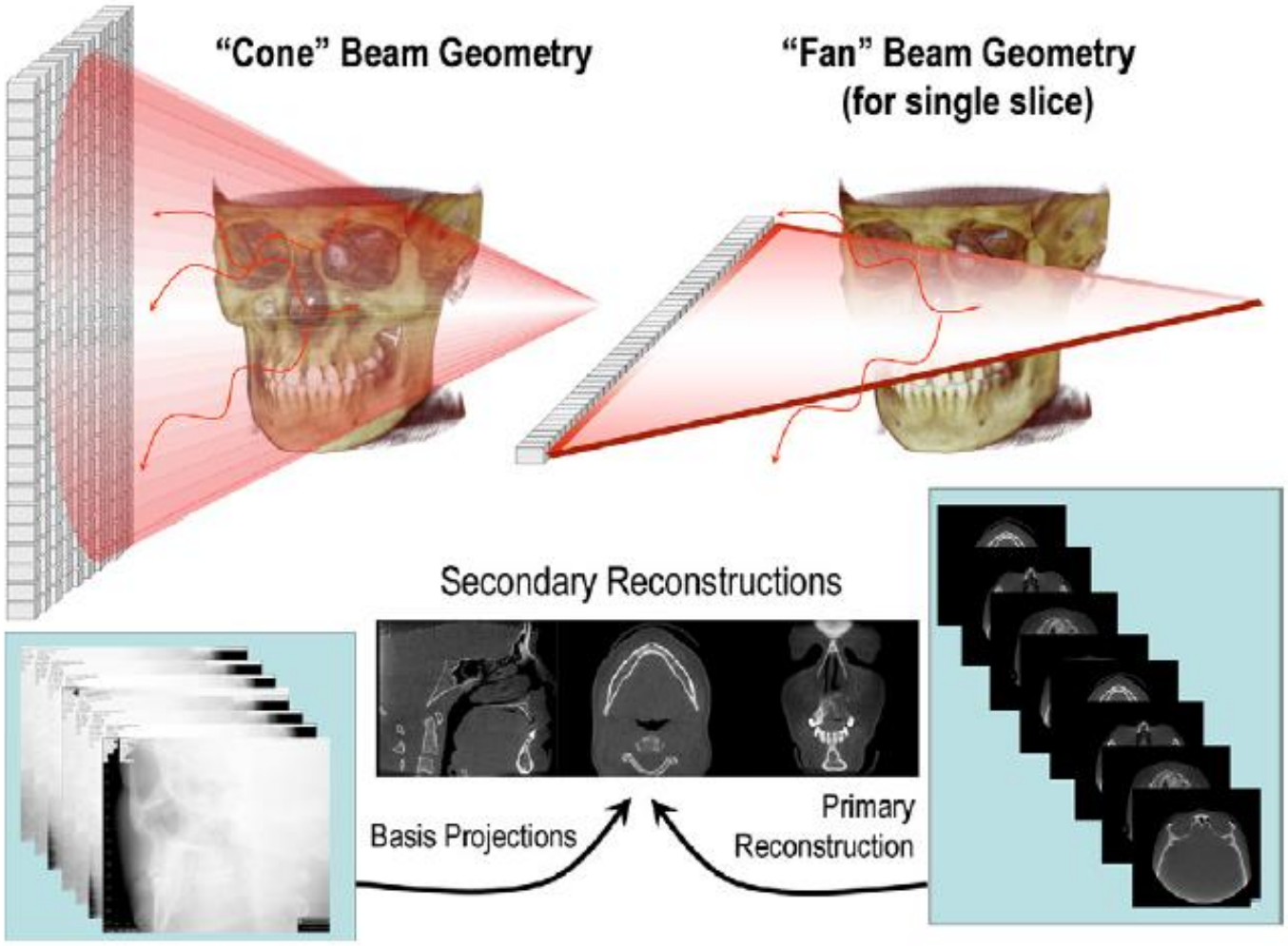


Fig. 1. X-ray beam projection scheme comparing acquisition geometry of conventional or "fan" beam (*right*) and "cone" beam (*left*) imaging geometry and resultant image production. In cone-beam geometry (*left*), multiple basis projections form the projection data from which orthogonal planar images are secondarily reconstructed. In fan beam geometry, primary reconstruction of data produces axial slices from which secondary reconstruction generates orthogonal images. The amount of scatter generated (sinusoidal lines) and recorded by cone-beam image acquisition is substantially higher, reducing image contrast and increasing image noise.

Dent Clin N Am 52 (2008) 707–730

CBCT

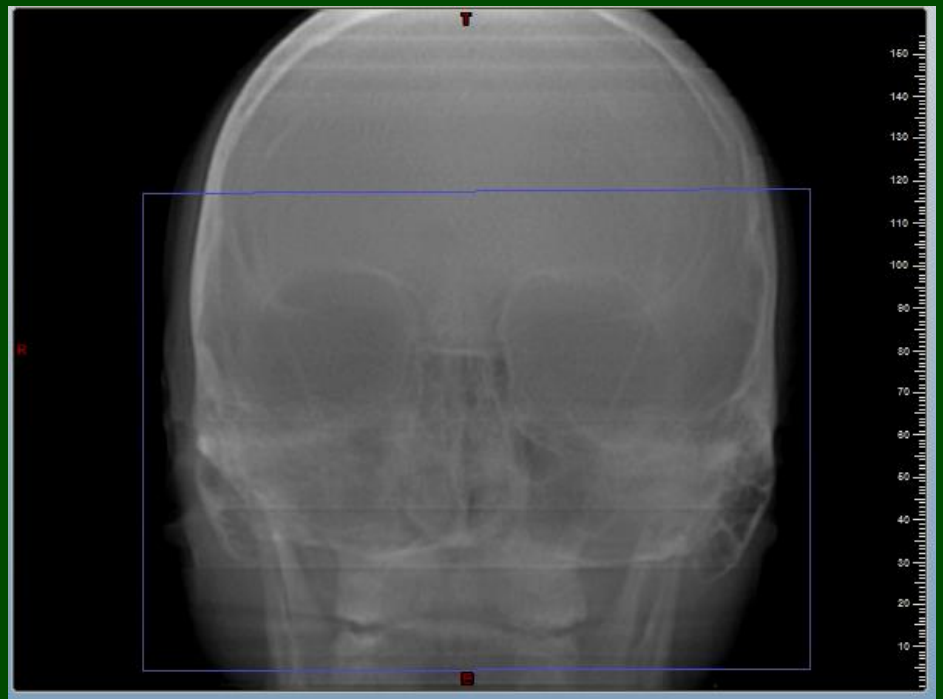
FIGURE 1. Some currently available CBCT scan devices. *A*, NewTom 3G (courtesy of Aperio Services, Sarasota, FL). *B*, i-Cat (courtesy of Imaging Sciences, Hatfield, PA). *C*, ILUMA (courtesy of IMTEC Corp, Ardmore, OK). *D*, ProMax 3D (courtesy of Planmeca Oy, Helsinski, Finland). *E*, CB MercuRay (courtesy of Hitachi Medical System America Inc, Twinsburg, OH). *F*, Dental CBCT (courtesy of TeraRecon Inc, San Mateo, CA). *G*, 3D Accuitomo (courtesy of J Morita USA, Irvine, CA). *H*, Sirona Galileos (courtesy of Sirona Dental Systems North America, Charlotte, NC).

Queresby, Savell, and Palomo. Cone Beam Computed Tomography. J Oral Maxillofac Surg 2008.

NewTom 3G / i-Cat / ILUMA/ ProMax 3D

CB MercuRay / Dental CBCT / 3D Accuitomo / Sirona Gelileos

J Oral Maxillofac Surg
66:791-796, 2008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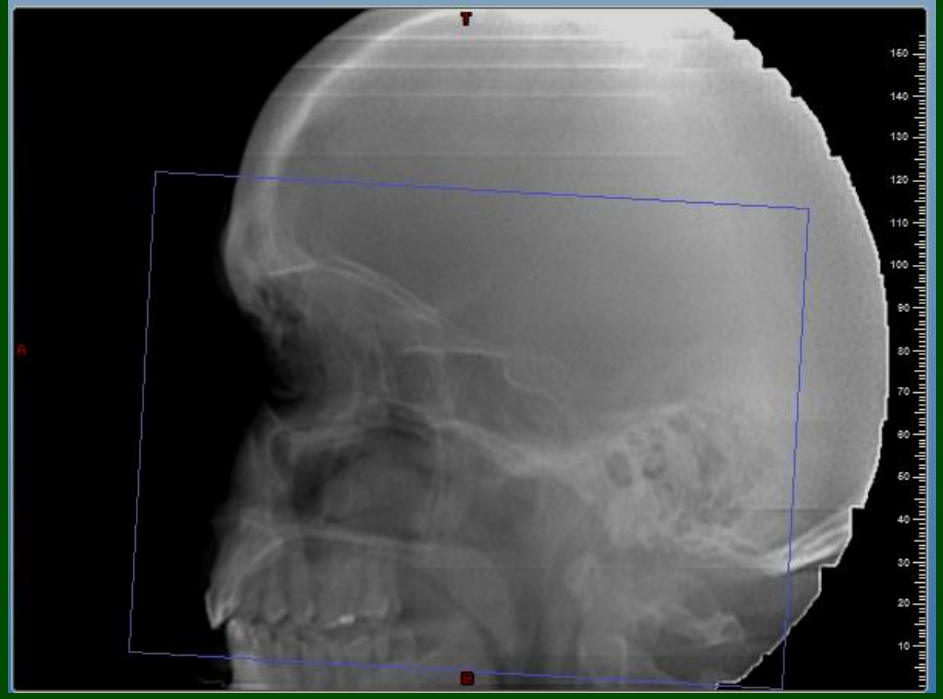
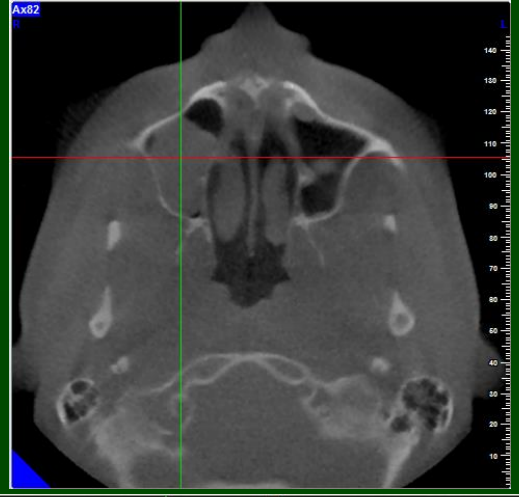
R
B


T
A
B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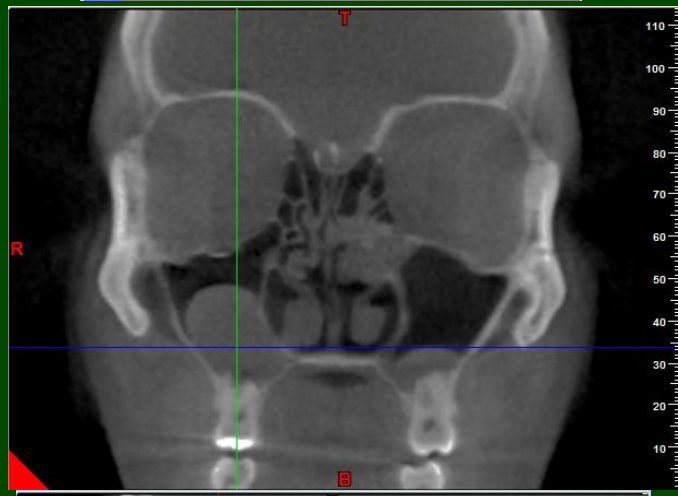
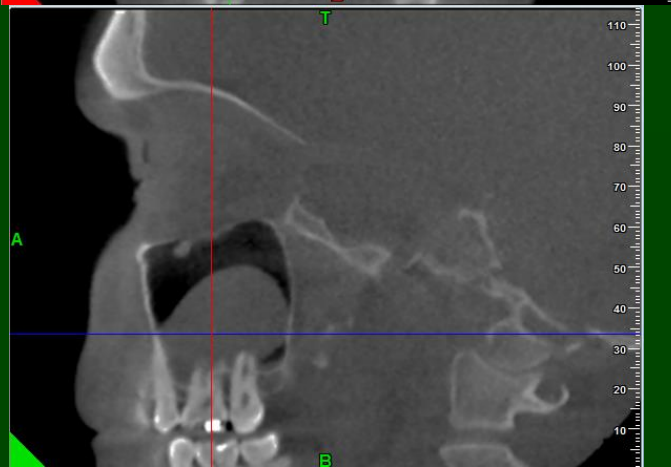
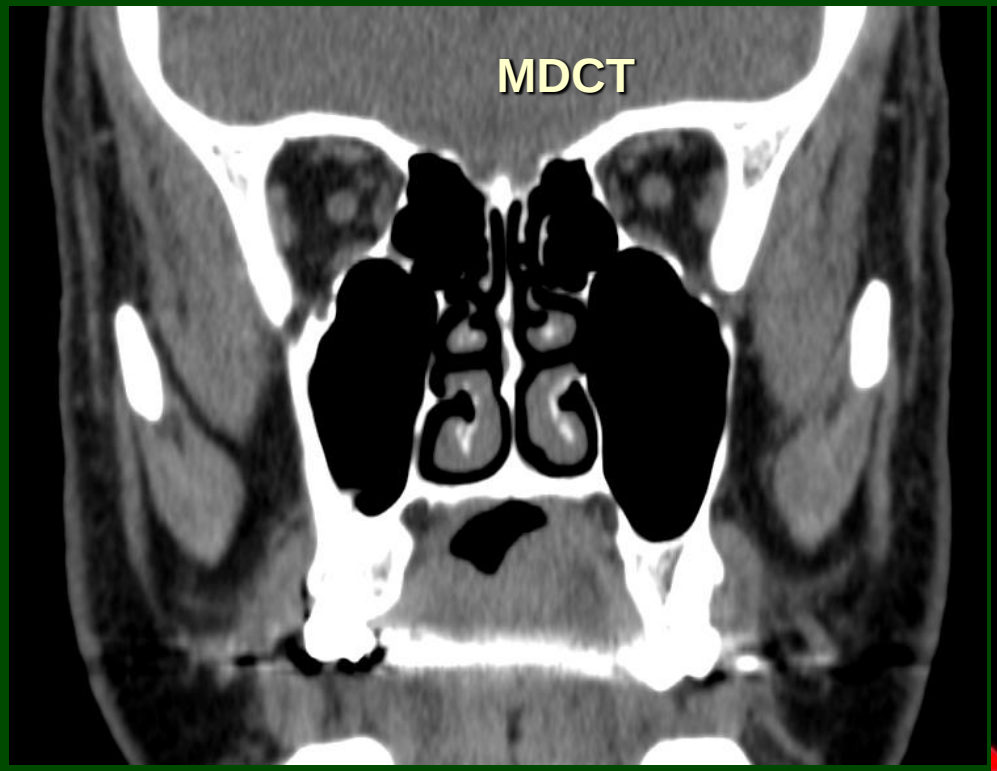
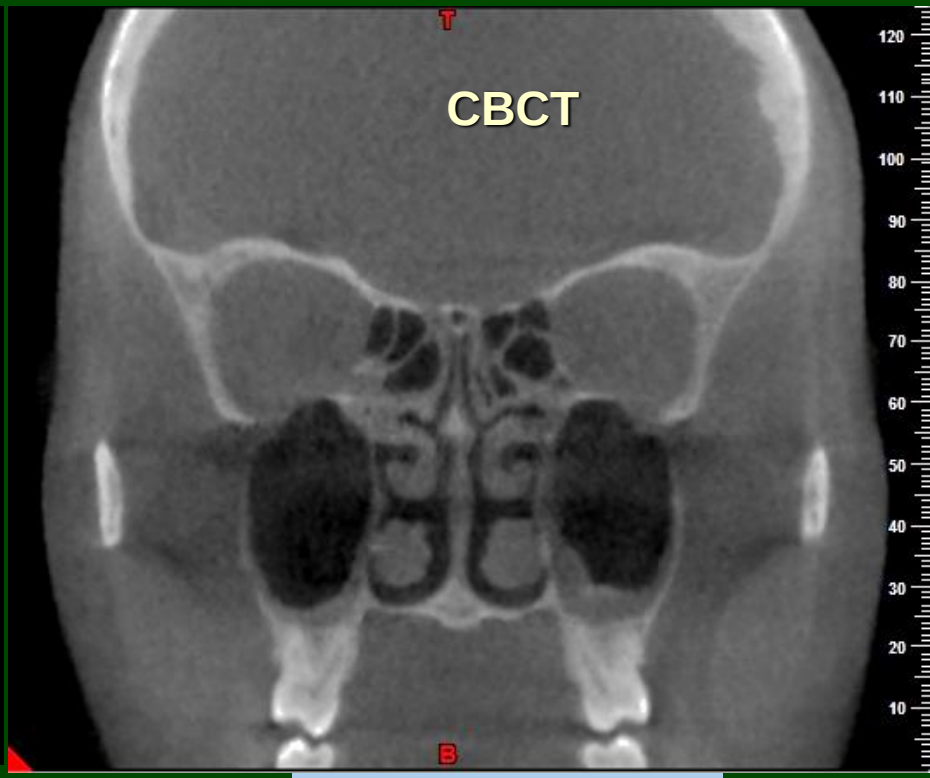

T
R
B


T
A
B

	kV	mAs	CTDIvol (mGy)
Face MDCT	120	250	38.1
Face CBCT	110	7.91	1.06



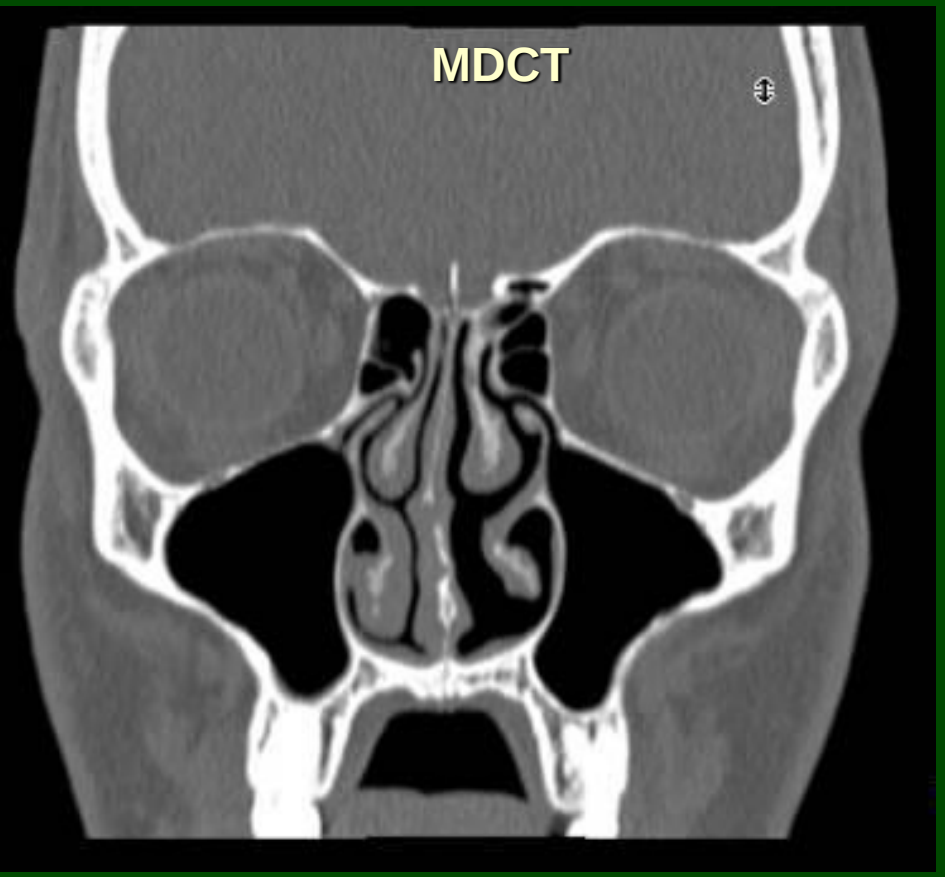


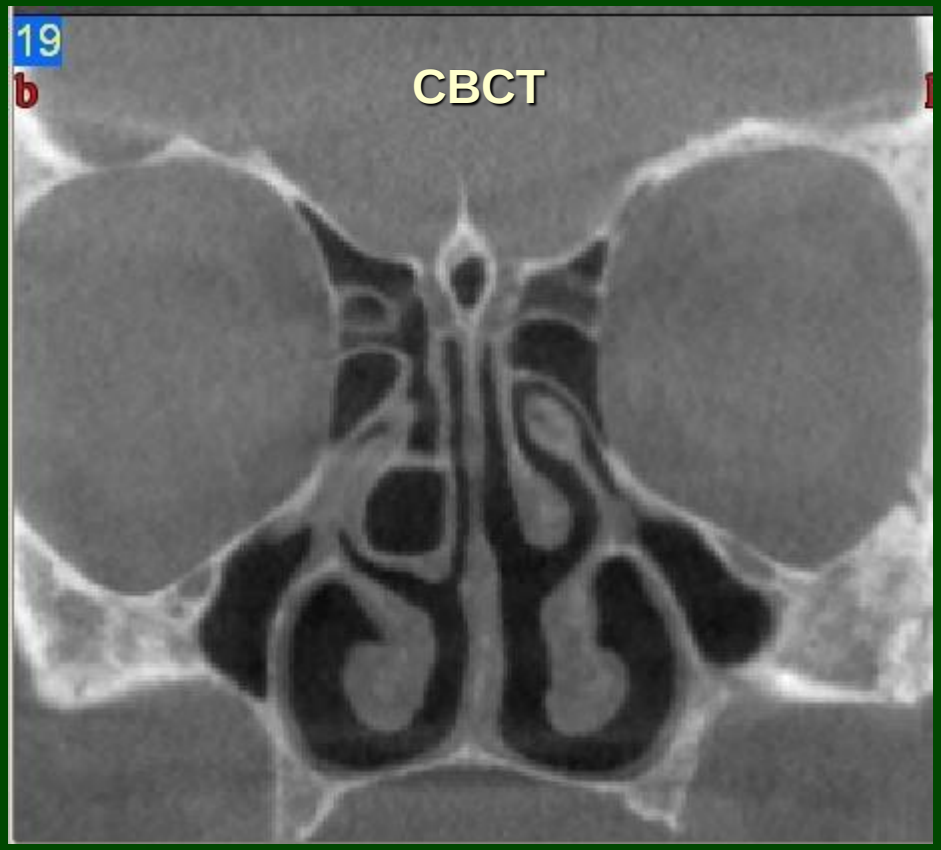
Total DLP: 620.2 mGy*cm

Dose

#	Description	Mode	CTDI [mGy]	DLP [mGy*cm]
1		Surview	0.0	0.00
2		Helical	38.1	620.20

FSV:	110 kV
FSV:	4,81 mA
SSV:	110 kV
SSV:	1,42 mA
FOV:	12"
Exposure time:	2,5 s
mAs:	7,91
Air Kerma:	1,46 mGy
DAP:	443,11 mGy · cm²
CTDIw:	1,06 mGy
CTDIvol:	1,06 mGy





Significantly lower radiation

max 100 µSv (↔MDCT kb. 1200-3300 µSv)

Panoramic X-ray 10-12 µSv (daily background radiation 8 µSv)

1. táblázat. **A CBCT-vizsgálatokkal járó sugárterhelések**

Készülékek	Effektív dózis
Háttérsugárzás (1 nap)[1]	8 μSv
Panoráma-röntgenfelvétel (átlagos)[1]	10-15 μSv
Digitális panorámaröntgen[1]	4,7–14,9 μSv
Régebbi analóg panoráma-röntgenkészülék[1]	26 μSv
Kodak 9000 3D digitális panoráma-röntgenfelvétel[2]	7 μSv
Kodak 9000 3D alsó metszőfog régiója, 70 kV–10 mA[2]	4,7 μSv
Kodak 9000 3D felső moláris fogak, 80 kV–10 mA[2]	18,8 μSv
iCAT Classic 20 másodperces felvétel, 6 cm magas[3]	32 μSv
iCAT Classic 10 másodperces felvétel, 13 cm magas[1]	34 μSv
Sirona Galileo alapbeállítás[4]	68 μSv
iCAT Classic 20 másodperces felvétel, 13 cm magas[1]	68 μSv
NewTom 3G „12" FOV[4]	70 μSv
Iluma 1,0 mA, 20 másodperces felvétel[4]	111 μSv
Sirona Galileo, maximális dózis[4]	125 μSv
iCAT Classic 40 másodperces felvétel, 13 cm magas[3]	133 μSv
iCAT Classic 20+20 másodperces felvétel, 22 cm magas (EFOV)[3]	136 μSv
Planmeca Promax 3D, small adult[4] (több felvétel fúziója révén)	449 μSv
Iluma 3,8 mA, 40 másodperces felvétel[4]	592 μSv
CT[5]	1200–3300 μSv

1. Dr. Sharon Brooks, Dept. of Radiology, University of Michigan; 2. Trophy, IRSN; 3. Patient Positioning Guide for iCAT standard controls Version 3.0xx; 4. Ludlow JB, Dosimetry of CBCT Units for Oral and Maxillofacial Radiology; 5. Dr. Stuart White, Dept. of Radiology, UCLA

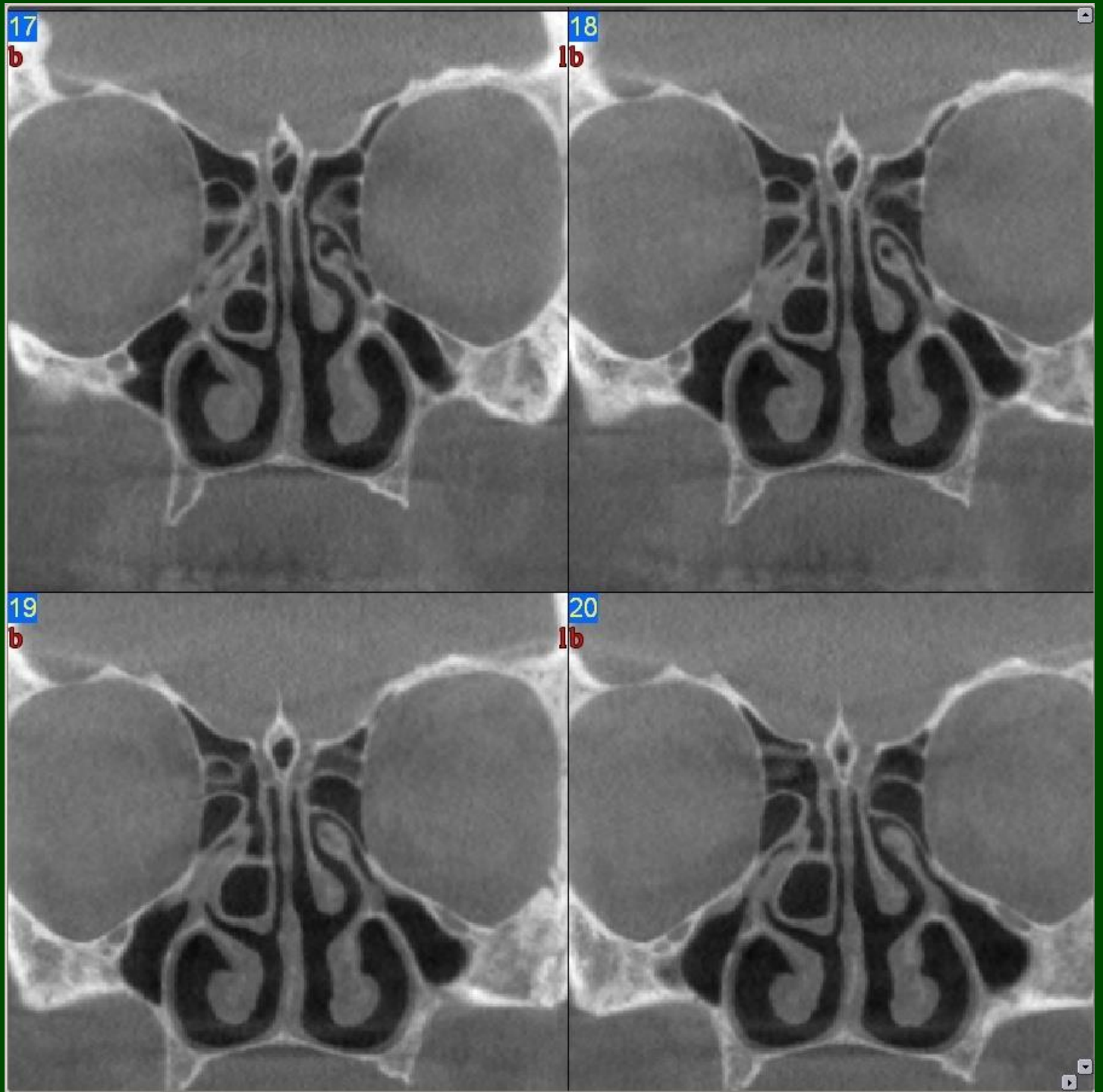
Advantages- Disadvantages

	MDCT	CBCT
Tissue contrast	Excellent	Moderate
Density measurement (HU)	precise	Not reliable
„Windowing”	Based on HU	Brightness and contrast
FOV	changeable	Standard
Ionising radiation	High (min. 10x)	low
Voxel	Isovolumetric 0.625mm	Isovolumetric 0.125mm
Duration of the examination	Irrelevant (10-30sec)	Sensitive to motion (<40sec)
Klausztrofóbia	Not likely (vs MR)	No
Space needed	Larger	Smaller
Metal artefacts	stronger	weaker
Expences	High	low
Covered by health insurance	yes	no

CBCT clinical indications

- implantiology
- oro- and maxillofacialis diseases
- TMJ
- Surgical planning
- fogszabályozás és orthognathia
- impactált fogak

DMF


17
b
18
lb
19
b
20
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Axl15
CORONALS
AXIALS
SAGITTALS

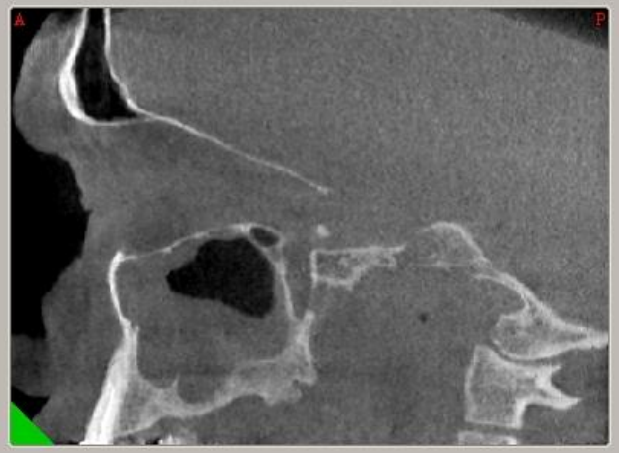
R
L


A
P

CORONALS

AXIALS

SAGITTALS



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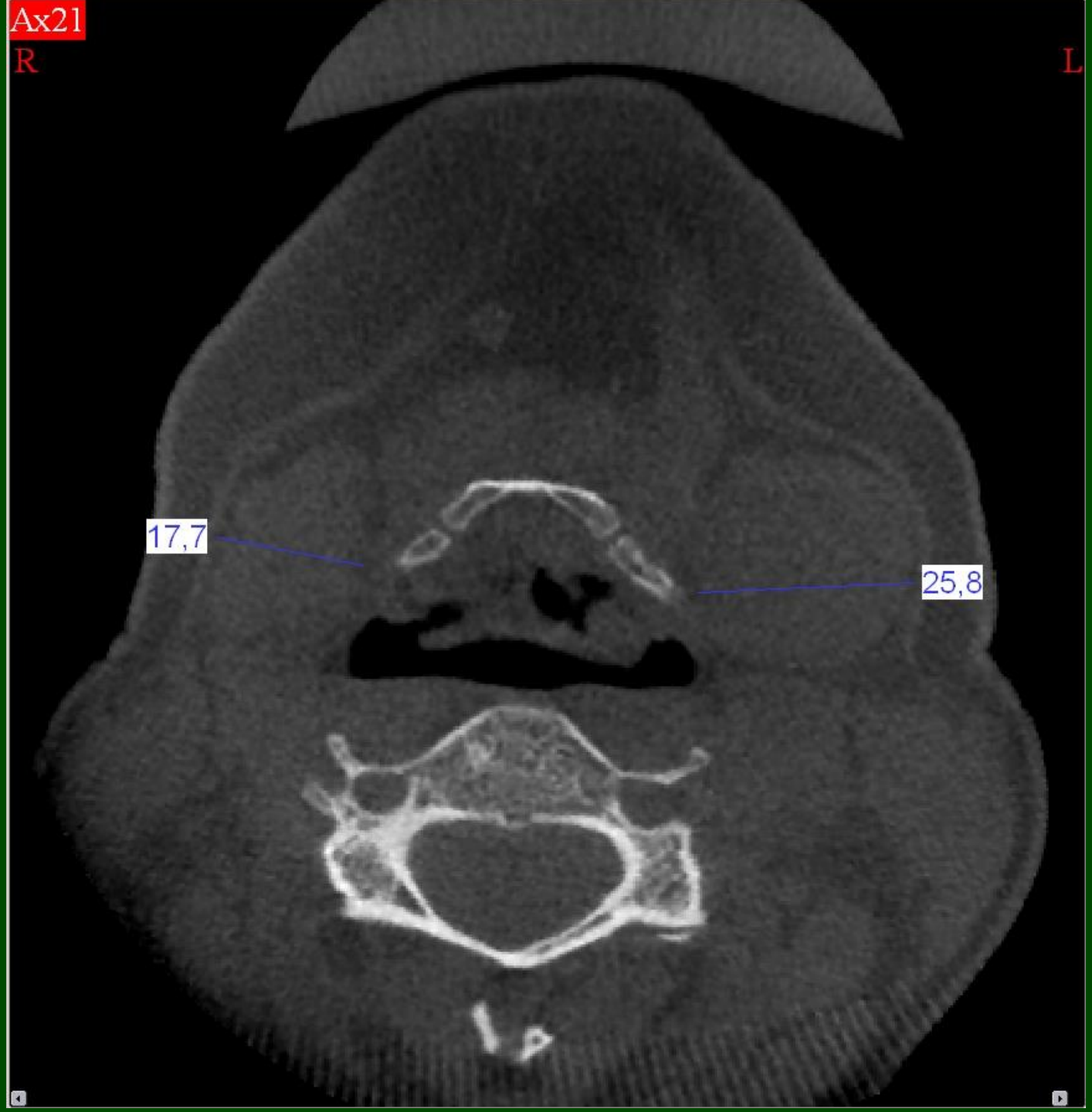
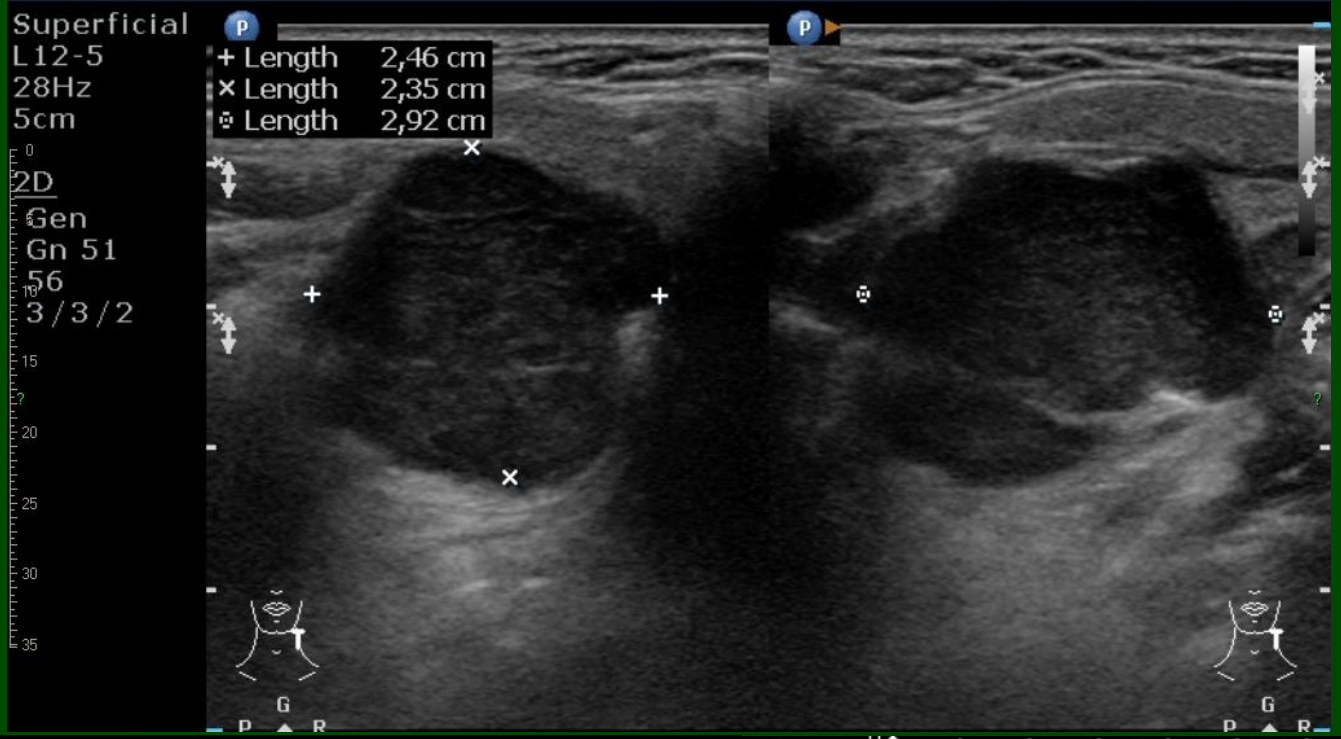
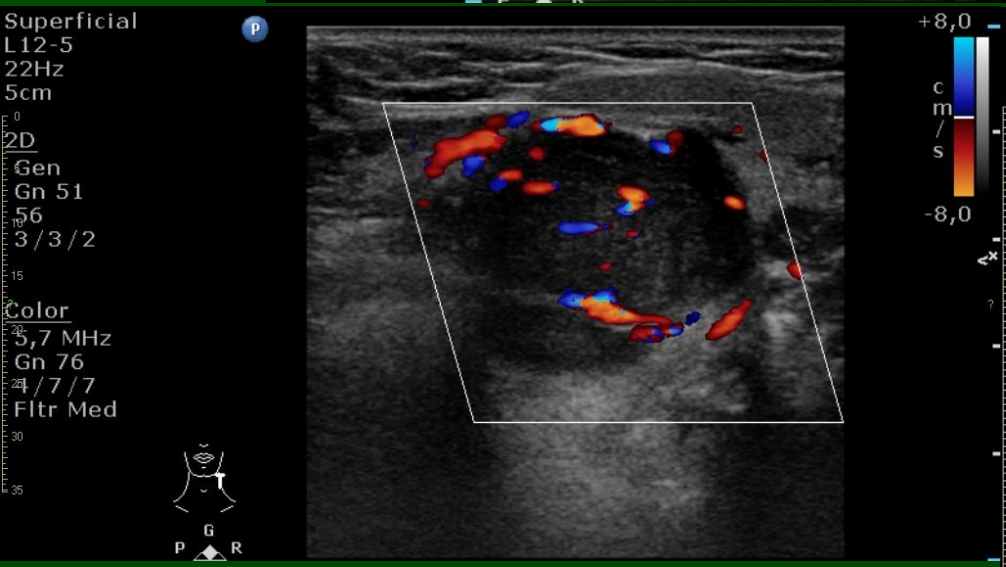

Ax21
R
L
17,7
25,8


Superficial
L12-5
28Hz
5cm
2D
Gen
Gn 51
56
3/3/2
+ Length 2,46 cm
× Length 2,35 cm
Length 2,92 cm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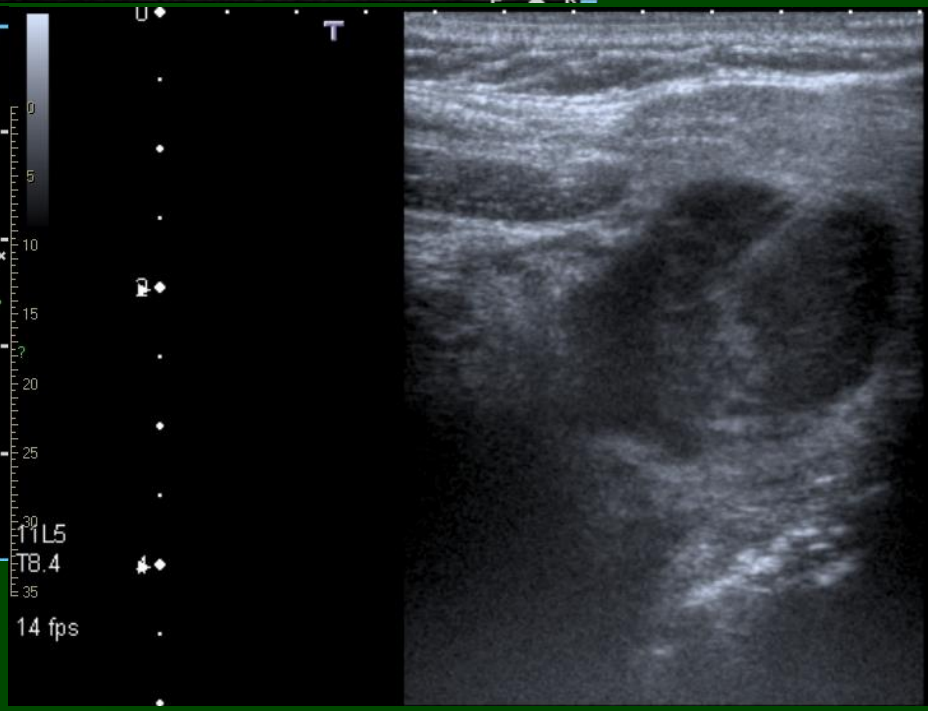
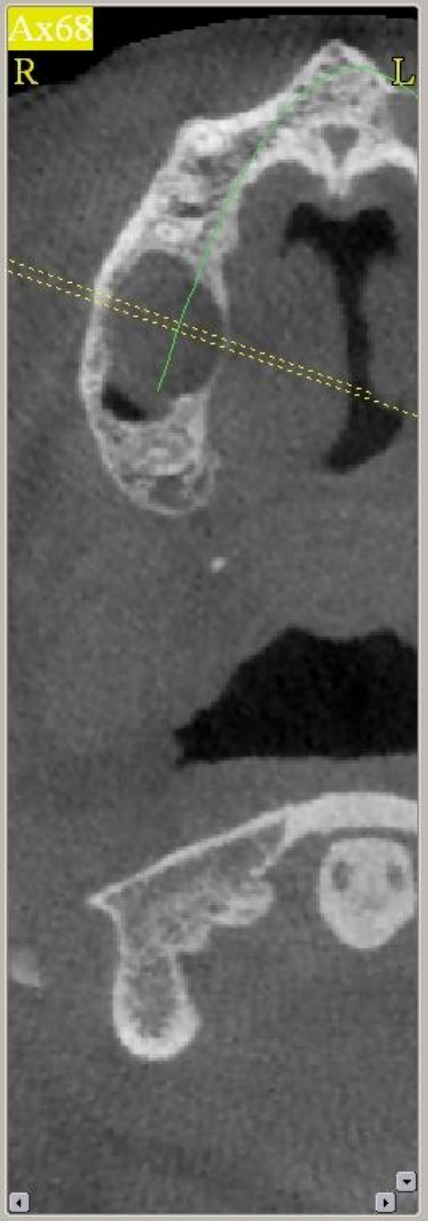
L12-5
22Hz
5cm
2D
Gen
Gn 51
56
3/3/2
Color
5,7 MHz
Gn 76
4/7/7
Fltr Med
+8,0
cm/s
-8,0


T1L5
T8.4
14 fps


Ax68
R
L


R
L
T: 4mm
10


b


Ax32
R
L

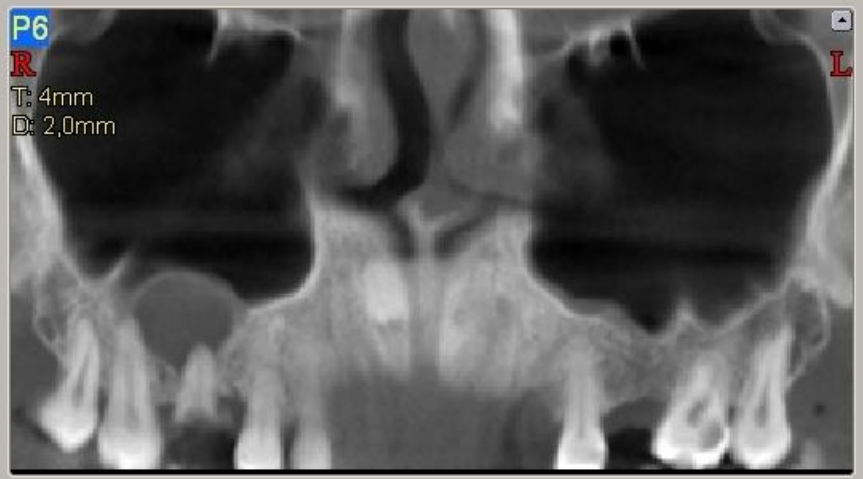

Ax49
R
L


Ax77
R
L

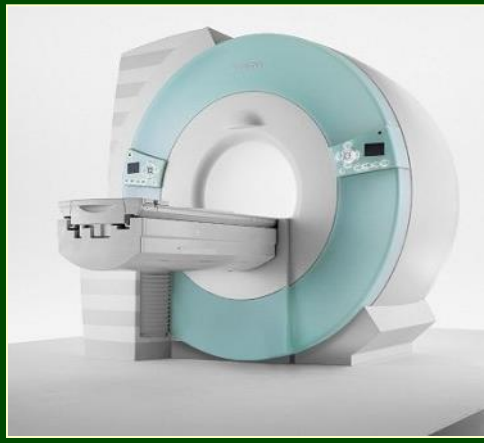

Ax73
R
L
P5
P6


P4
R
L
T: 4mm
D: 2,0mm


P5
R
L
T: 4mm
D: 2,0mm


P6
R
L
T: 4mm
D: 2,0mm

Non contast and contrast enhanced MR



- Maps the Hydrogen atoms of tissues – best soft tissue resolution
- No ionizing radiation
- More expensive, less available
- Longer examination time (30-50 min)
- Problematic next to metallic objects, bones harder to assess

Non contrast and contrast enhanced MR

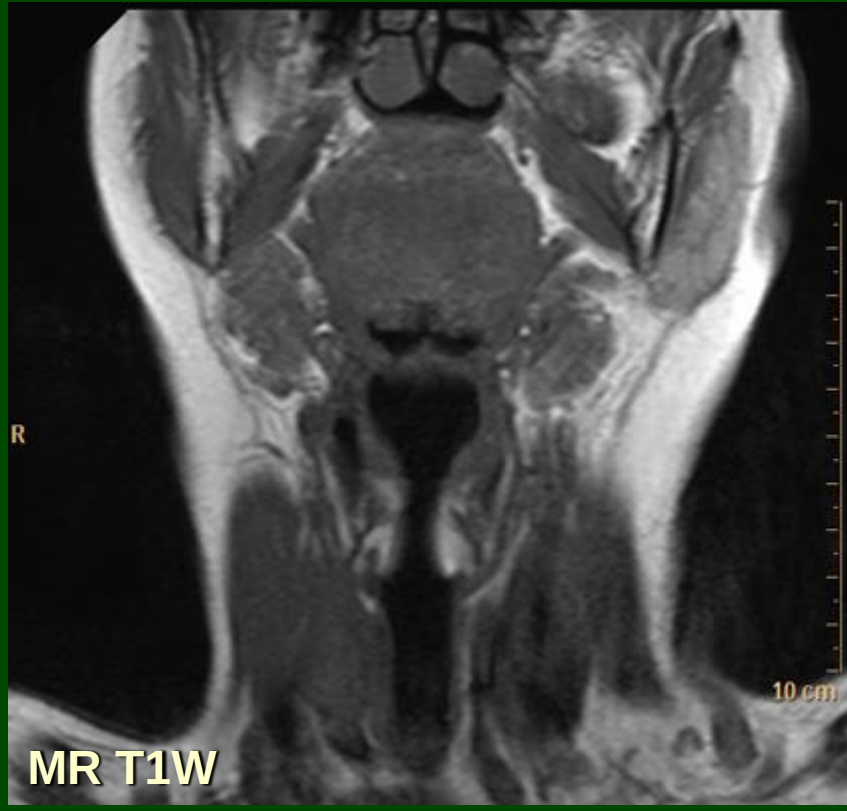
Indications

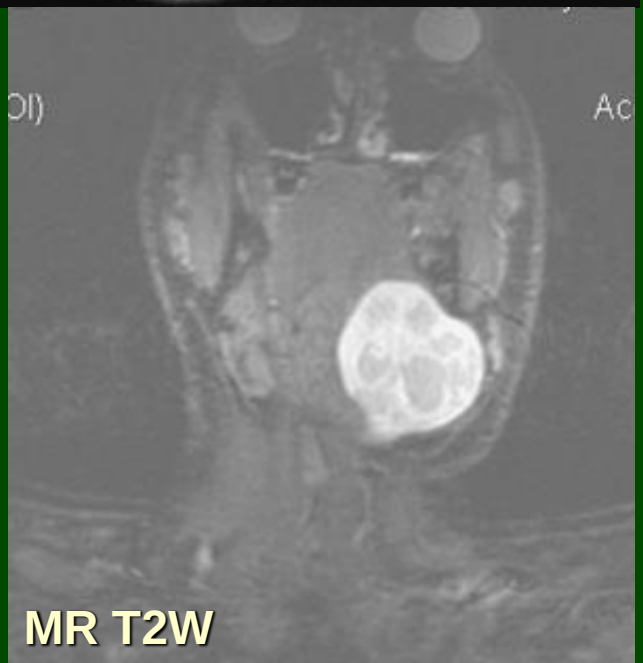
- Suprahyoid neck
- Skull base (foramens)
- Tumor extent
  (scar tissue ↔recurring tumor)

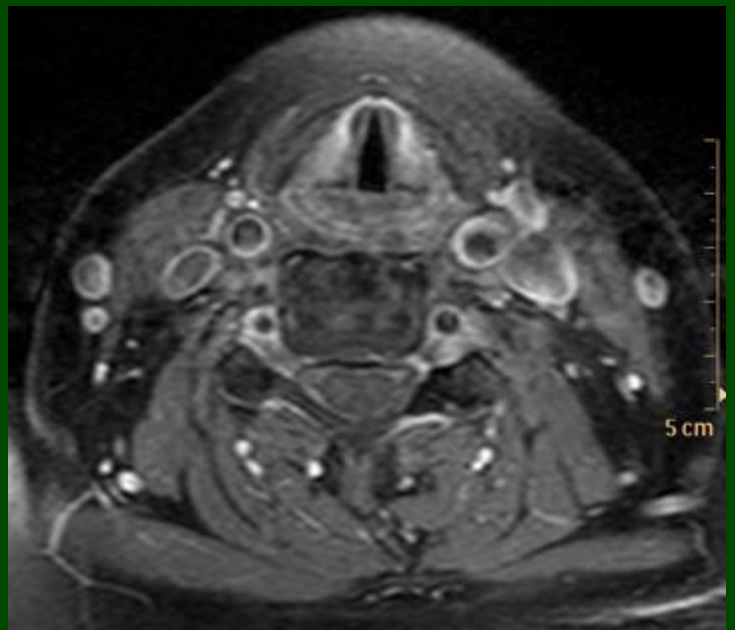
Preparation

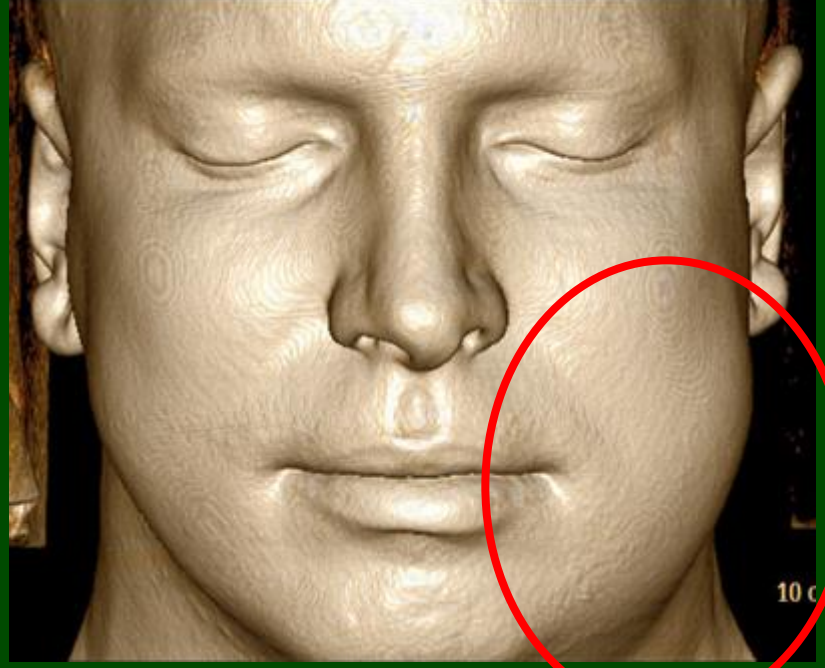
- Metallic objects removed
- Consent
- Contraindicated metallic prosthetics, pacemaker
- claustrophobia

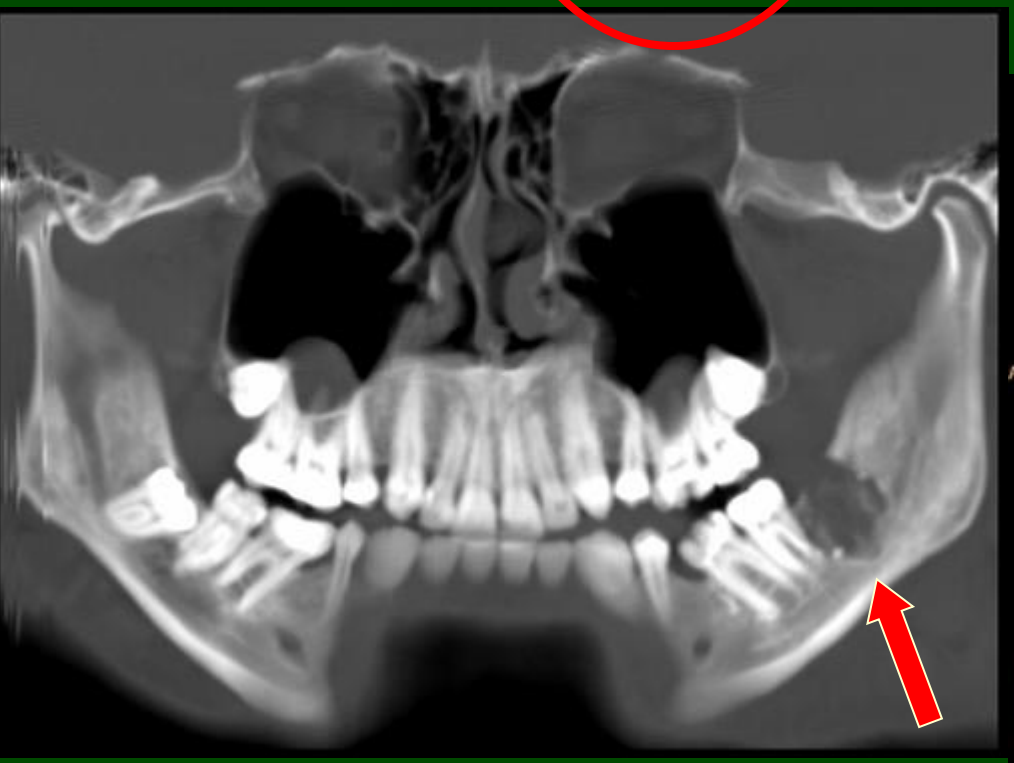

R
10 cm
MR T2W

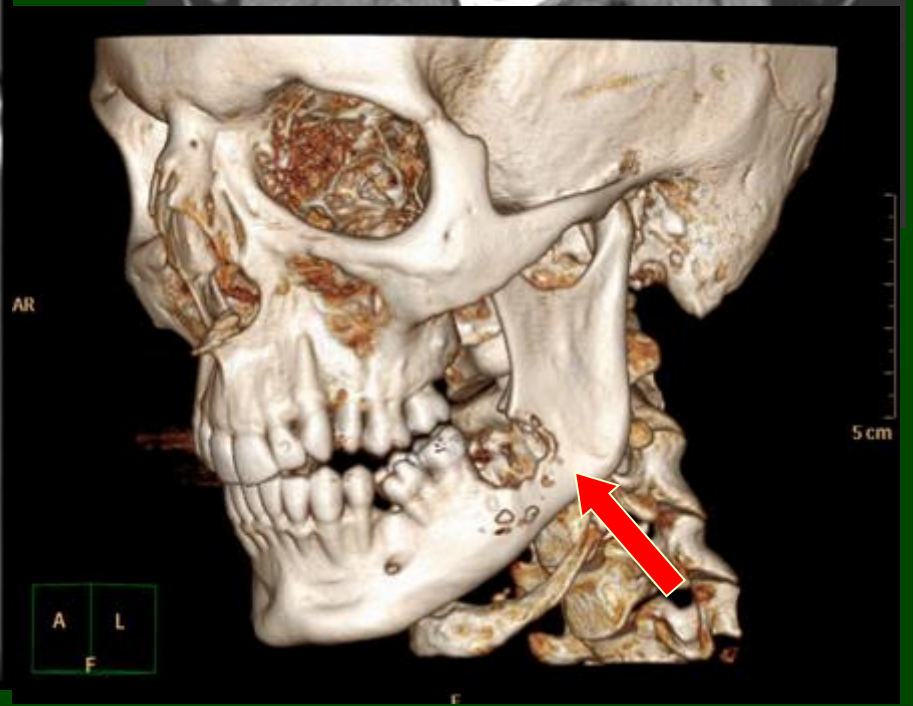

R
10 cm
MR T1W

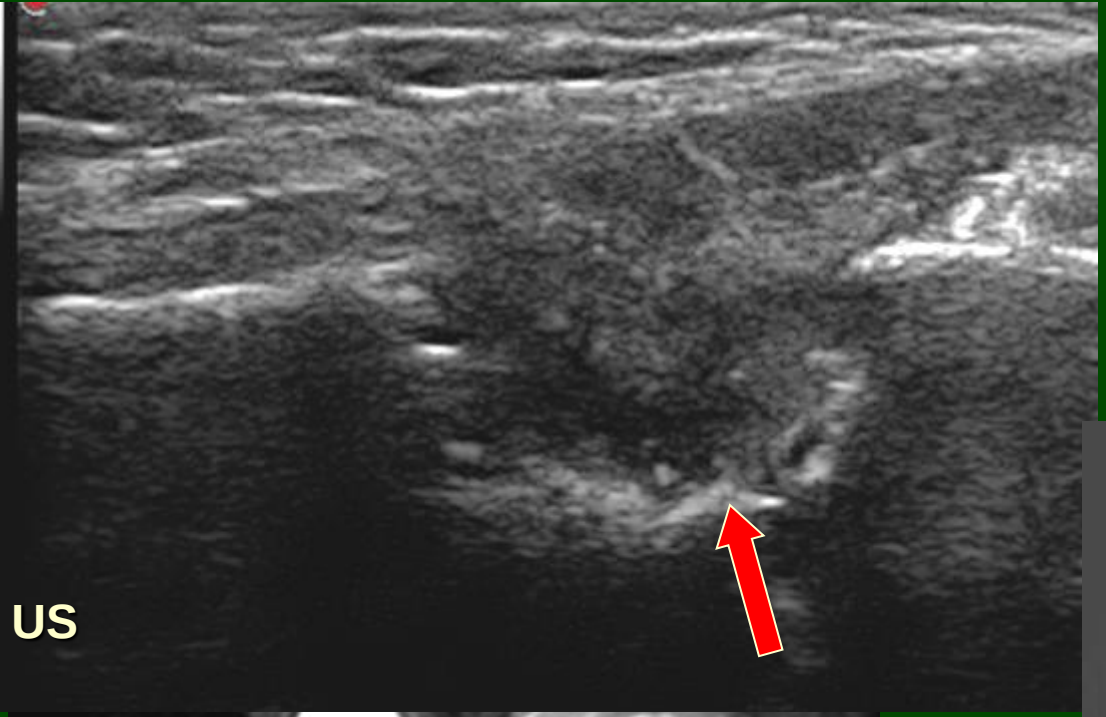

OI)
Ac
MR T2W


5 cm






AR
5 cm
A
L
F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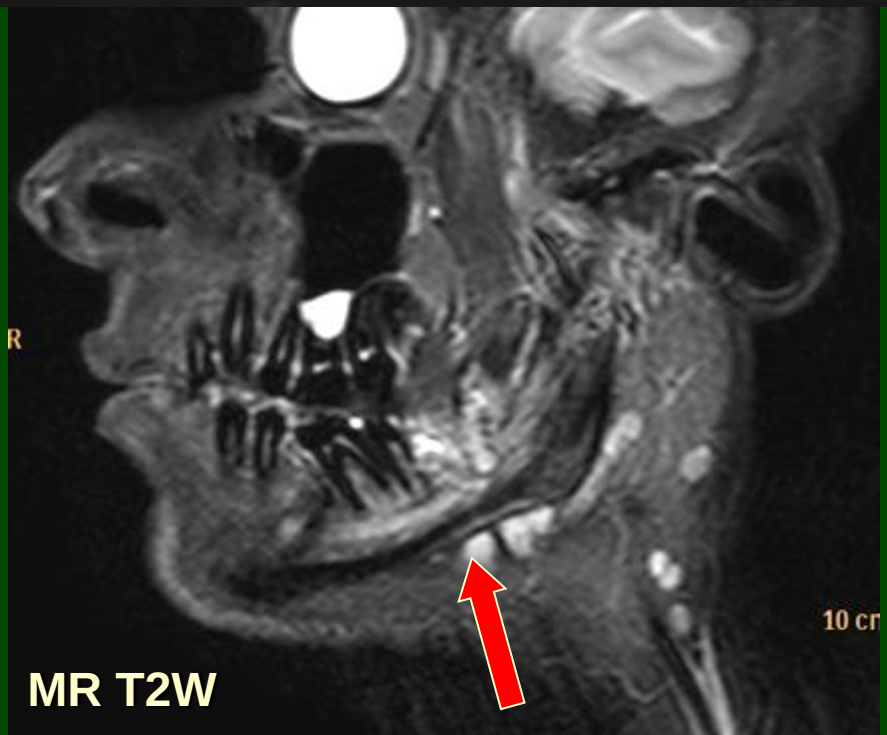
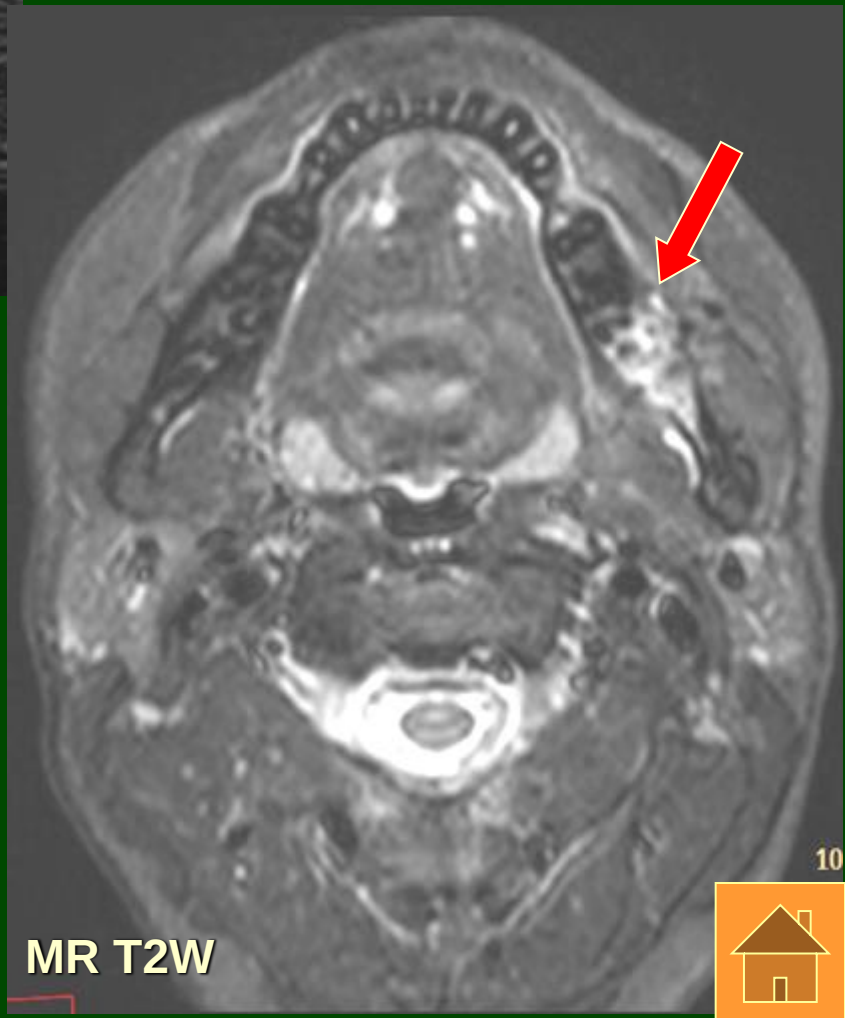

MR T2W


MR T2W

DSA

- Digital X-ray + subtraction
- High radiation, semi-invasive
- Regional vascular structure
- Problems are usually related to contrast agents

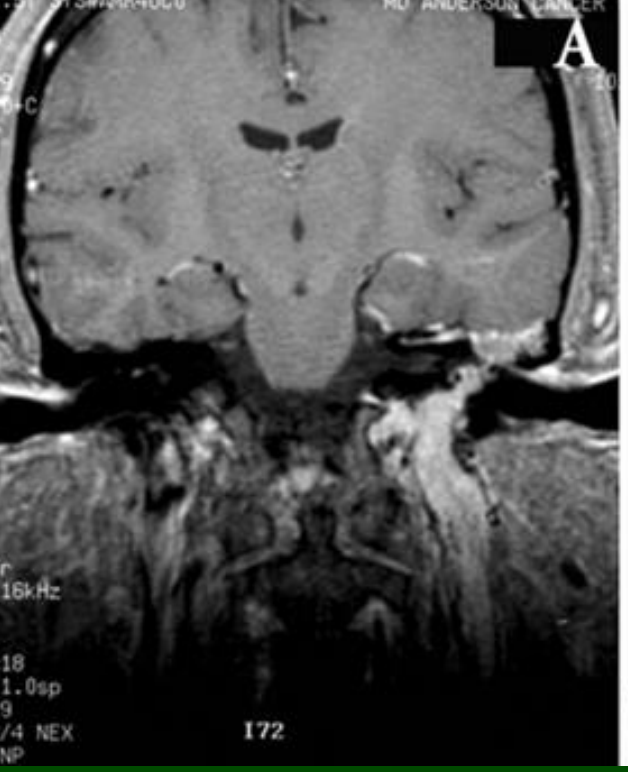
Digitális szubtrakciós angiográfia

Indications

- Vascular structure of tumors – possible interventions (RFA-, chemoembolisation, chemoablation, embolsation,
- paraganglioma
- glomus tumors

Preparation

- Consent – empty stomach
- Sterile environment


A
16kHz
1.0sp
/4 NEX
172

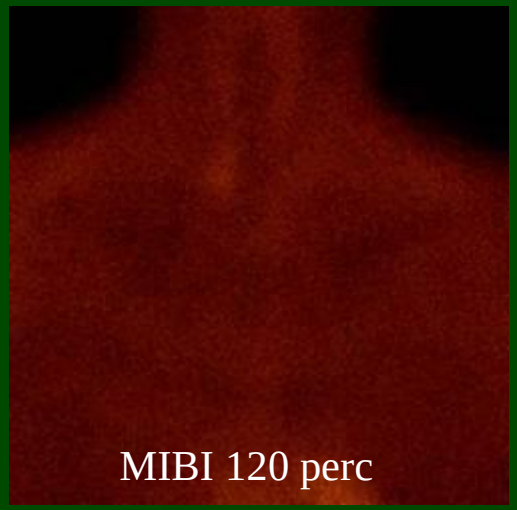

B

Molecular imaging

- Poor morphologic resolution
- Good temporal / functional res.
- Tc isotope
  - Gamma camera (thyroid)
  - SPECT – single photon emission CT
- FDG-PET
  - F18 glucose – positron .
  - Tumor metastasis, primary malignancy or inflammation
  - PET-CT – fused images - better morphology

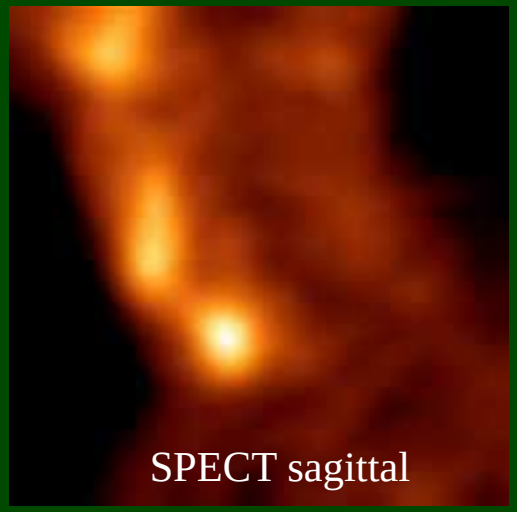
Ectopic parthyroid


MIBI 5 perc

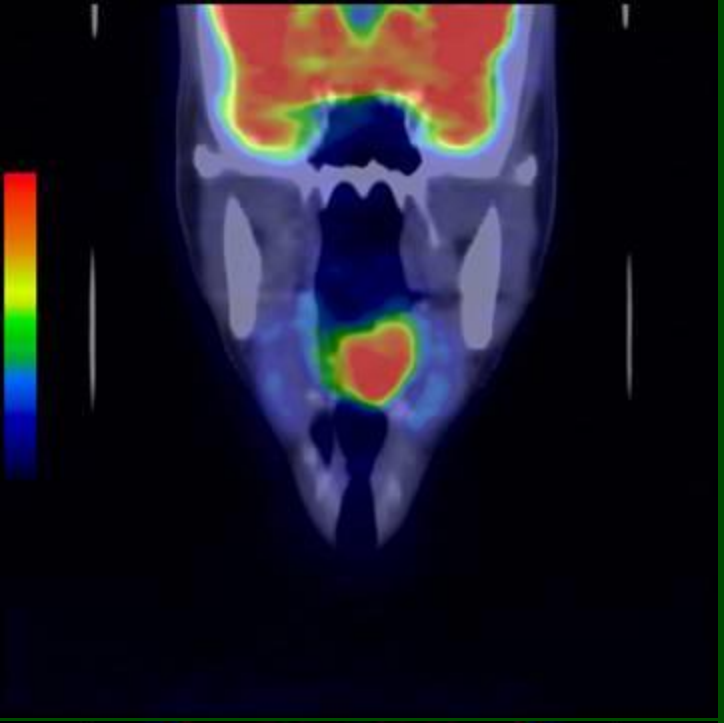
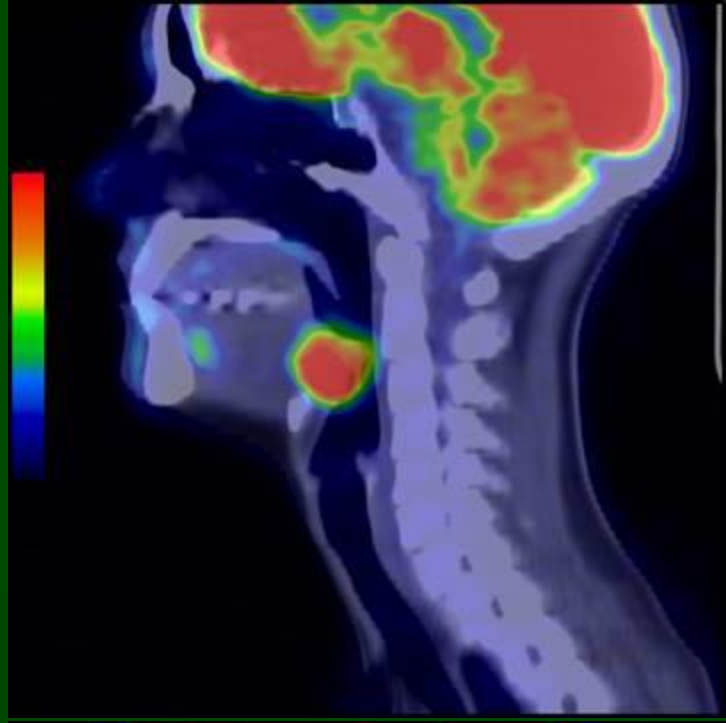
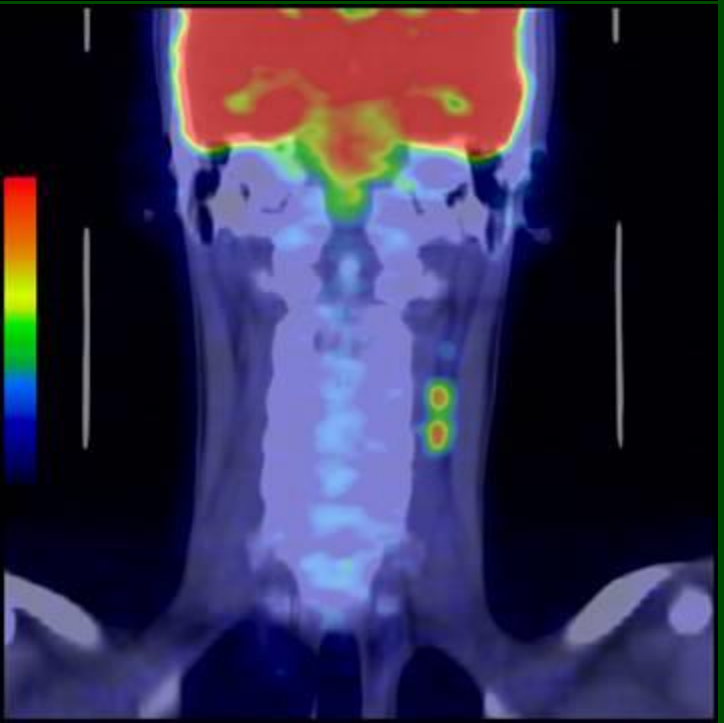
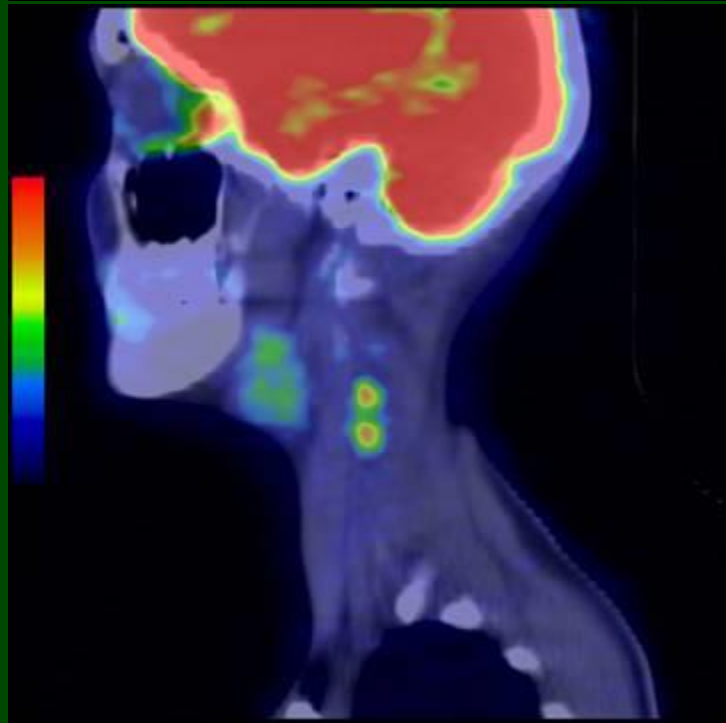

MIBI 120 perc

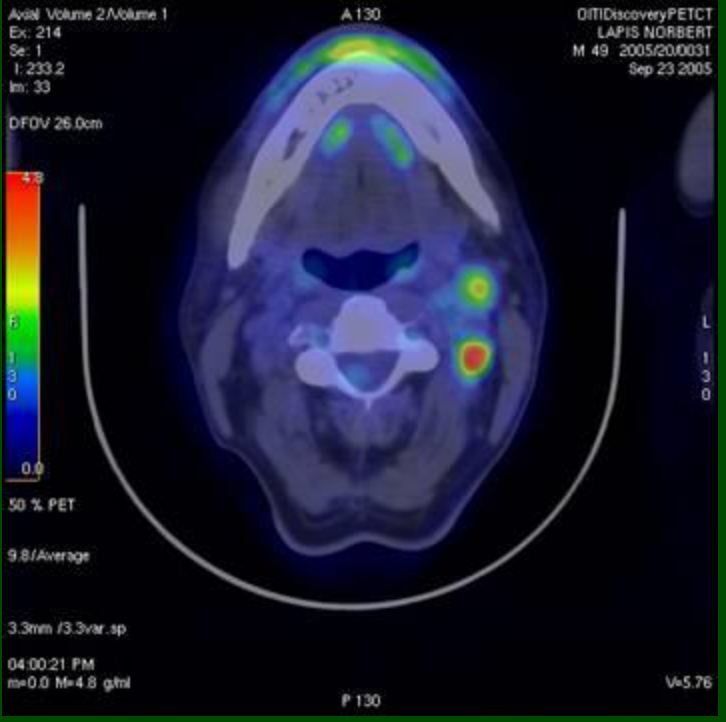

Kontroll célzott UH


pertechnetát

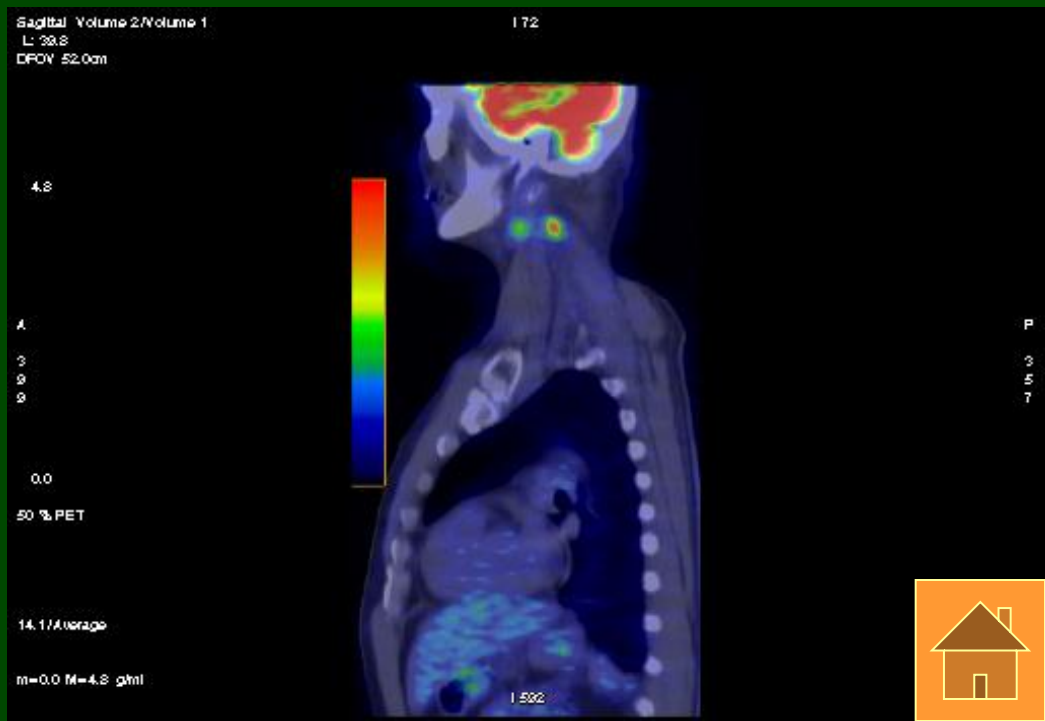

SPECT sagittal

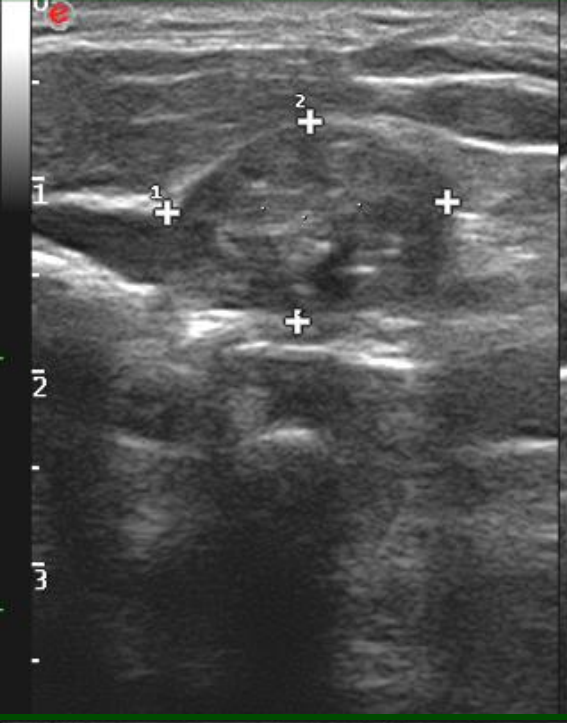
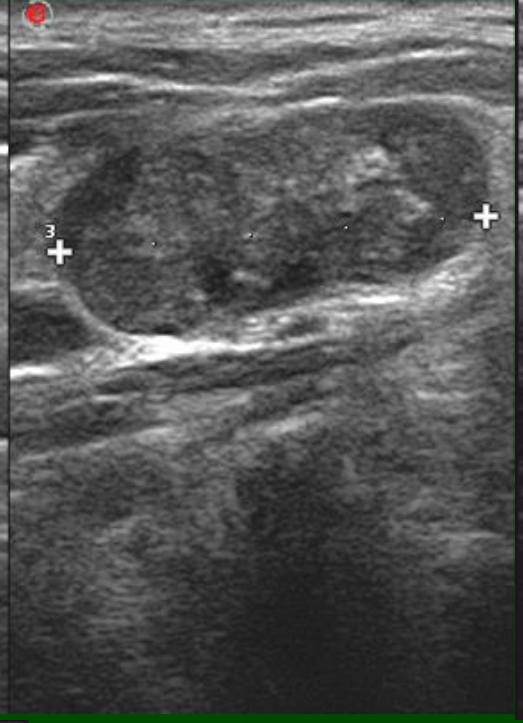
21 éves nő,
PTH: 58 pg/ml (!),
seCa: 2,85 mmol/l
adenoma

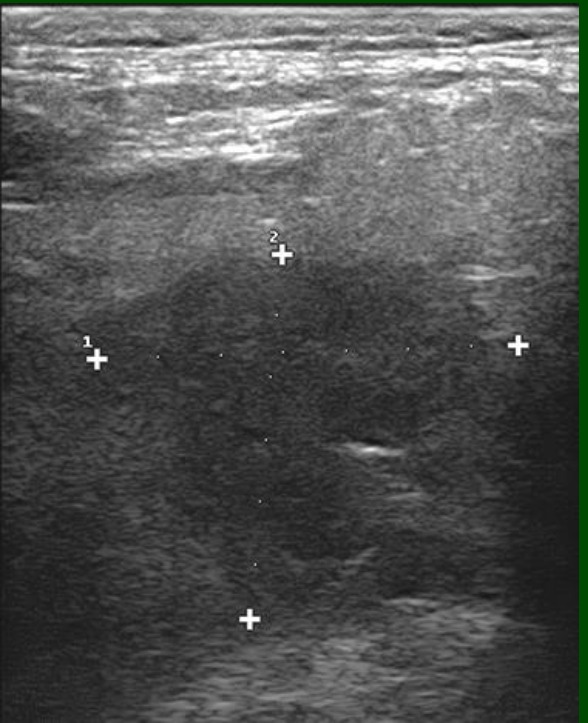






Axial Volume 2/Volume 1
Ex: 214
Se: 1
I: 233.2
Im: 33
A 130
OITIDiscoveryPETCT
LAPIS NORBERT
M 49 2005/20/0031
Sep 23 2005
DFOV 26.0cm
4.8
0.0
50 % PET
9.8/Average
3.3mm /3.3var.sp
04:00:21 PM
m=0.0 M=4.8 g/ml
V=5.76
P 130

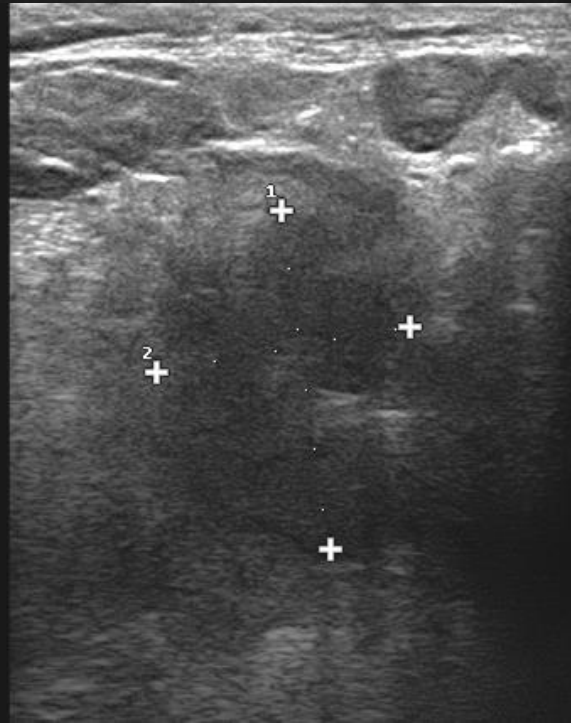

Axial6 Volume 1
Ex: 214
Se: 2
I: 233.1
Im: 33
A 130
OITIDiscoveryPETCT
LAPIS NORBERT
M 49 2005/20/0031
Sep 23 2005
DFOV 26.0cm
STND
9.8/Average
kv 140
mA 200
Rot 0.80s/HE 27.0mm/rot
3.8mm 1.35:1 /3.3sp
Tilt: 0.0
03:58:26 PM
W = 620 L = 160
V=44.00
P 130


Sagittal Volume 2/Volume 1
L: 39.8
DFOV 52.0cm
I 72
4.8
0.0
50 % PET
14.1/Average
m=0.0 M=4.8 g/ml
I 592



tu. rad. linguae +
met lgg. colli



FDG-PET: metastasis