

Arterial Radioanatomy of the Cranio-Cervical Junction

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kittipong1970@gmail.com



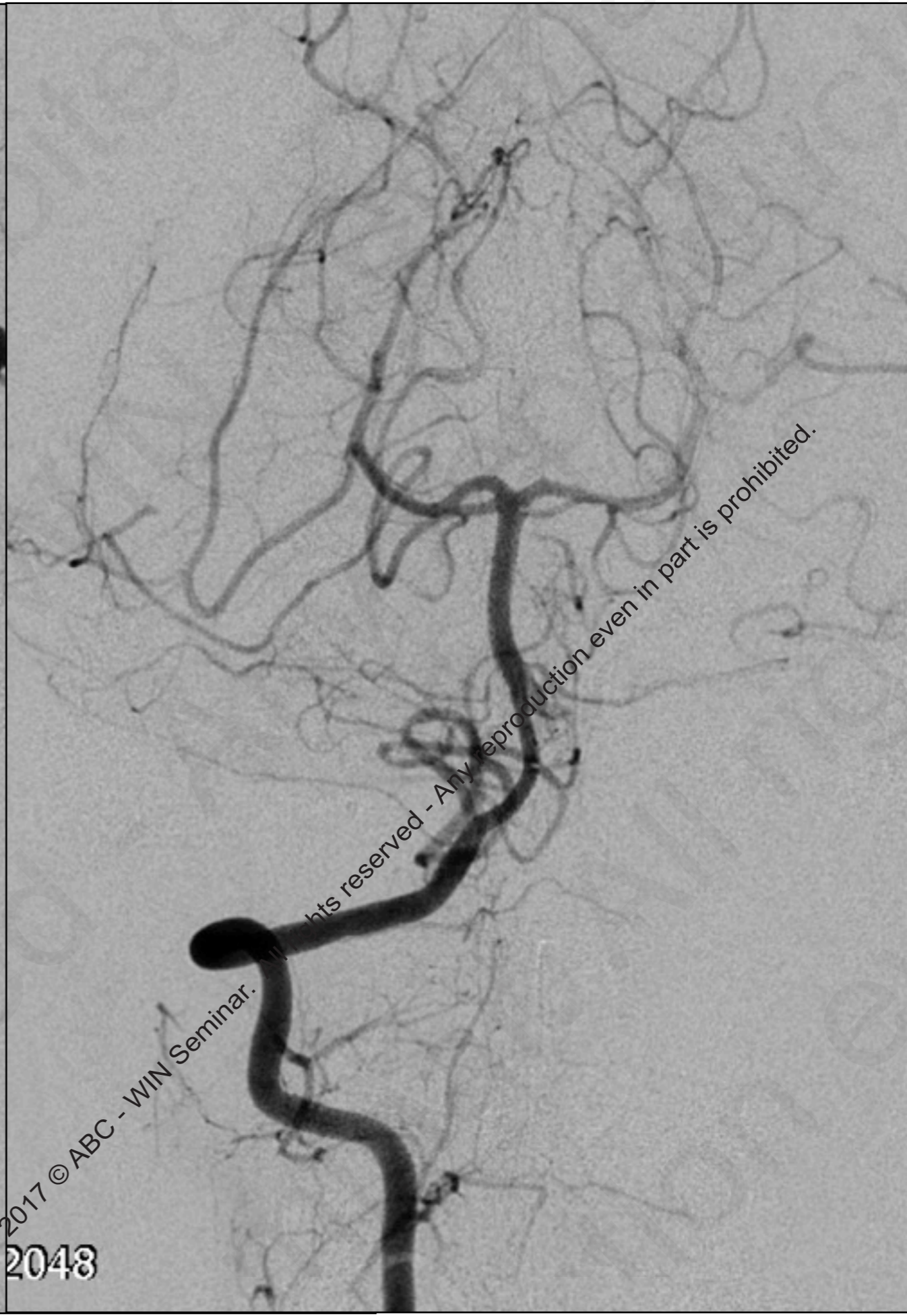
Introduction 1

The major participants of the
cranio-cervical junction (CCJ) arterial system

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10 F, cerebellar AVM



OA: mastoid branch

MMA: petrous/ petrosquamous br.

ICA: medial/lateral clival arteries

AICA: subarcuate artery

posterior meningeal artery/ artery of the falx cerebelli

jugular br.

hypoglossal br.

occipital artery/ ascending pharyngeal artery

1st
2nd
3rd
4th
cervical spaces

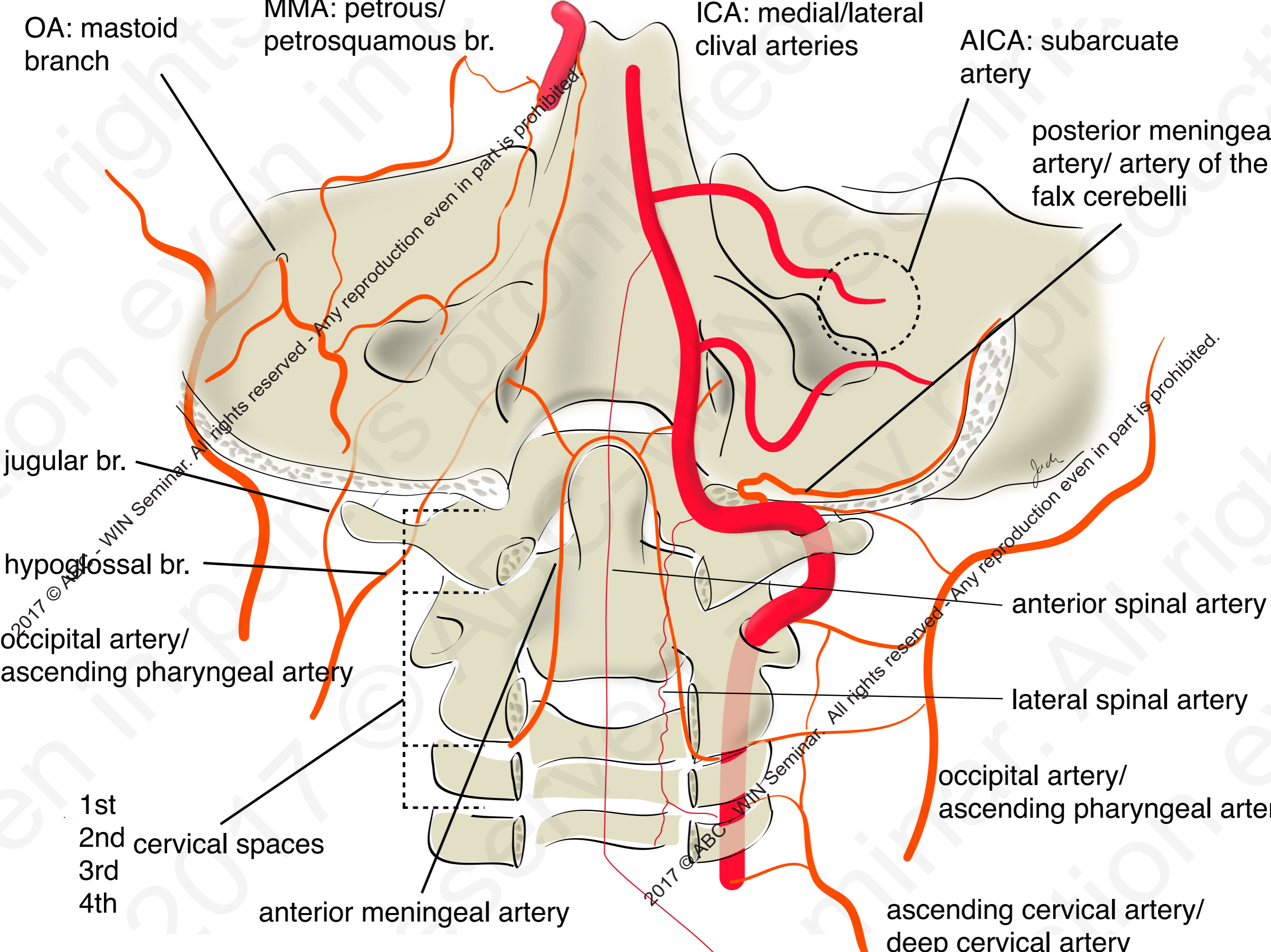
anterior meningeal artery

ascending cervical artery/ deep cervical artery

anterior spinal artery

lateral spinal artery

occipital artery/ ascending pharyngeal artery



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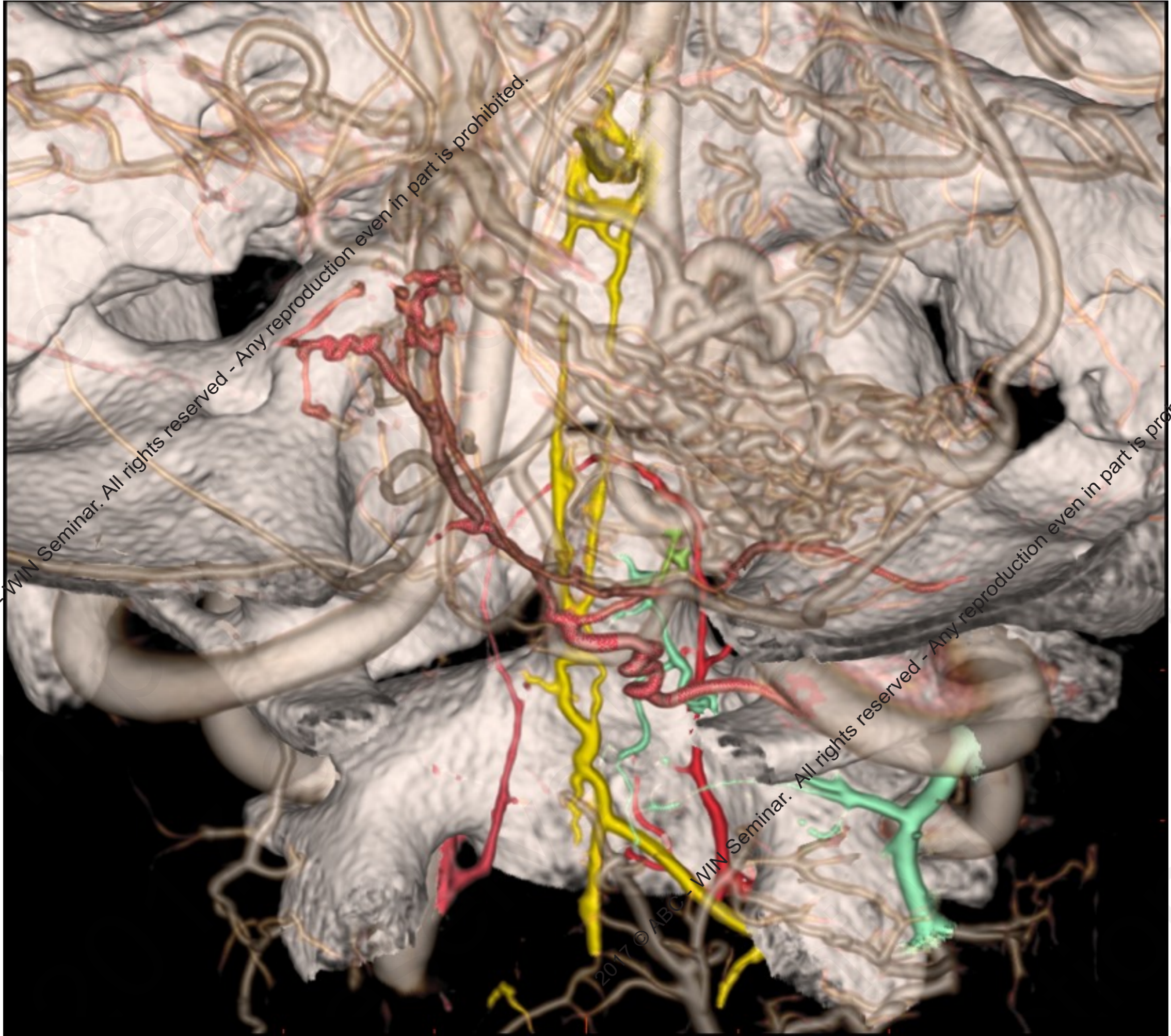
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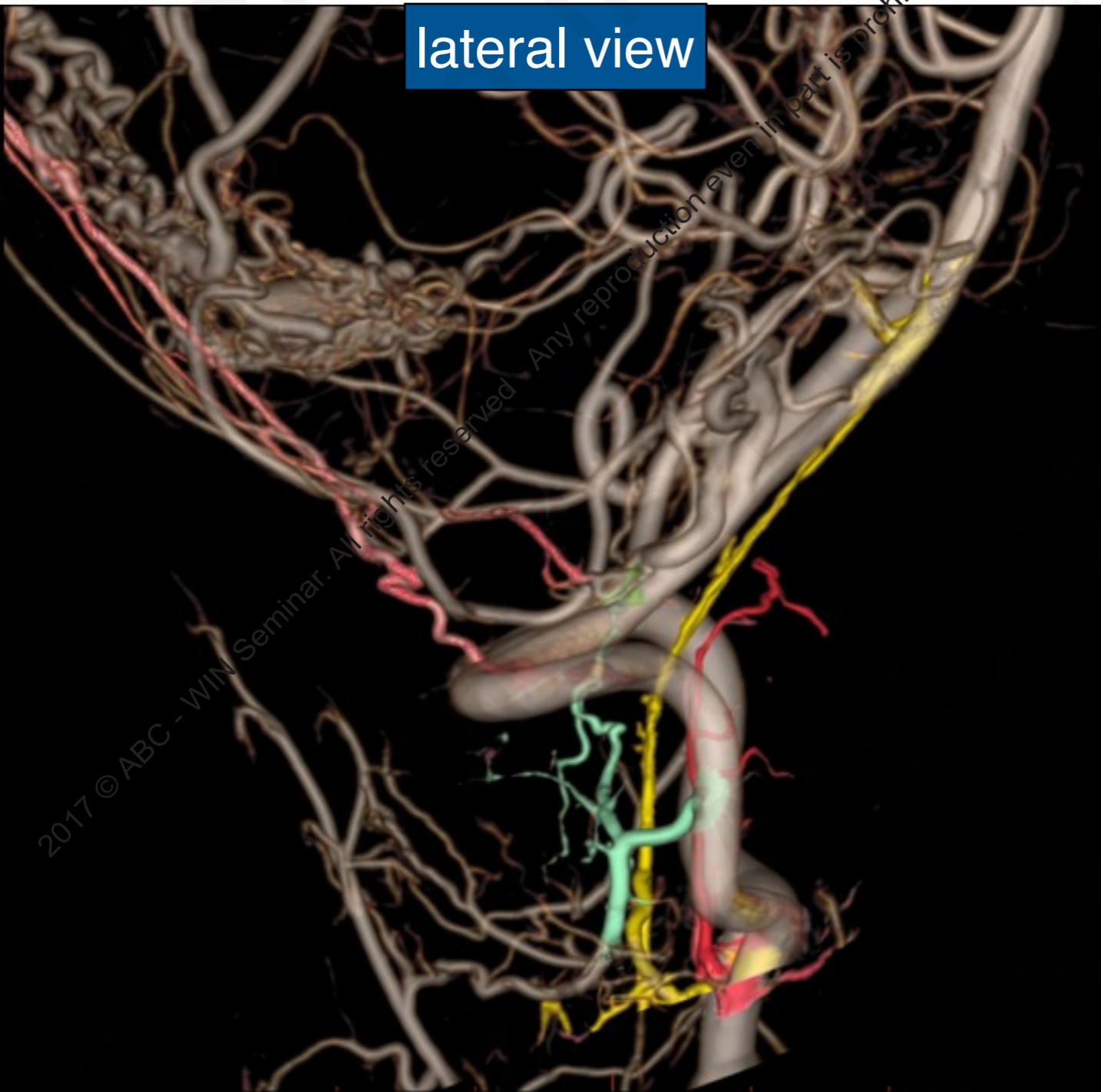
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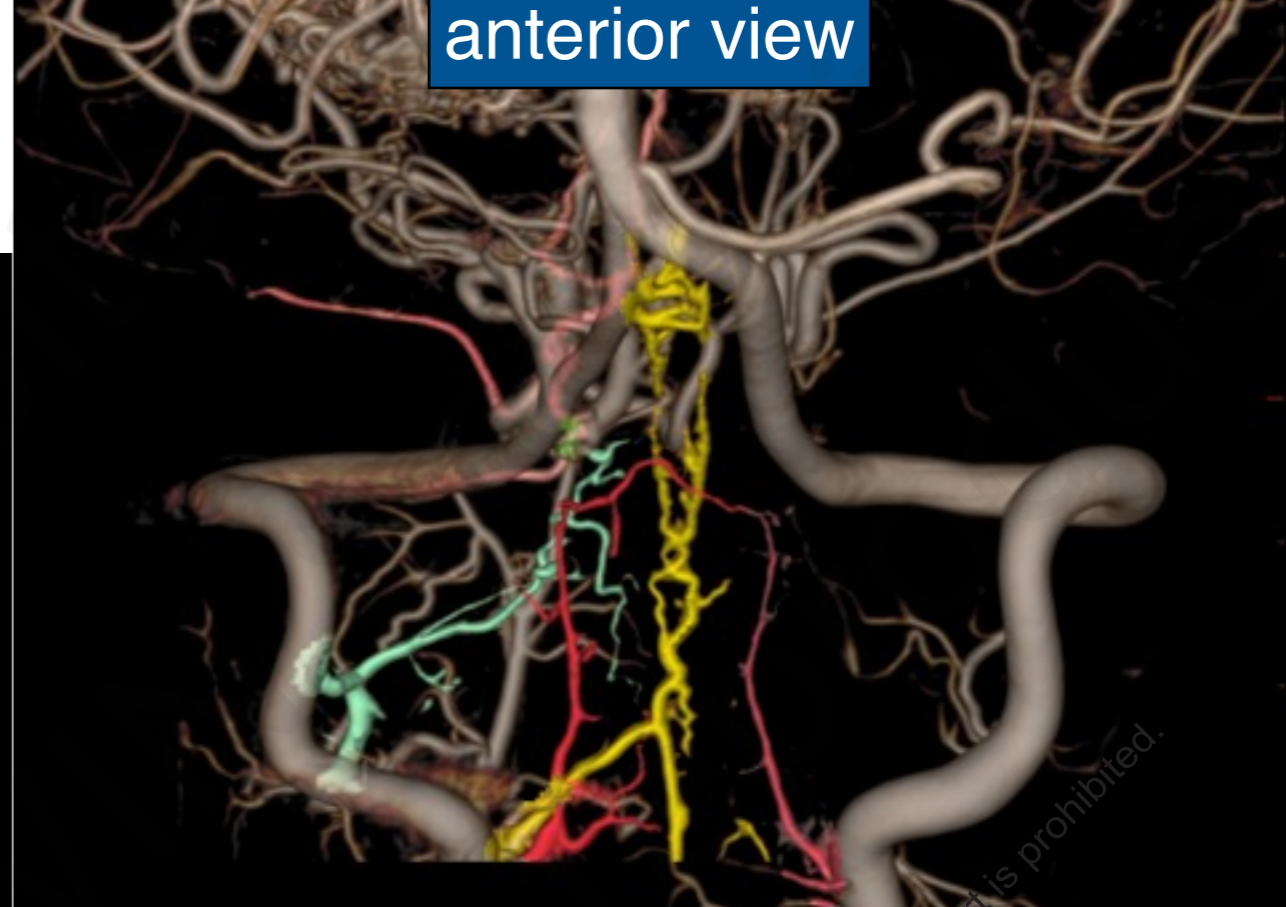
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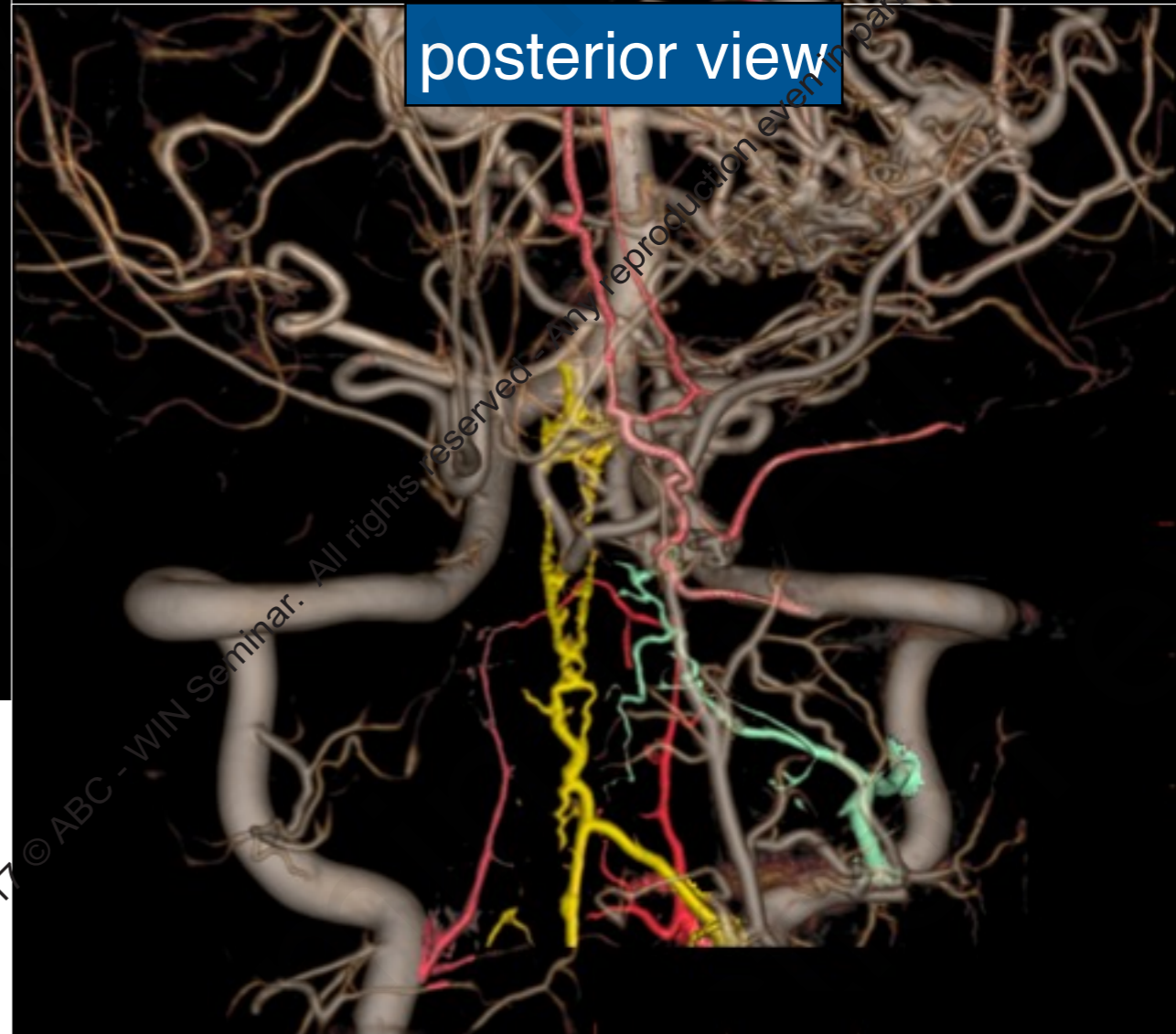
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lateral view



anterior view



posterior view

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Introduction 2

The segmental arrangement in the CCJ

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Anastomosis at the CCJ

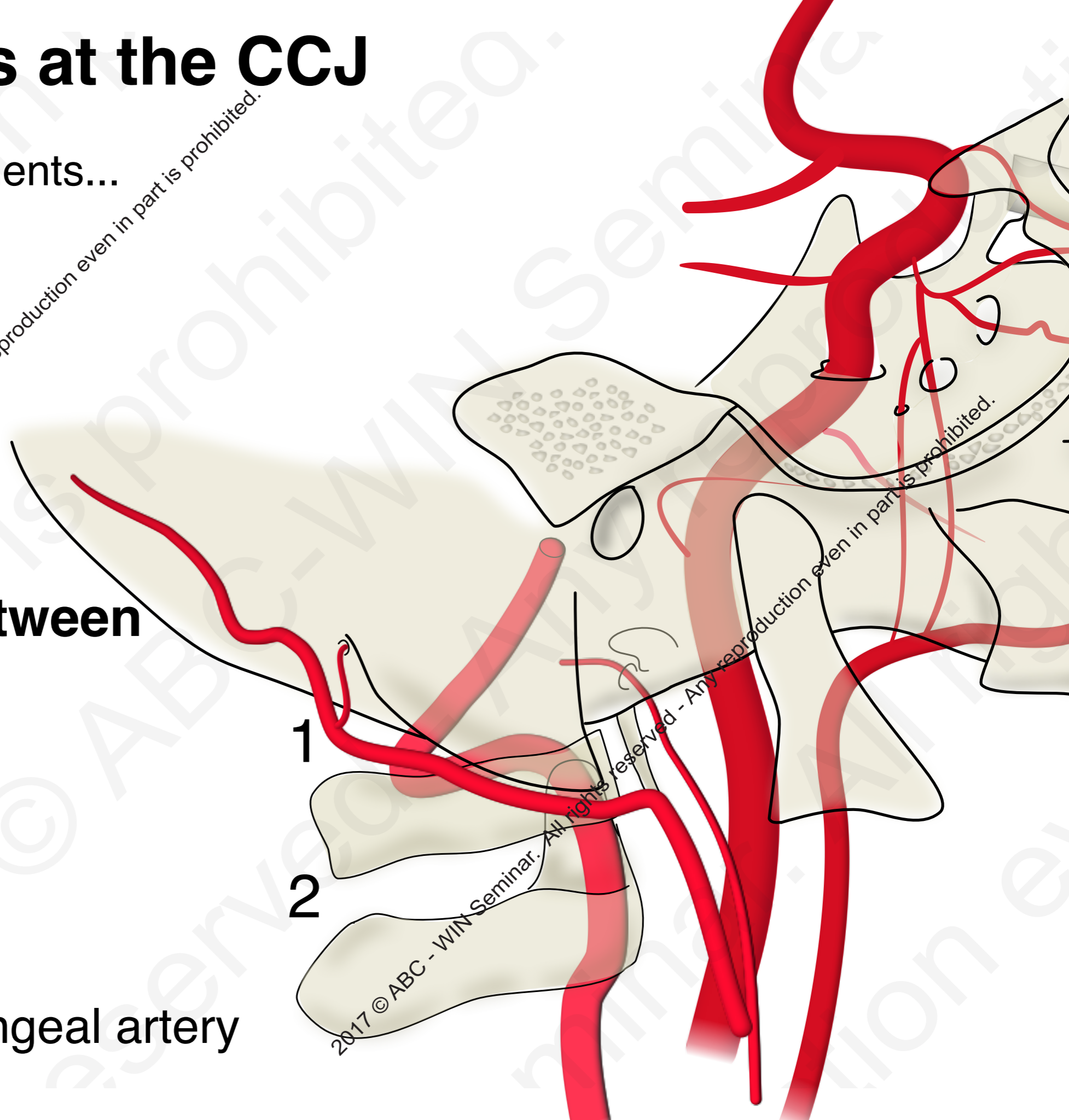
at the first two segments...

Connections between

Vertebral artery

Occipital artery

Ascending pharyngeal artery



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1

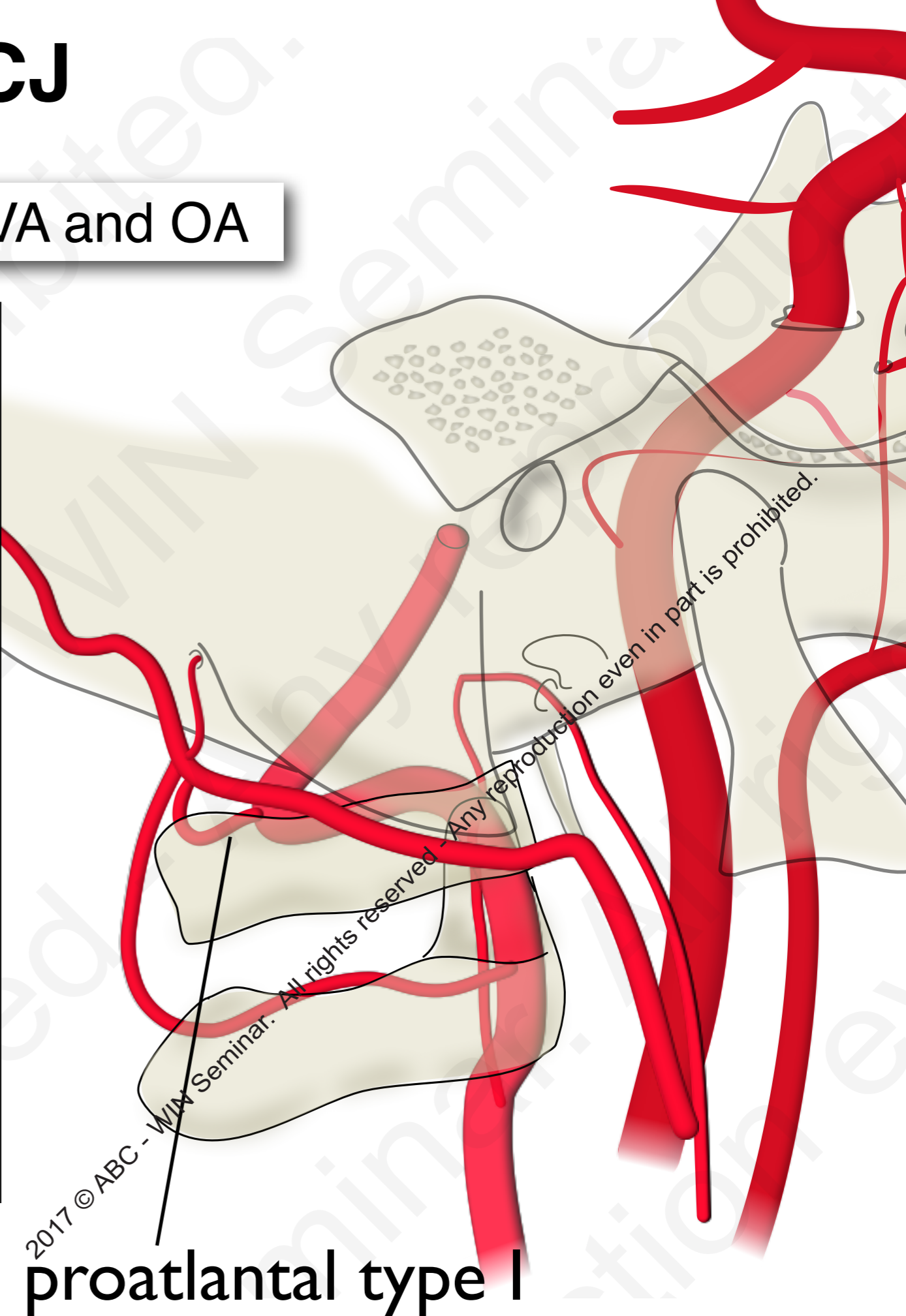
2

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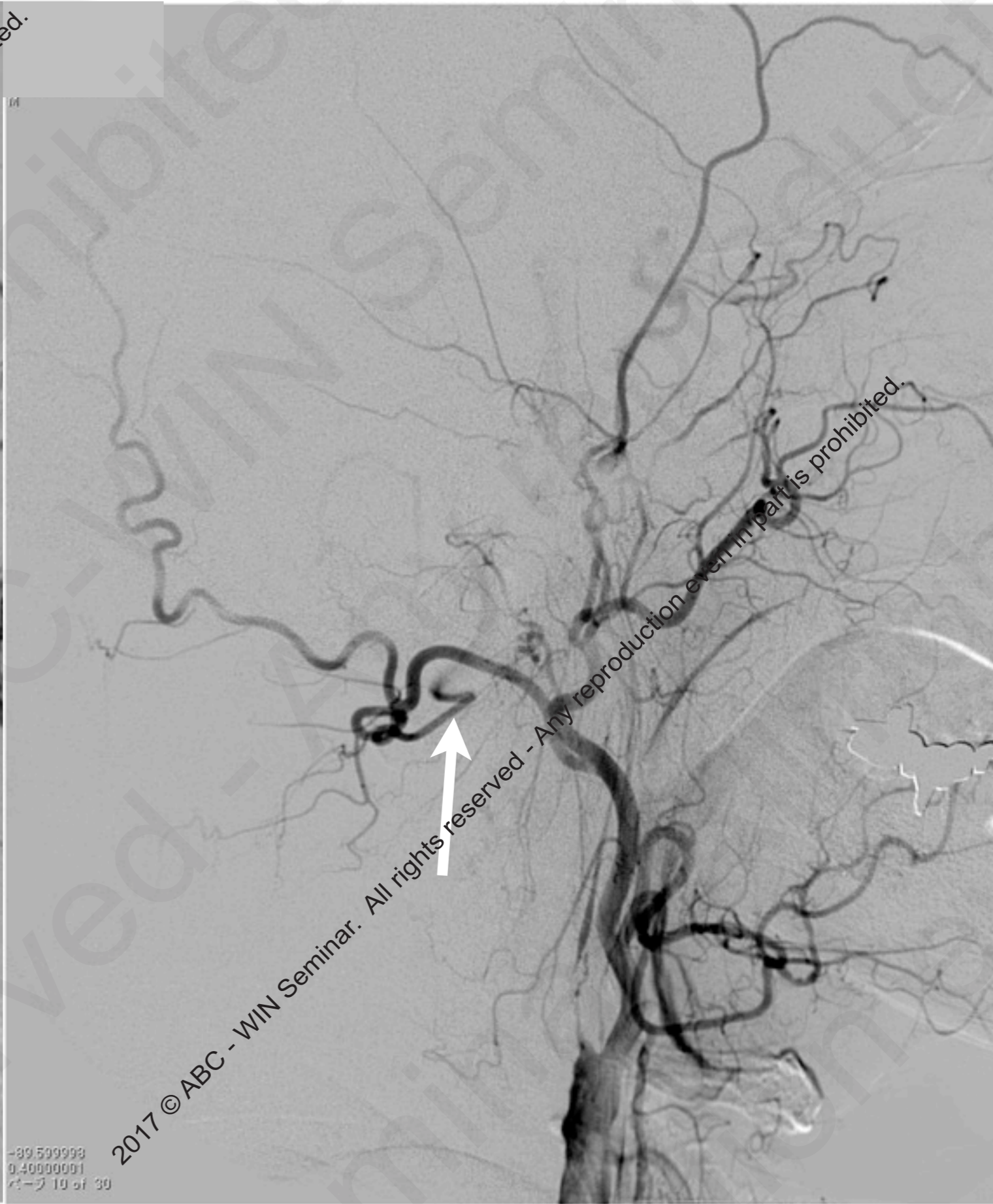
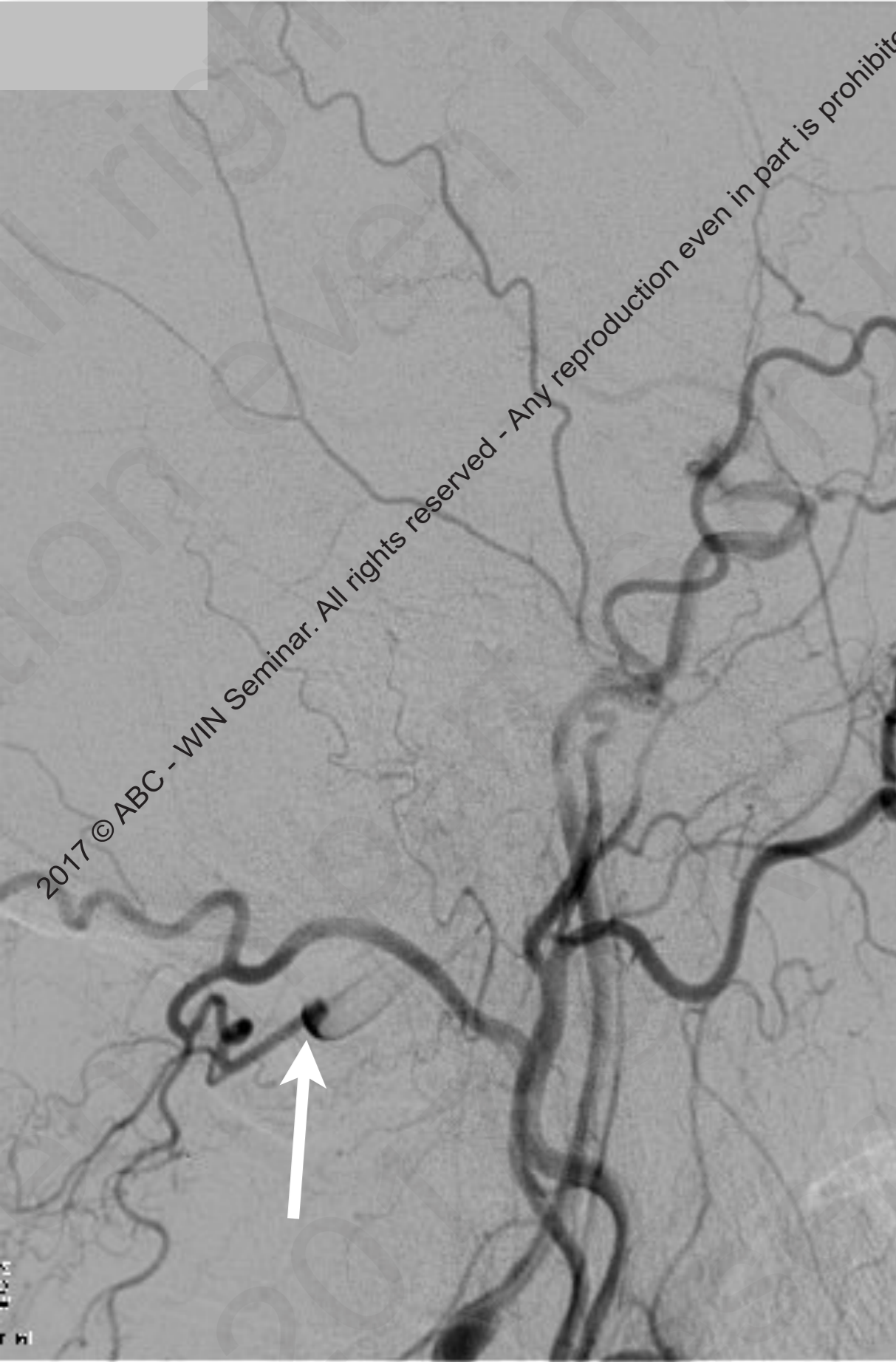
Anastomosis at the CCJ

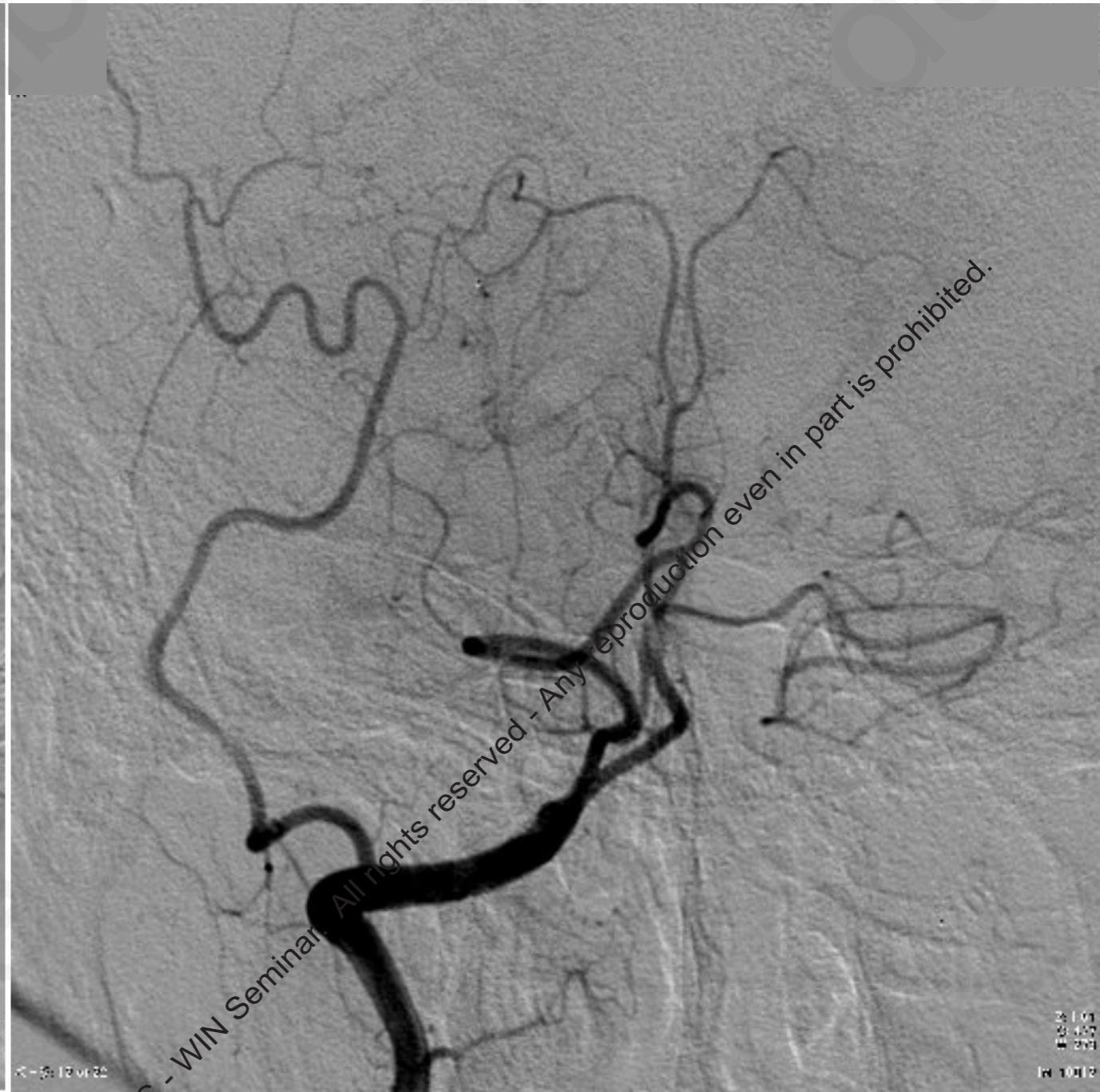
proatlantal type 1 anastomosis of VA and OA



proatlantal type 1

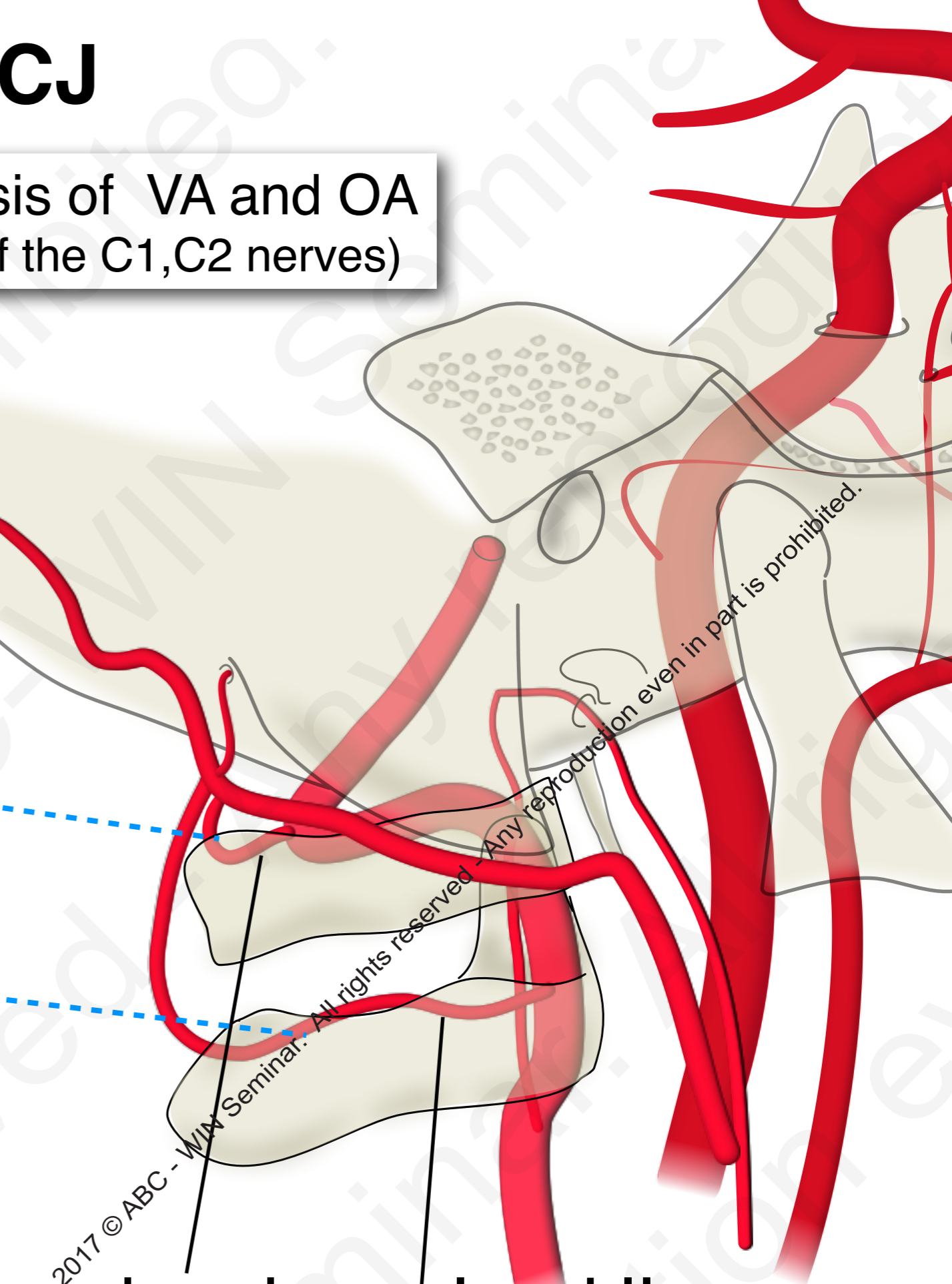
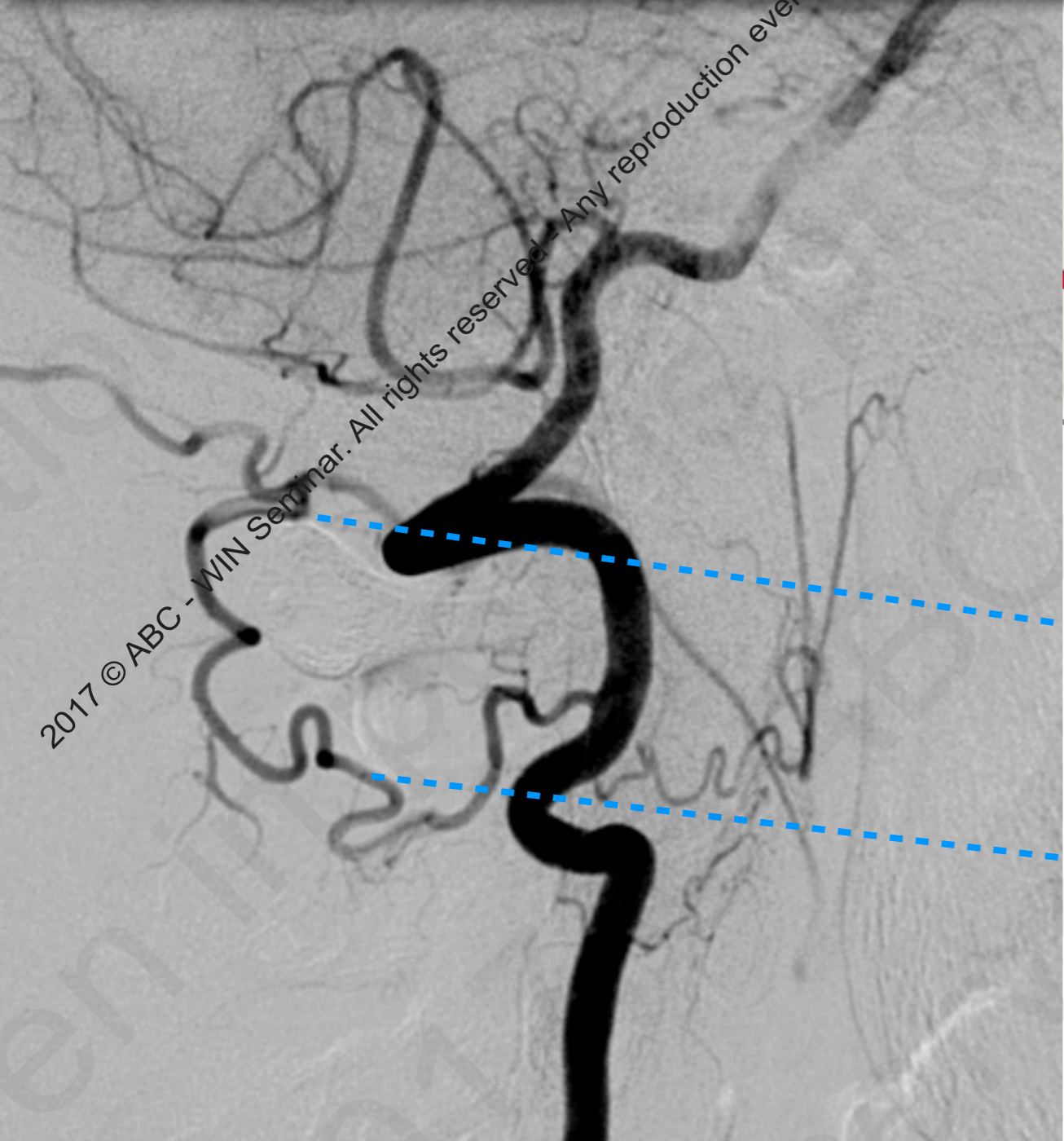
similar examples of this connection





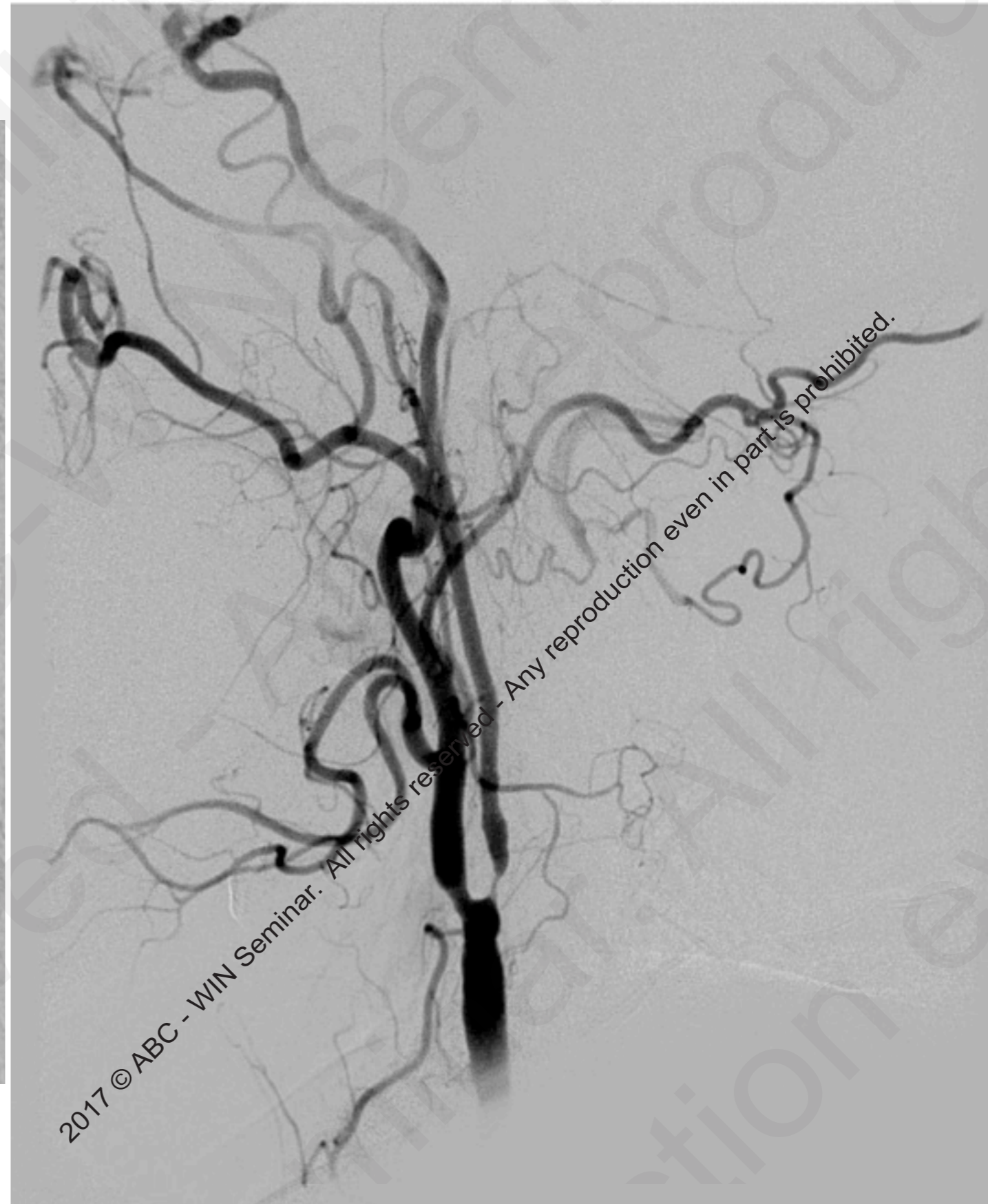
Anastomosis at the CCJ

proatlantal type 1 and II anastomosis of VA and OA
(connected through the posterior ramus of the C1,C2 nerves)



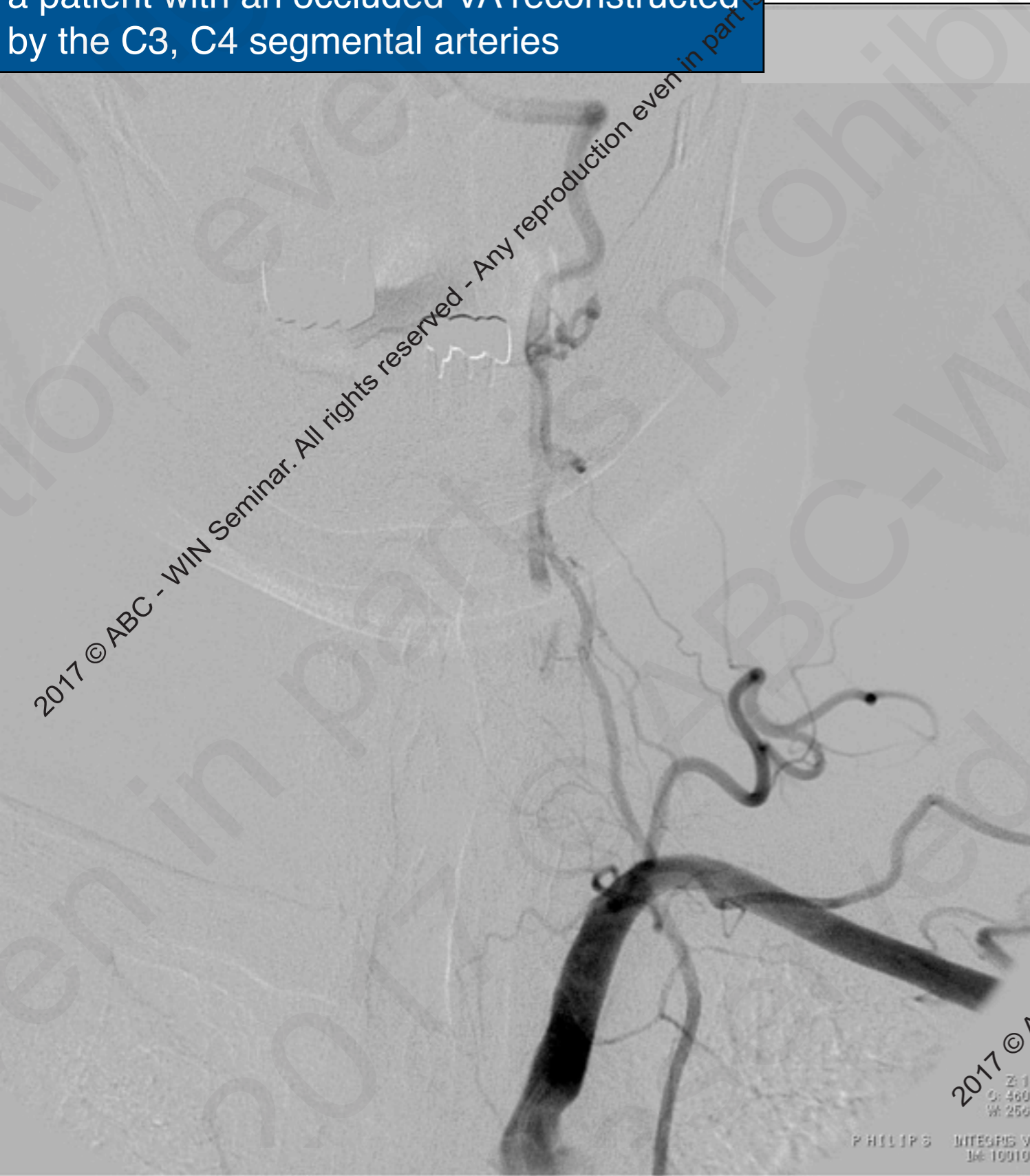
proatlantal type I and II

proatlantal type 1 and II anastomosis of VA and OA



lower down at the C3, C4 spaces, we see participations of the deep cervical artery

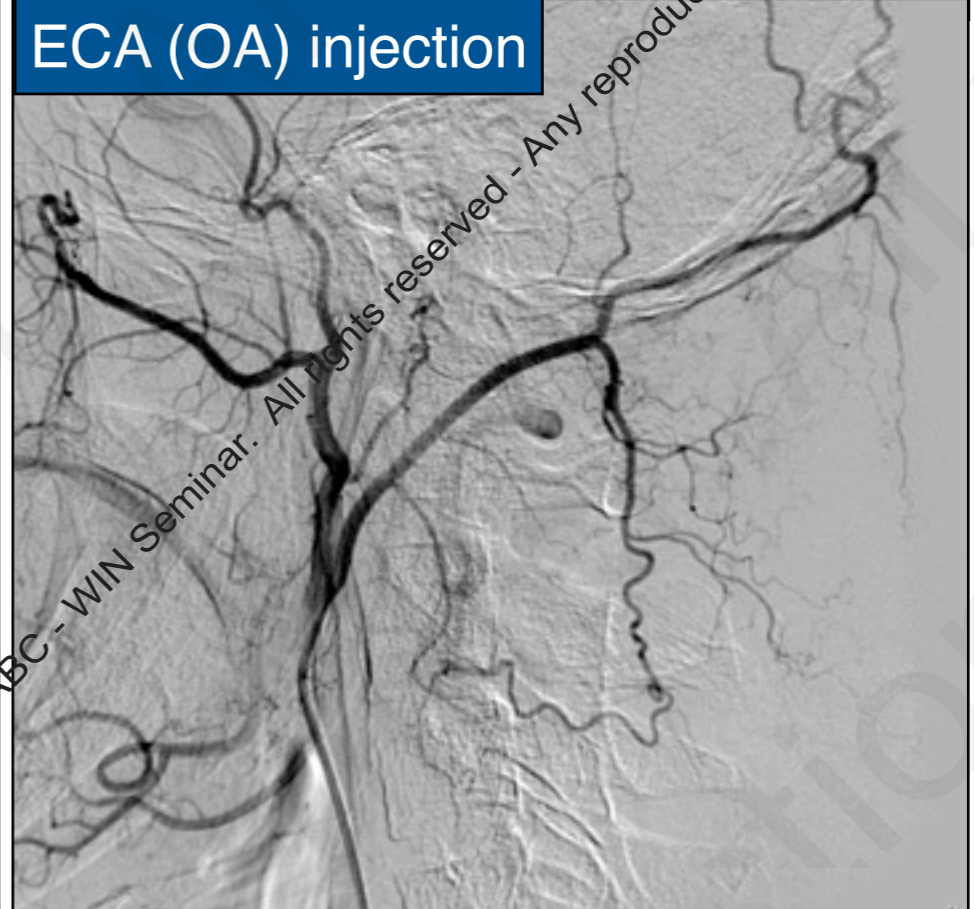
a patient with an occluded VA reconstructed by the C3, C4 segmental arteries



deep cervical artery injection

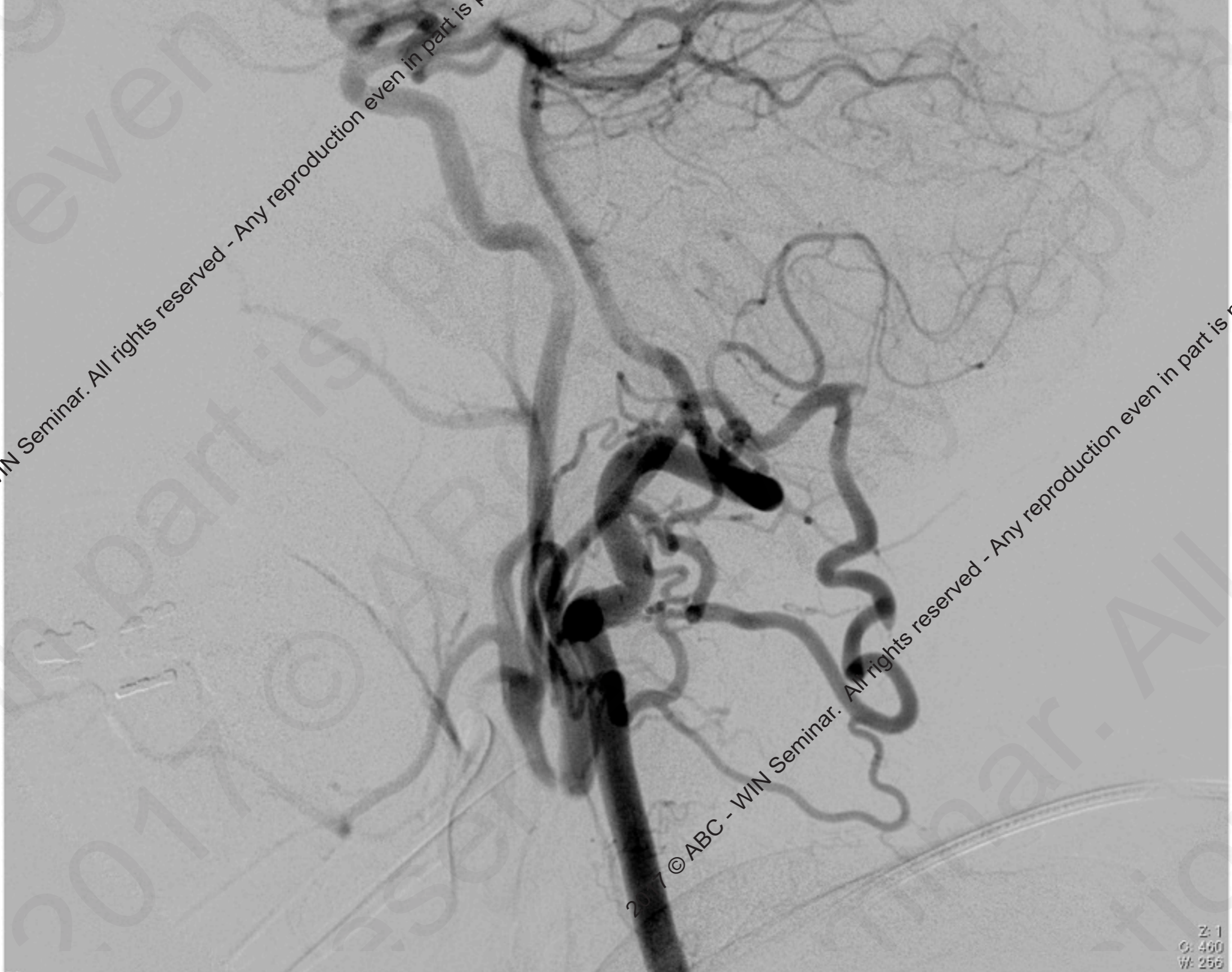


ECA (OA) injection



36 F, common carotid artery occlusion due to Takayasu arteritis, showing good collaterals through the C1, C2 and C3 cervical spaces.

血管造影 頸部造形
2006/09/13 15:07:28
3098120620060906



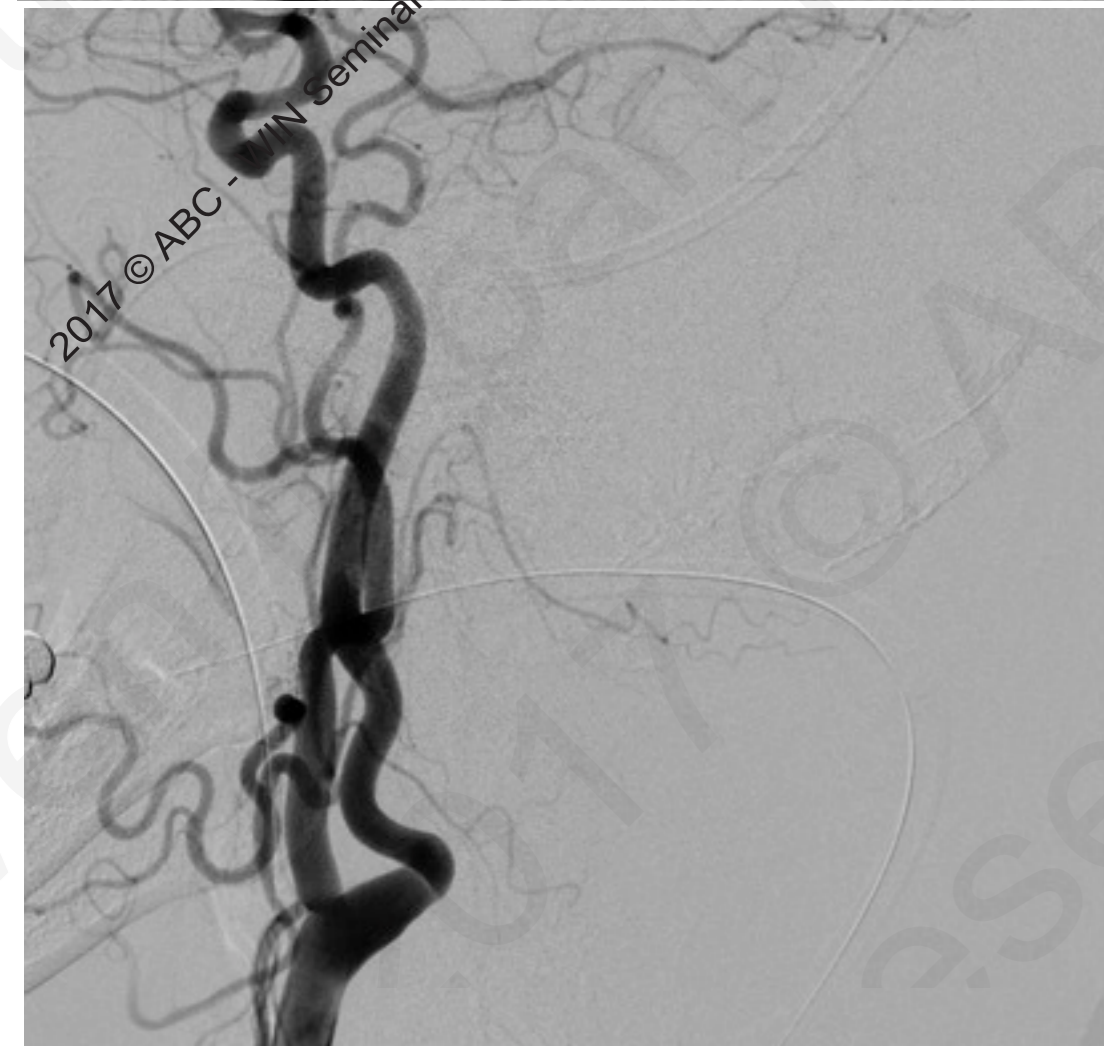
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Z: 1
C: 460
W: 256

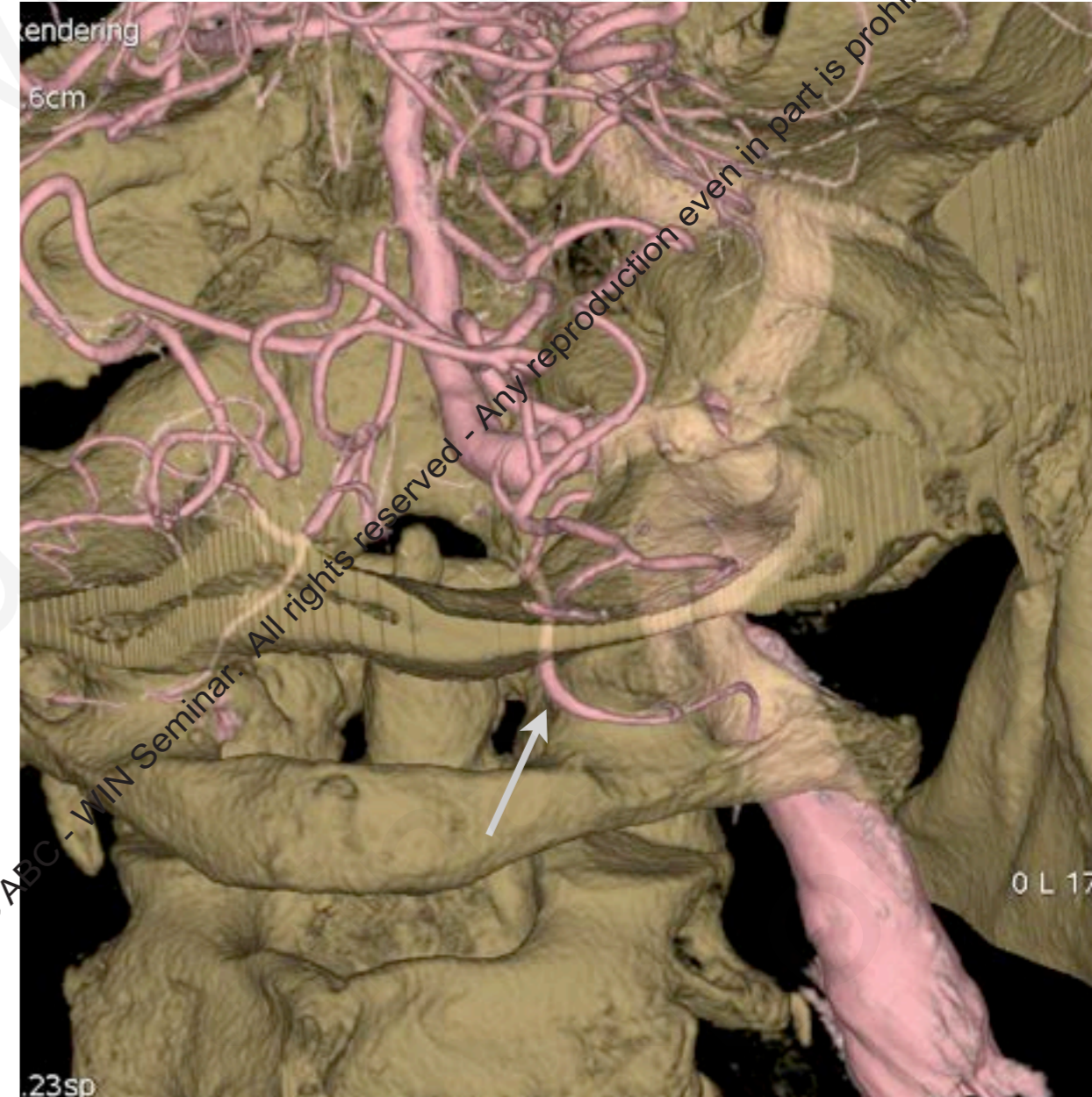
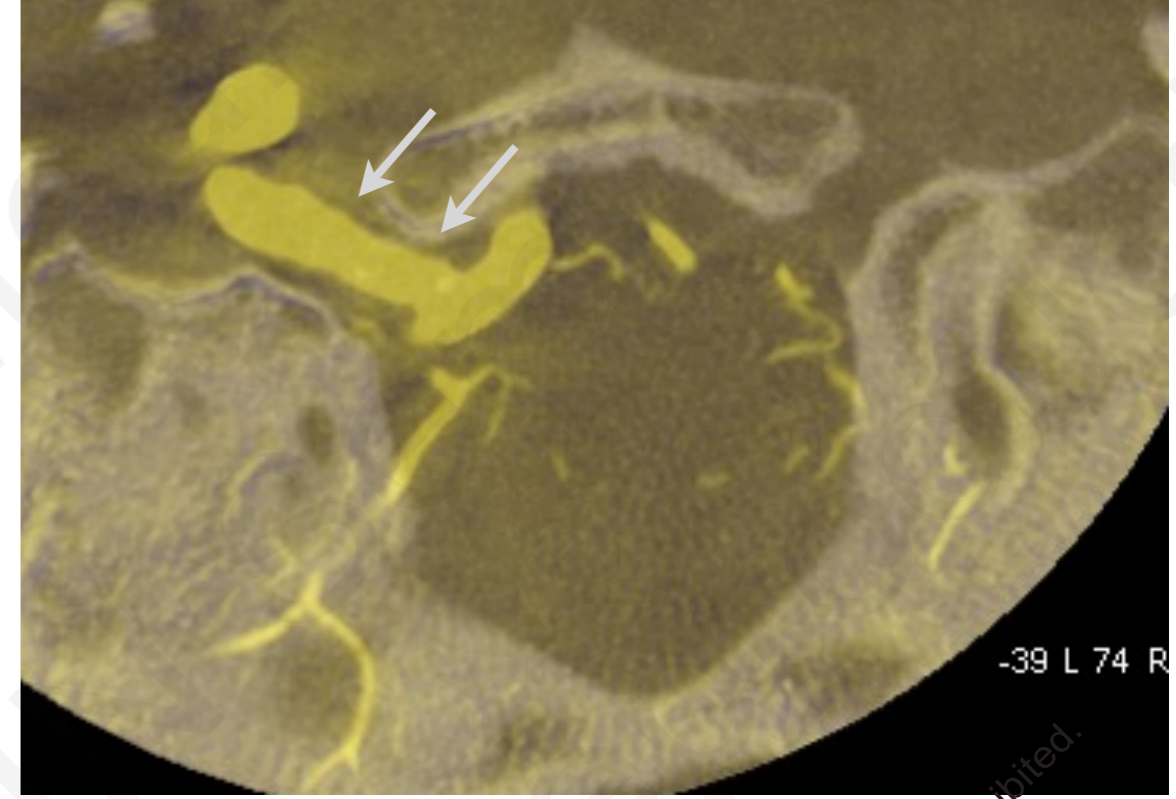
42 F, left VA dissection(SAH)

Selective injection shows a connection to the VA through a musculospinal branch of the ascending pharyngeal artery at the C3 level.(At f/u angio after trapping of VA)



65 M, BA top aneurysm

primitive hypoglossal artery



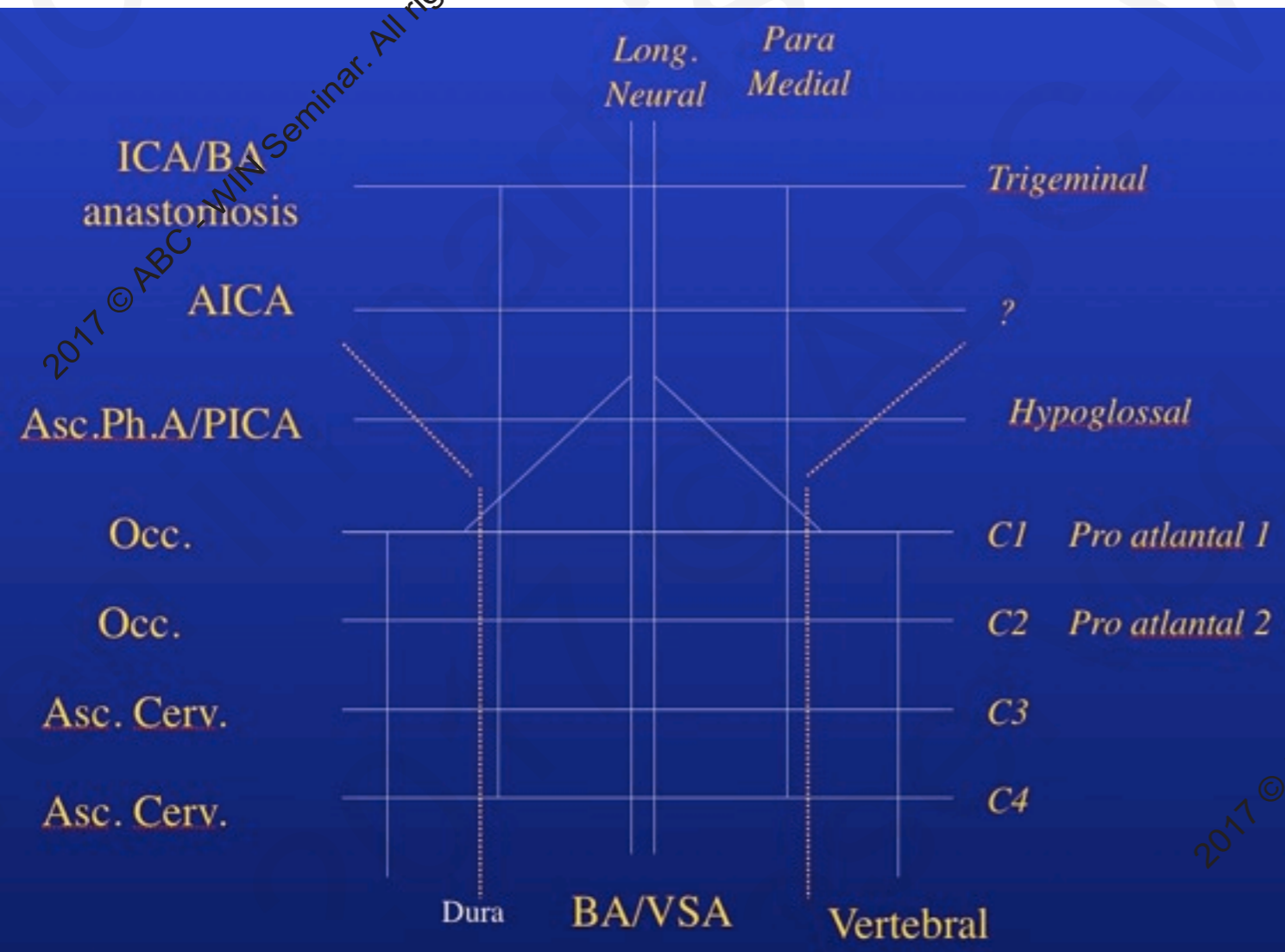
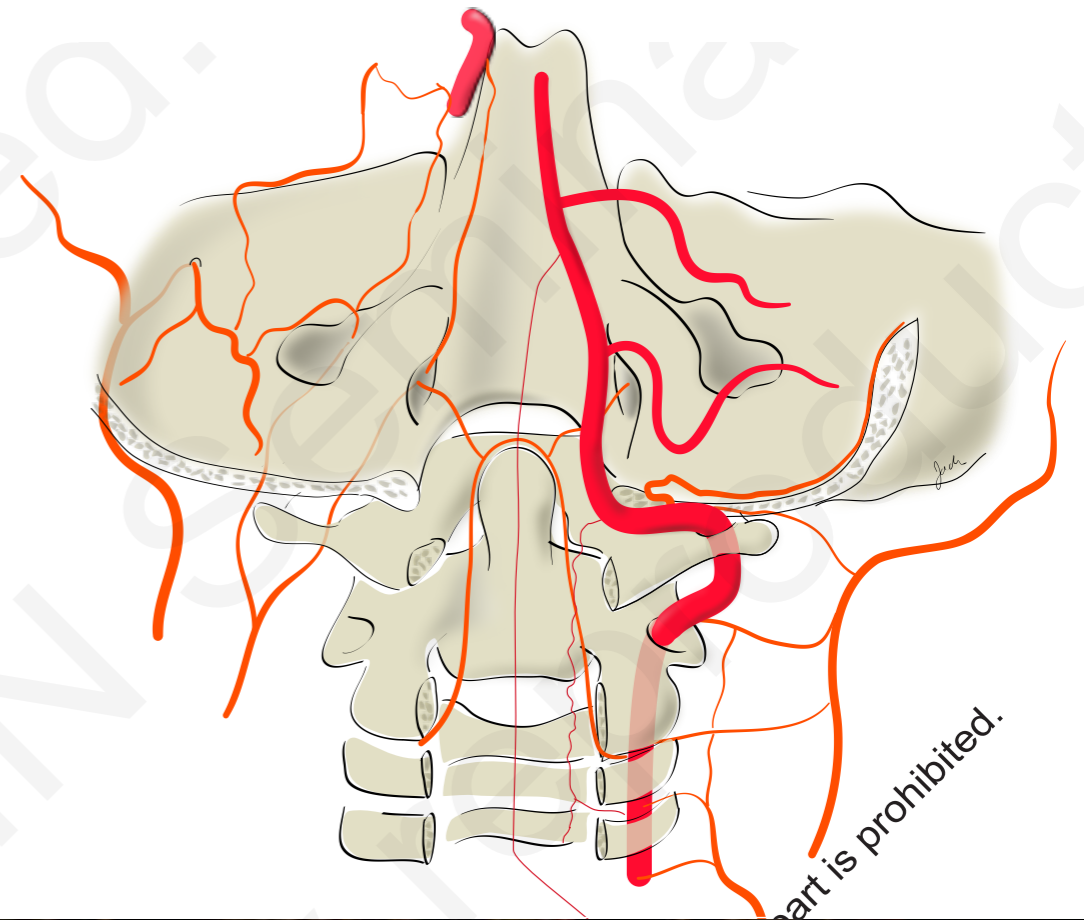
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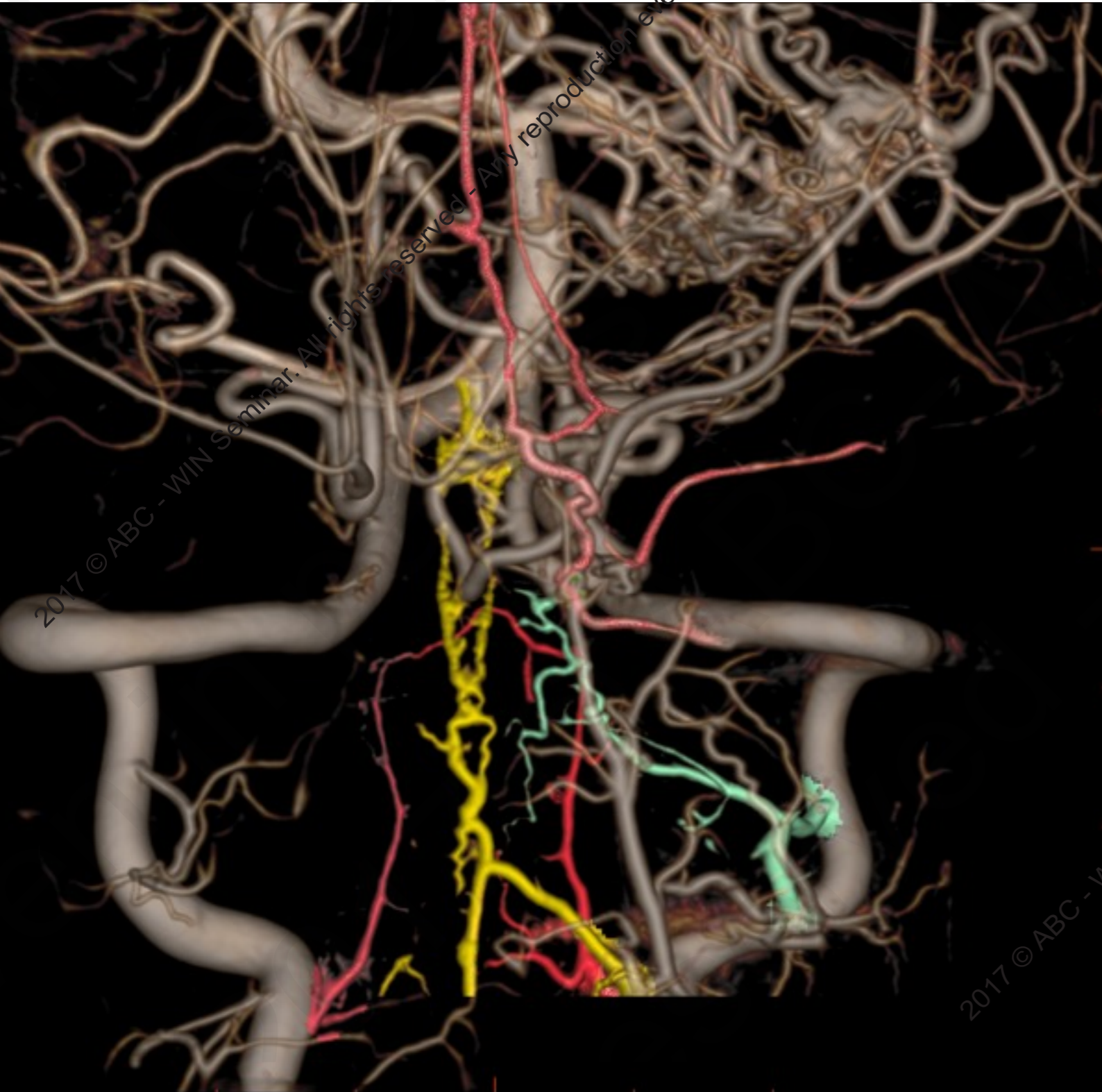
To summarize, the basic plan of the CCJ is based on the segmental arrangement as in the spine.

(segmental (“horizontal”) connection through the C1-C4 cervical spaces)

However it has an extradural (ie.VA), dural(odontoid arch) and intradural (lat spinal a.) longitudinal anastomosis that plays roles in the connection of each system with the original segmental arteries.



The craniocervical junction is a very important connection point of the...



Spinal arterial system

- dural branches
 - # anterior meningeal artery
- anterior spinal artery
- lateral spinal artery
- muscular branches

Intracranial arterial system

- dural branches
 - # posterior meningeal artery
 - # supratentorial dural br.
- anterior spinal artery
- lateral spinal artery
- PICA

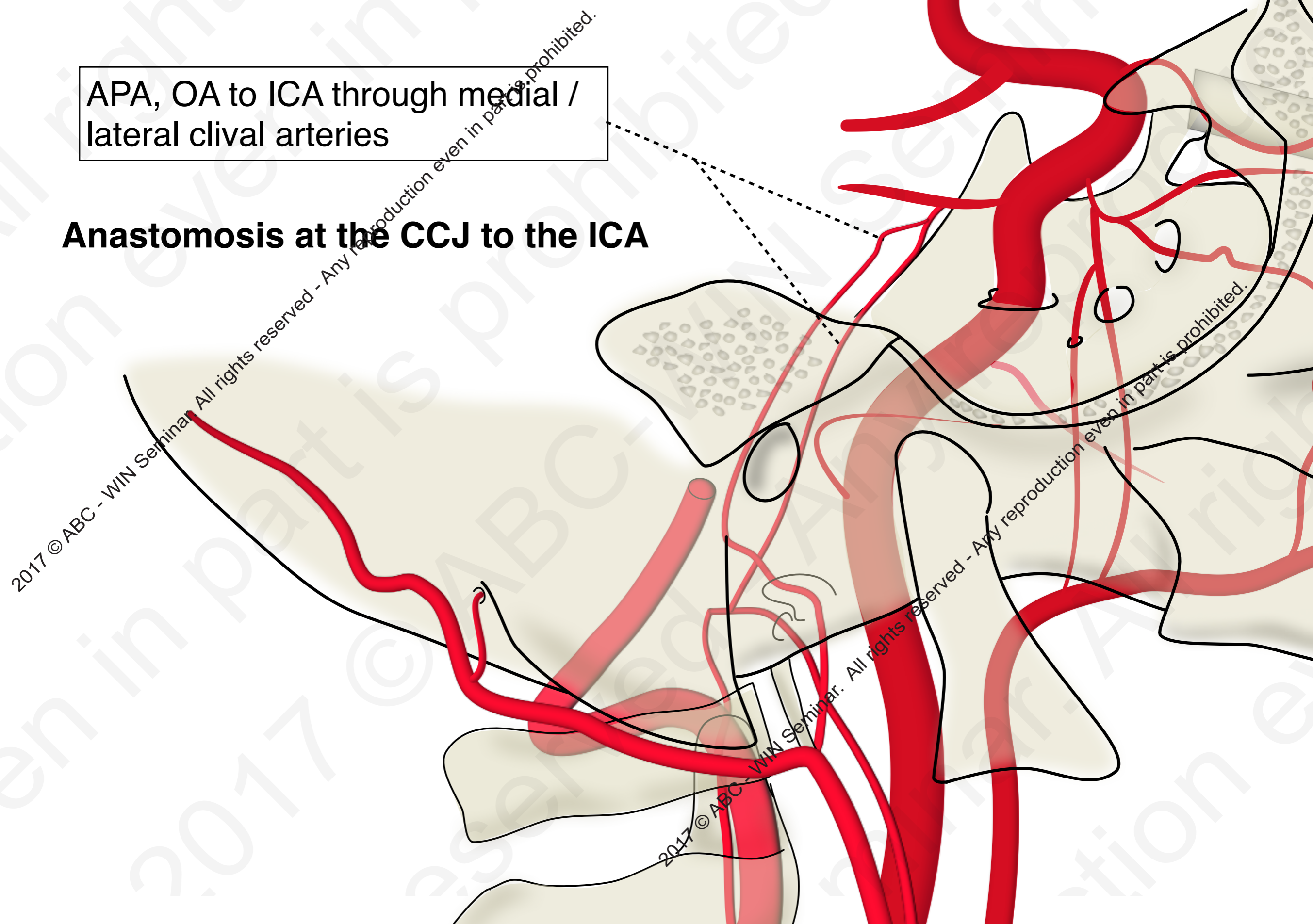
and also...

contributions from
the occipital artery and
the ascending pharyngeal artery
the deep/ascending cervical
arteries

The dural branches around the CCJ

APA, OA to ICA through medial / lateral clival arteries

Anastomosis at the CCJ to the ICA

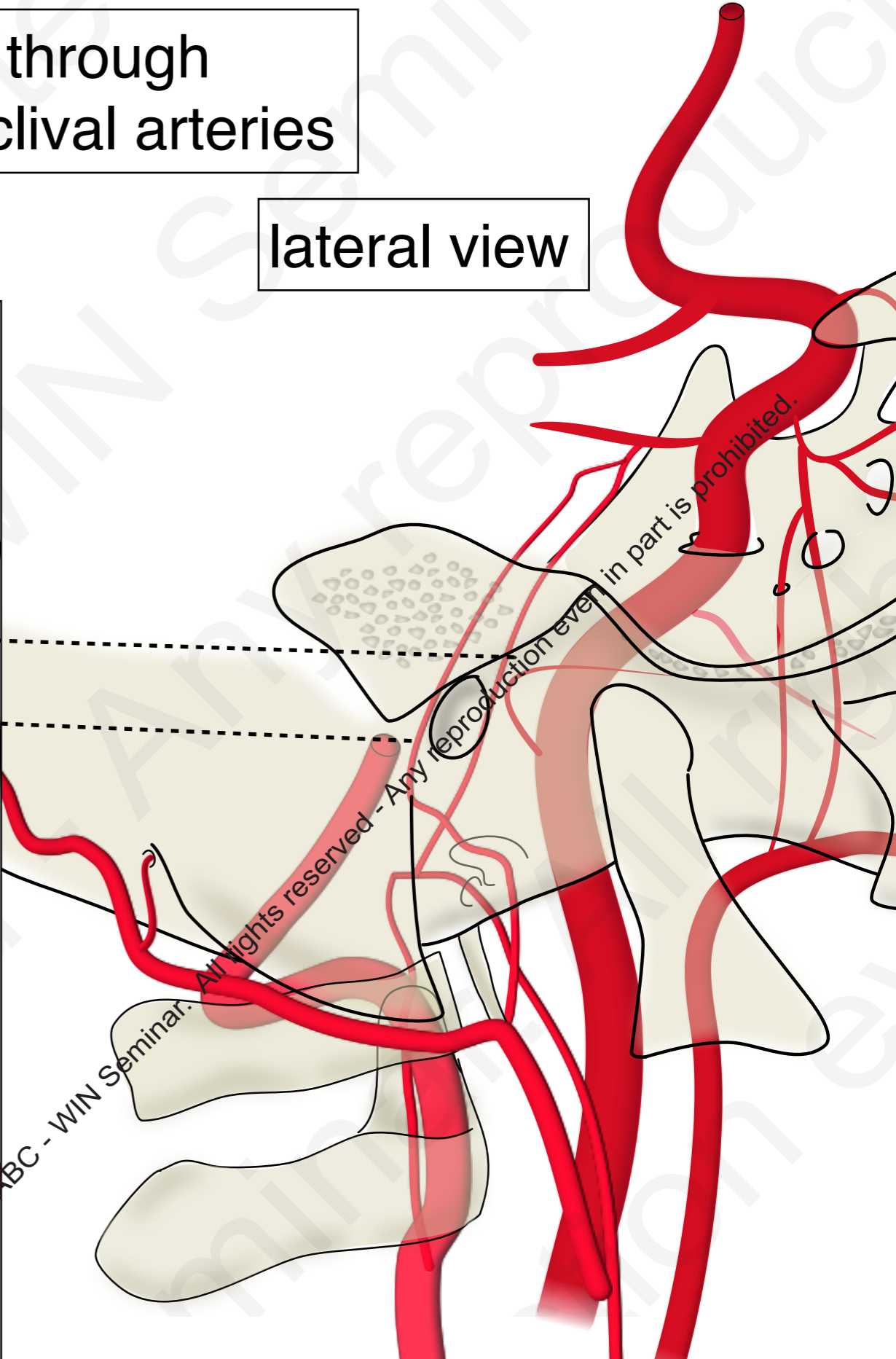
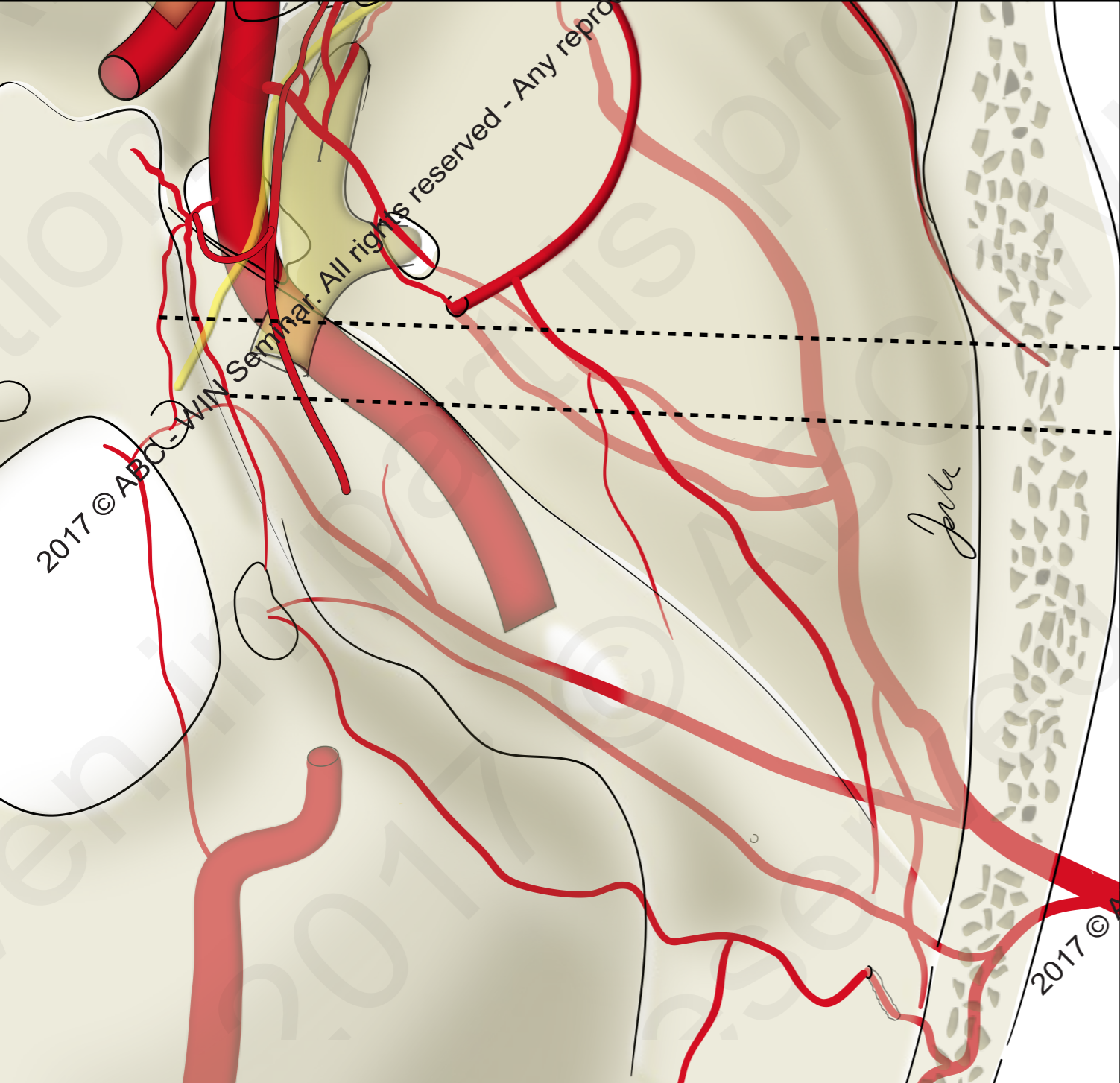


Anastomosis at the posterior fossa dura

APA, OA to ICA through
medial / lateral clival arteries

superior view

lateral view



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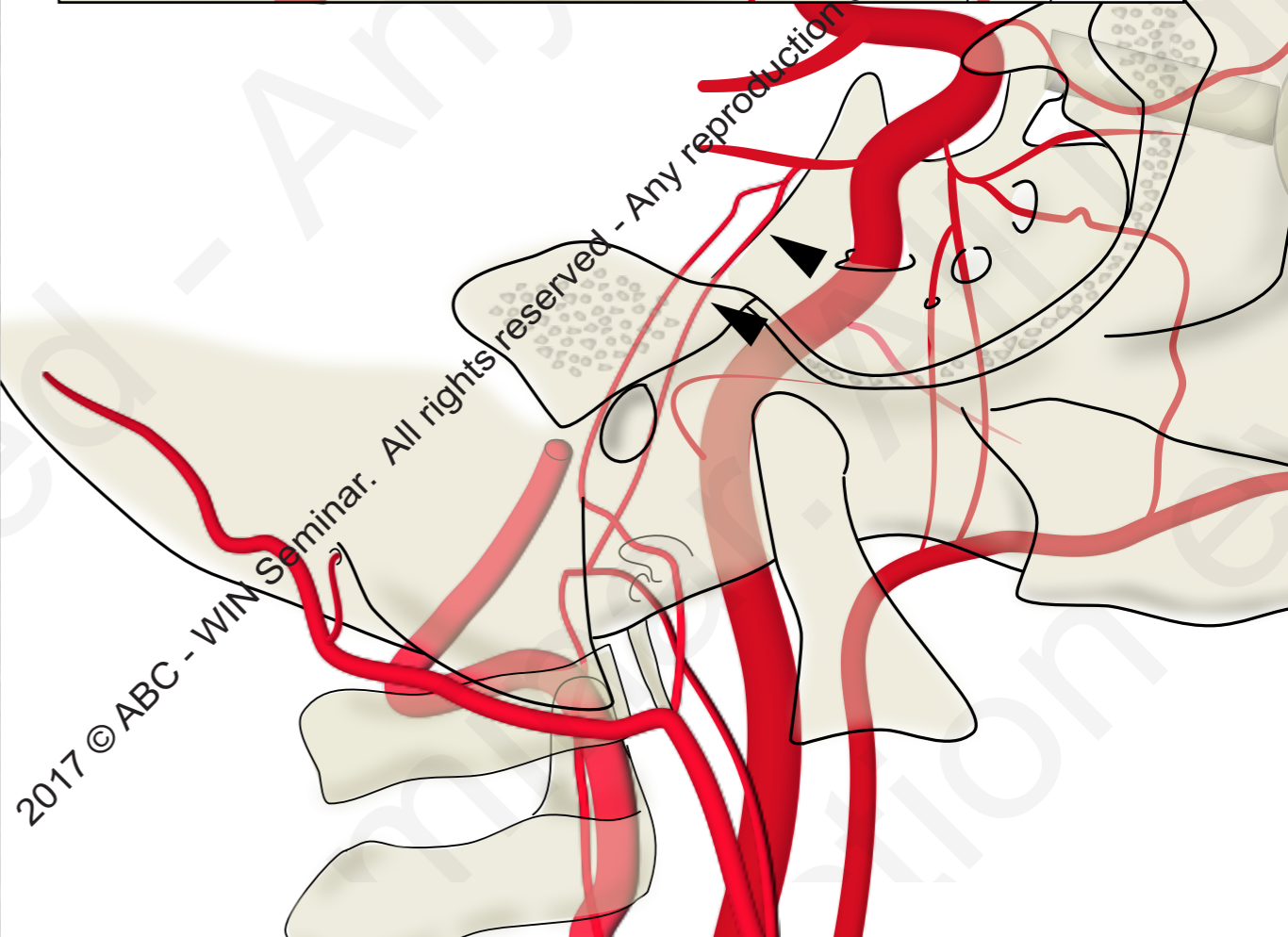
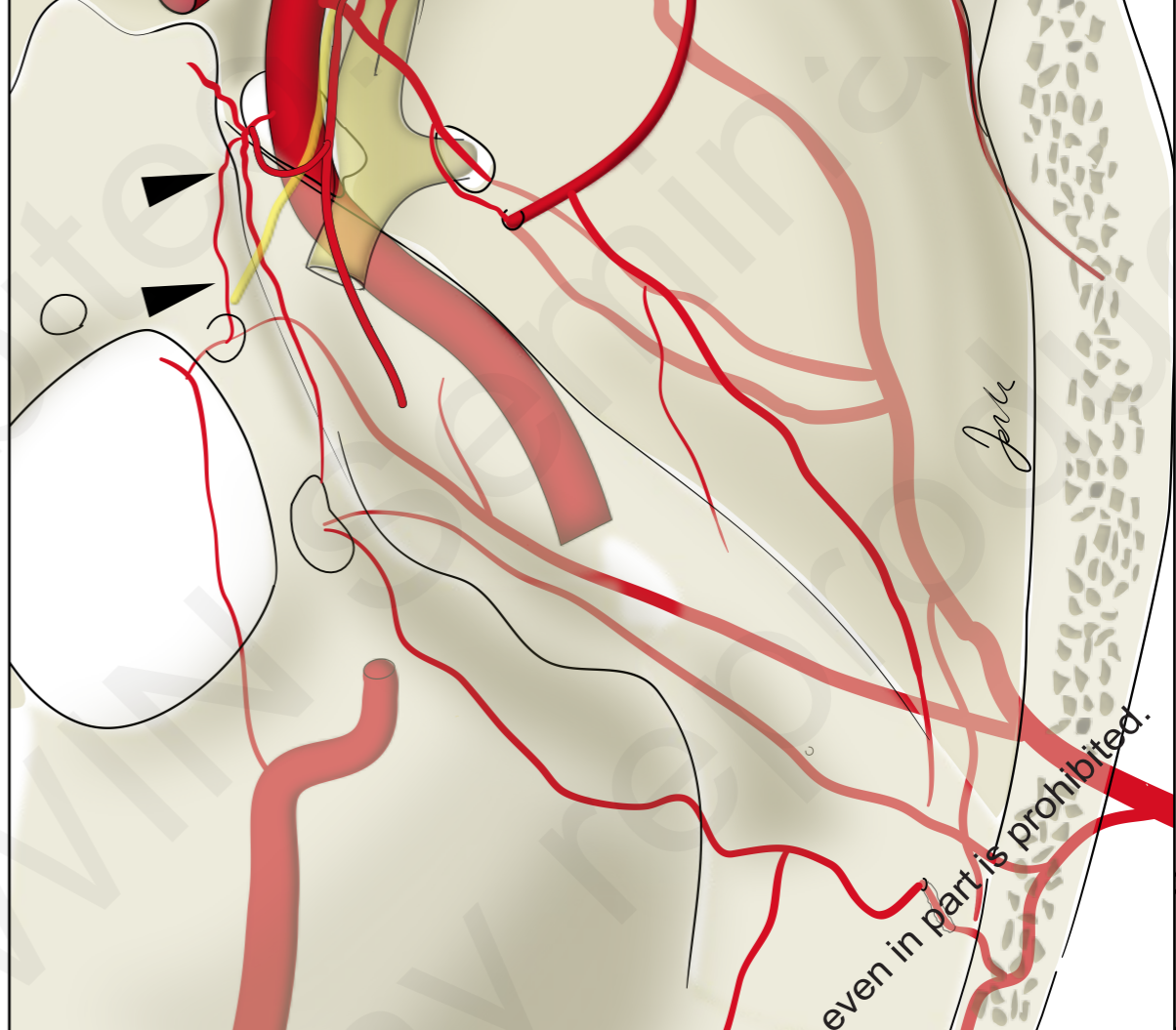
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APA --- medial clival artery --- MHT(ICA)

OA --- lateral clival artery --- MHT(ICA)

selective injection of ascending pharyngeal artery showing connection to the ICA through the medial clival artery.(black arrow heads)

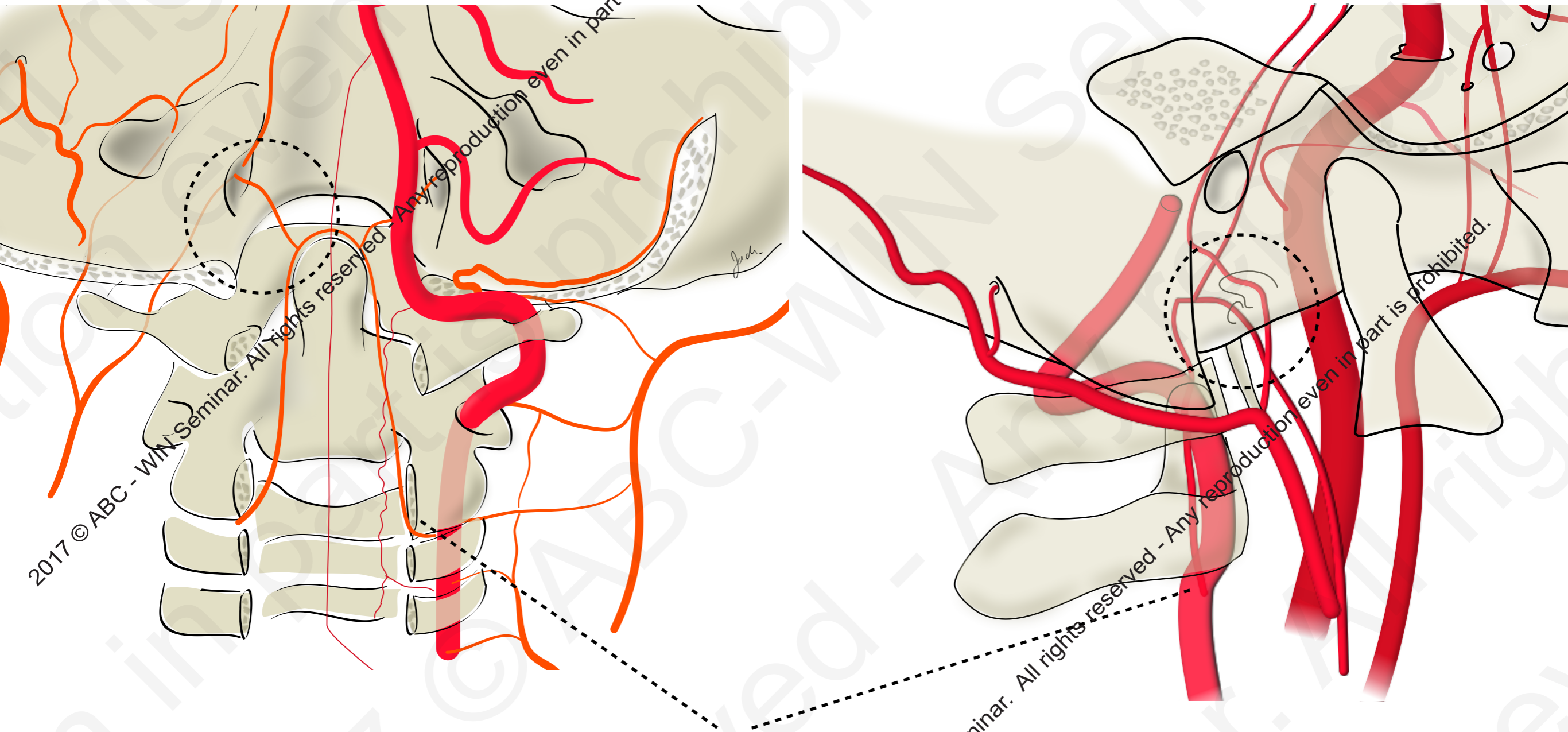


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The dural branches around the CCJ

The “odontoid arterial arch”



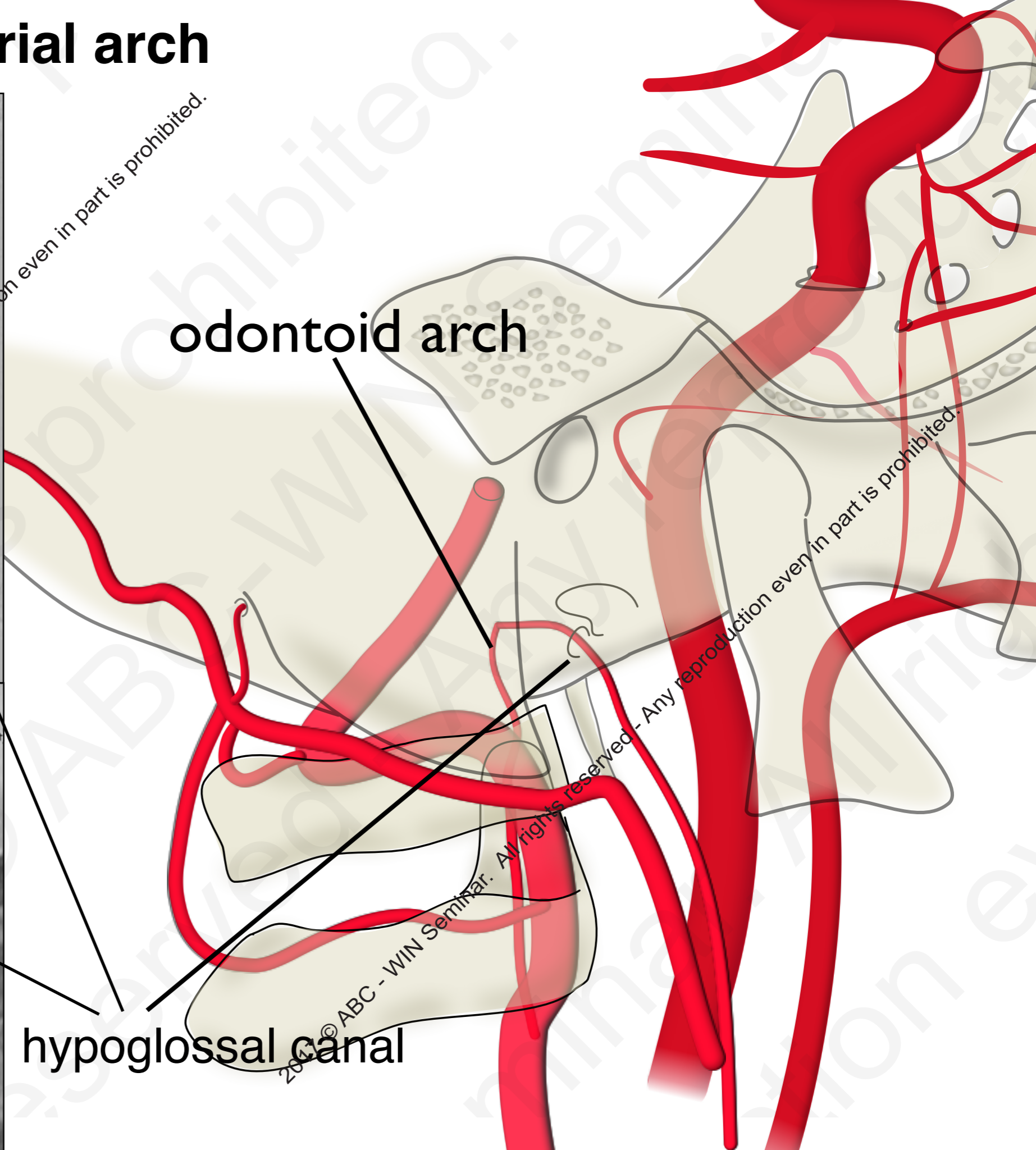
A dural branch arising from the C3 segment and forms an arch over the dens of the C2. It connects to the ascending pharyngeal system through the hypoglossal canal.

The odontoid arterial arch



coronal MIP image

Aug 17 2017



odontoid arch

hypoglossal canal

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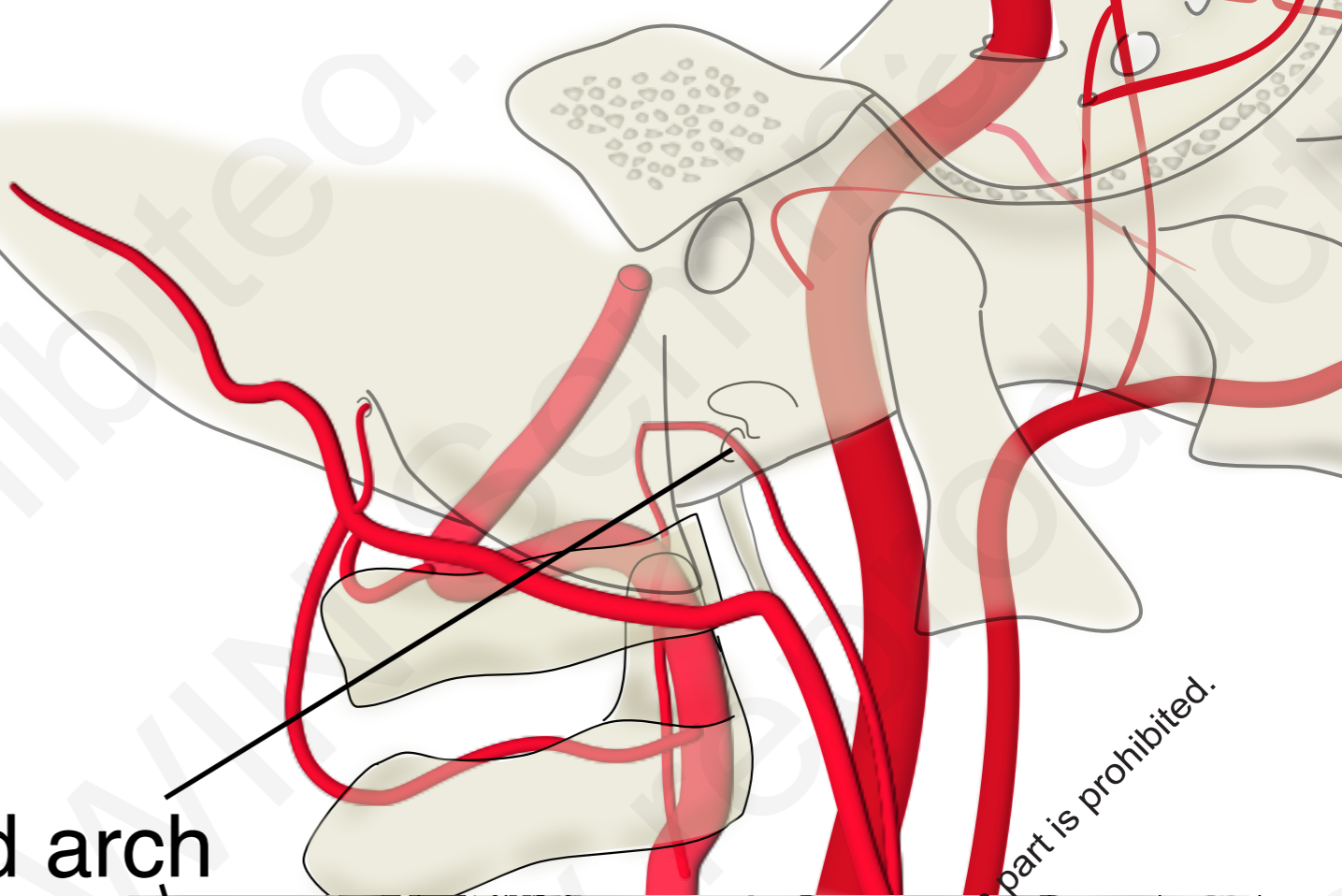
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The odontoid arterial arch



coronal MIP image

odontoid arch



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Juku

32 M, tympanic paraganglioma recurred after embo and surgery in another institute



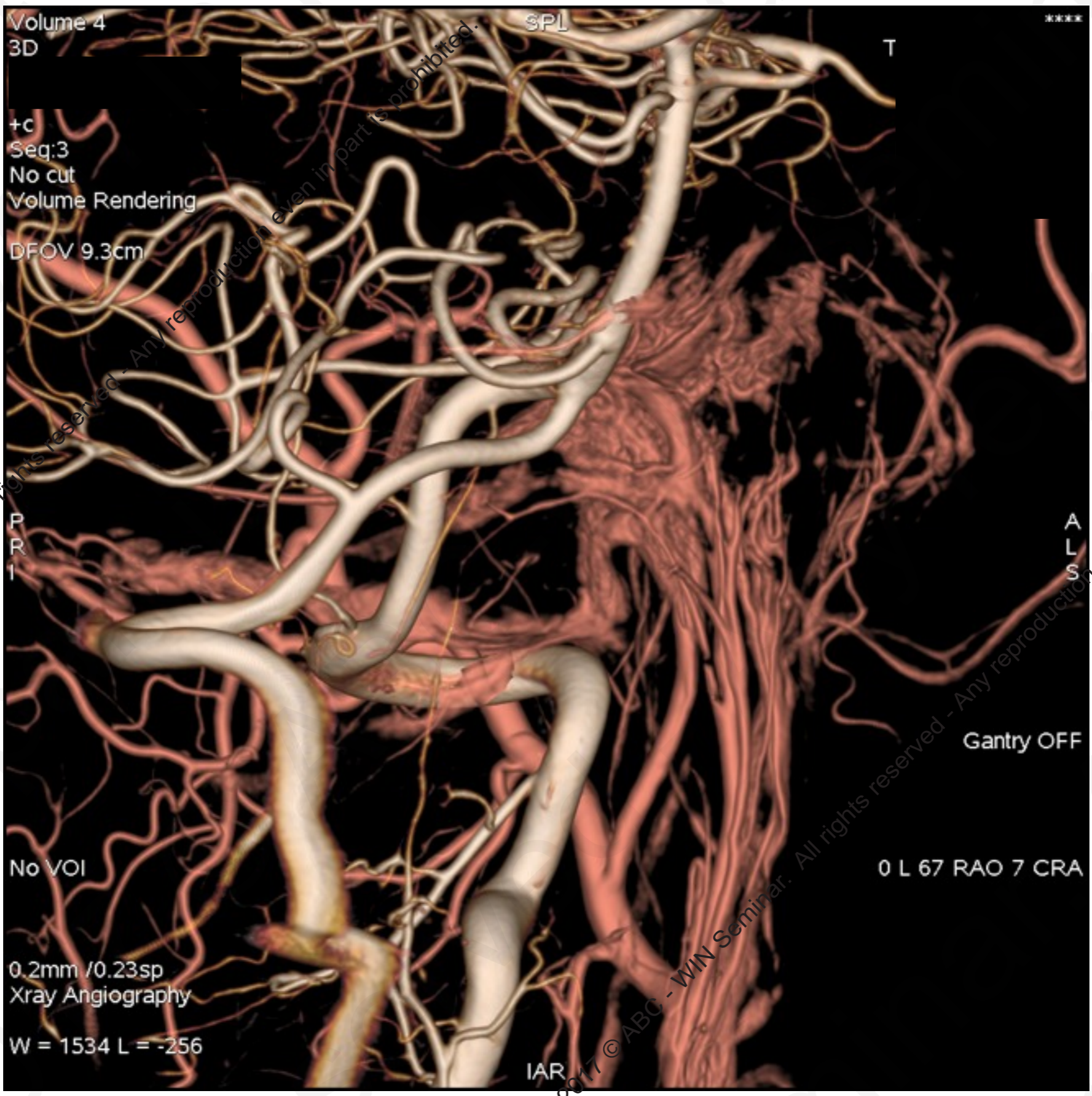
MASK

selective injection of the occipito-pharyngeal branch



no participation to the tumor from the VA!





Volume Rendering No cut

DFOV8.7cm

MOVIE file

R
L

No VOI

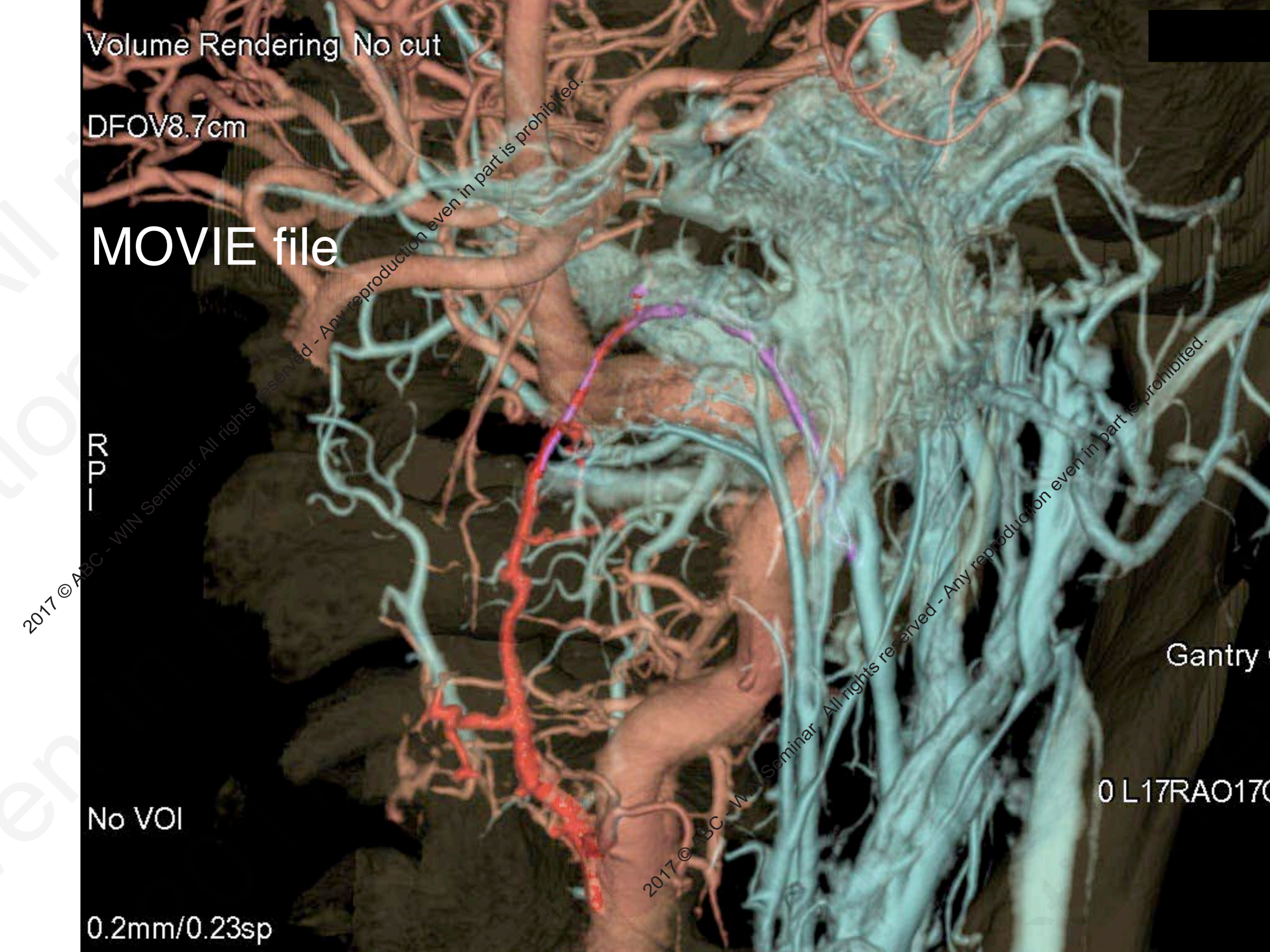
0.2mm/0.23sp

Gantry

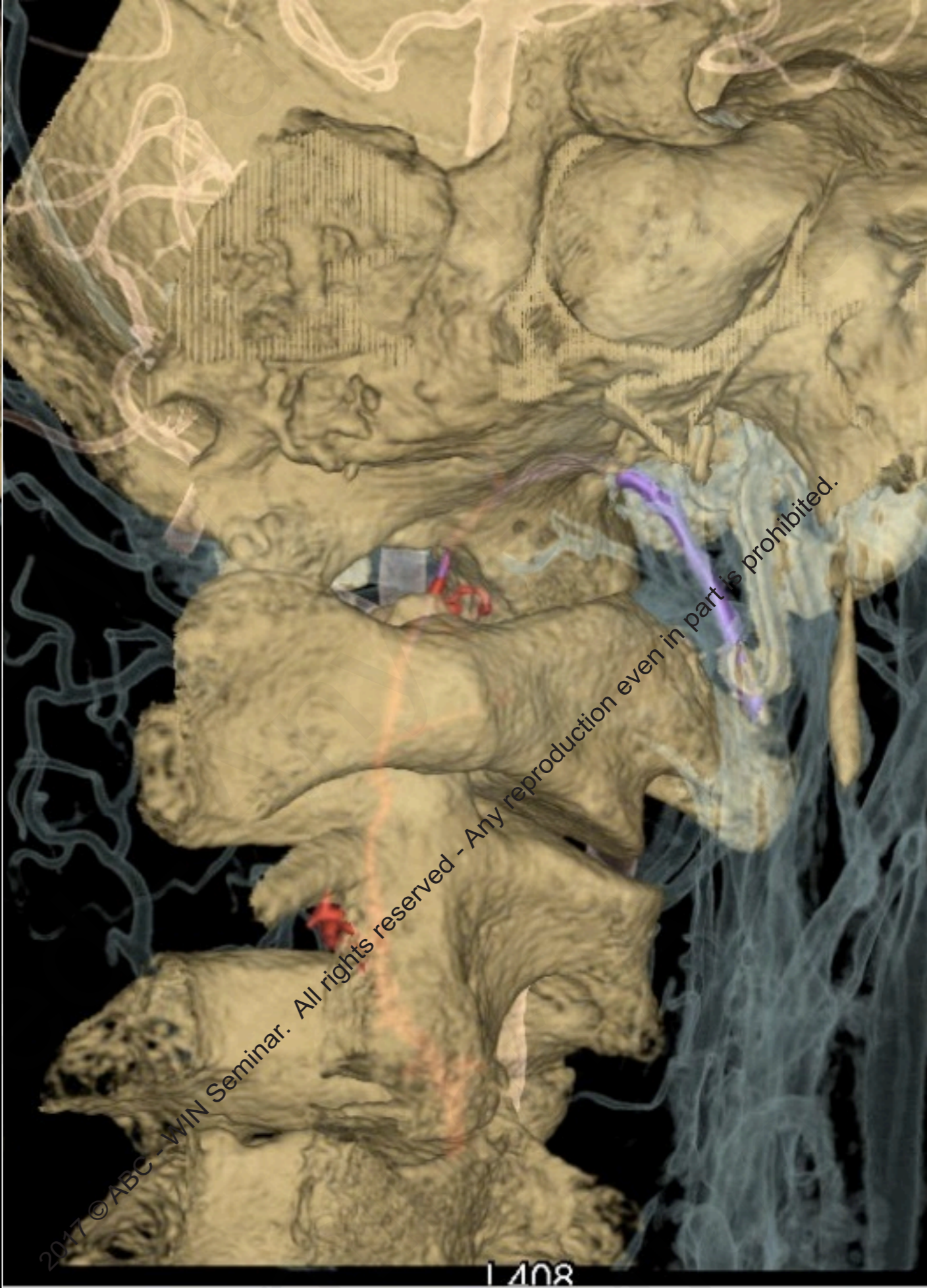
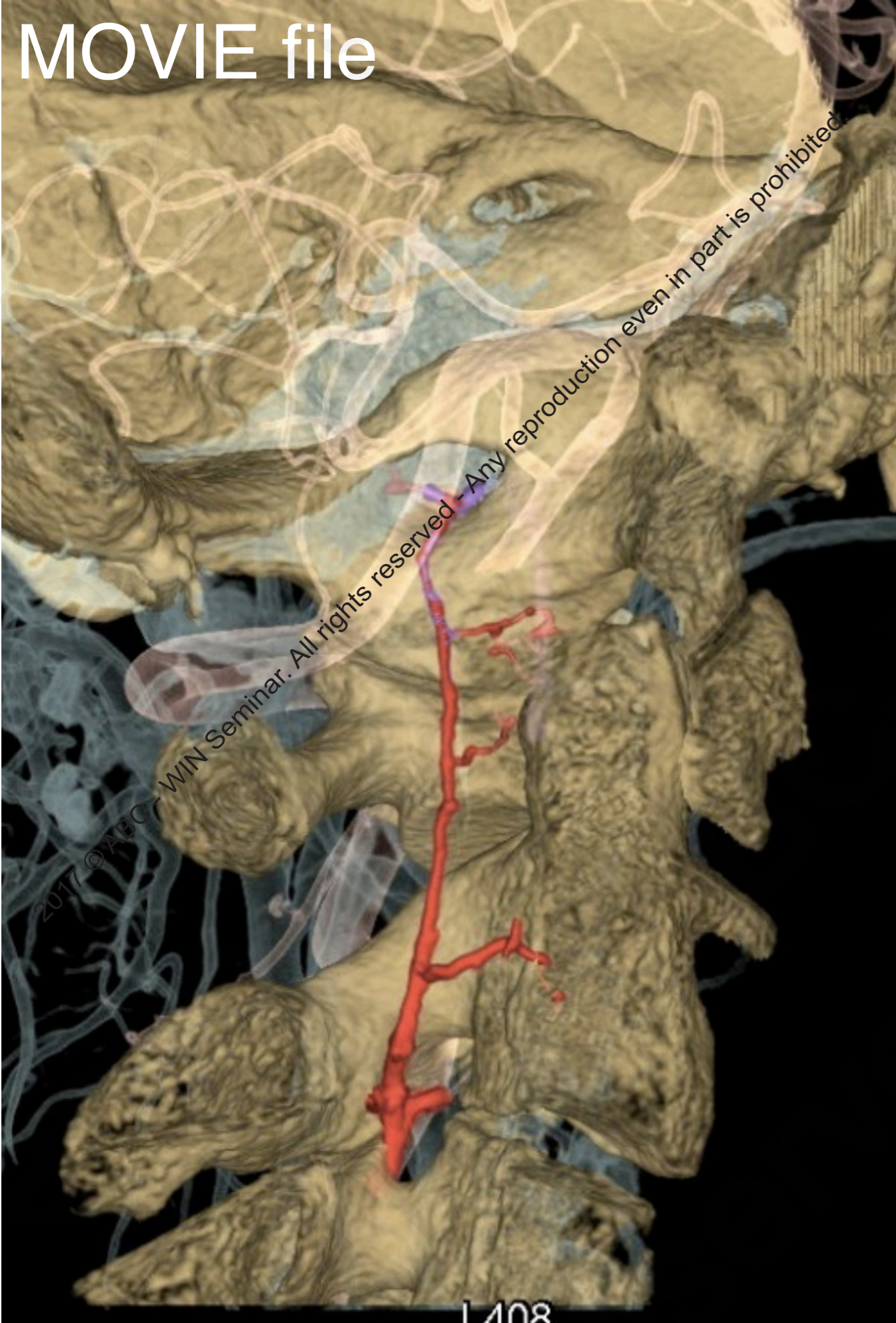
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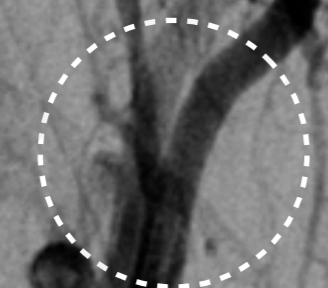
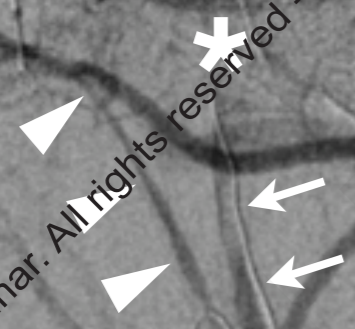
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MOVIE file



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(Filt. 3)

MASK = 1



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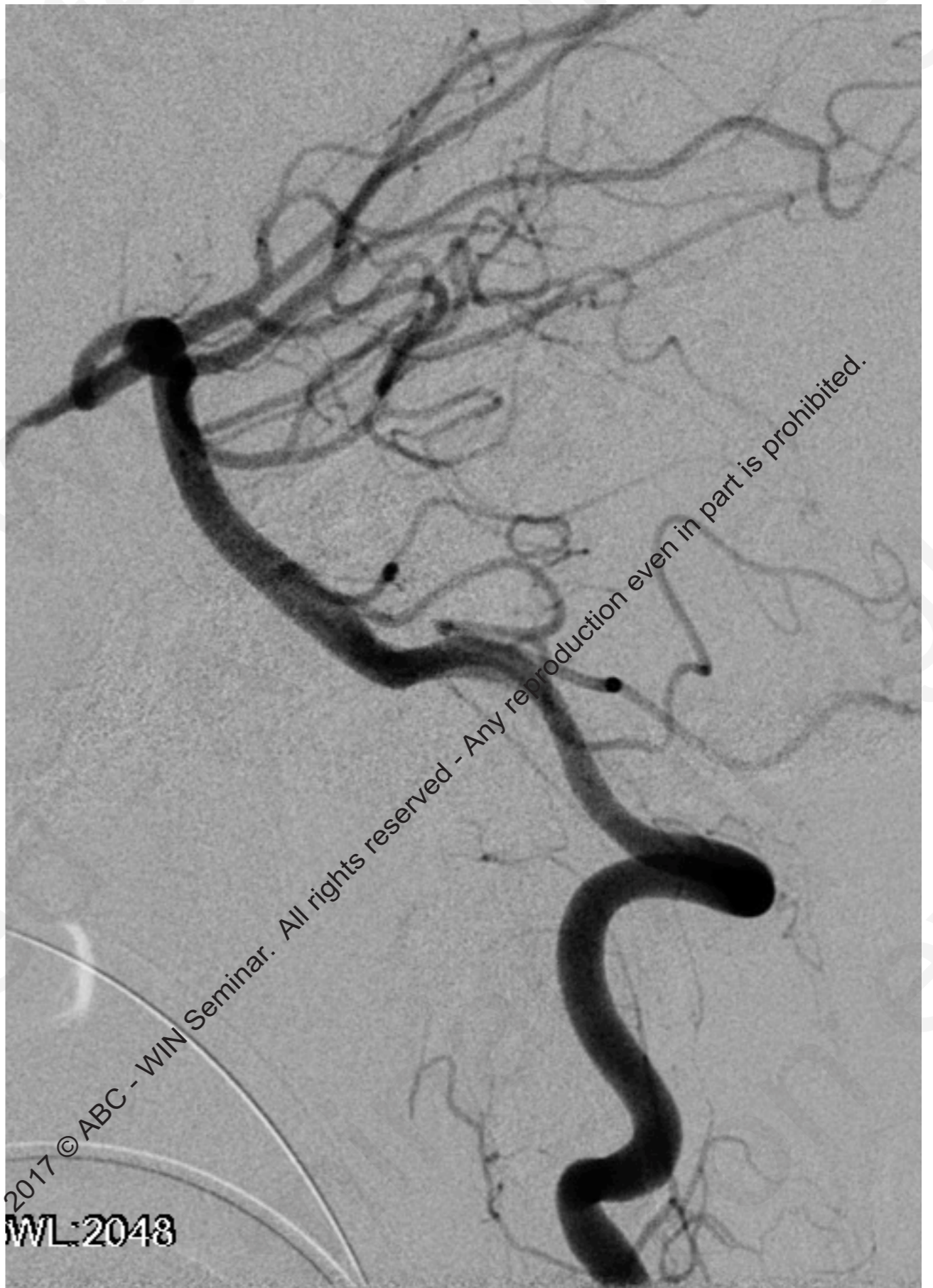
odontoid arch as a collateral in a subclavian steal syndrome patient

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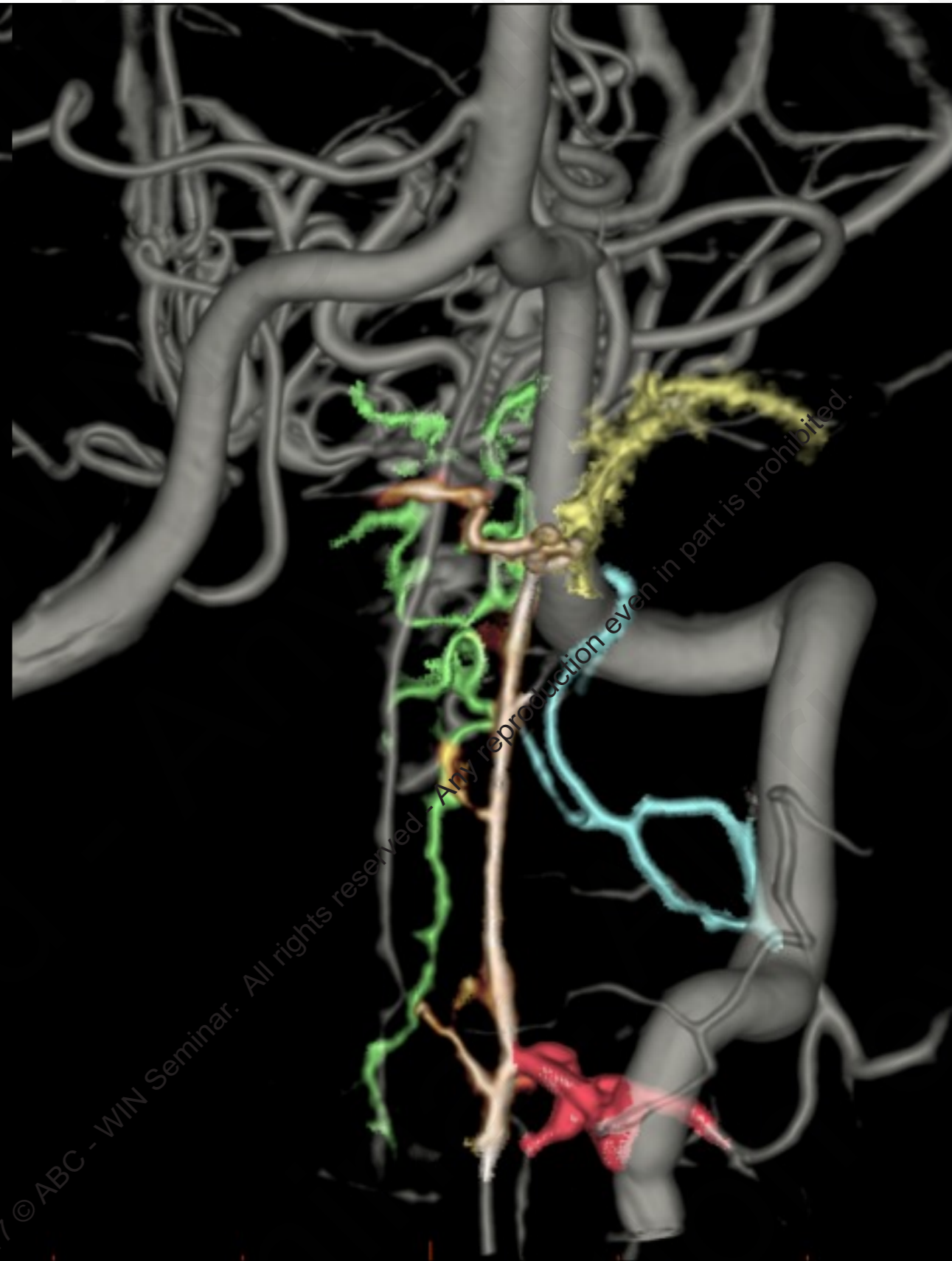
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11 F, cerebellar AVM



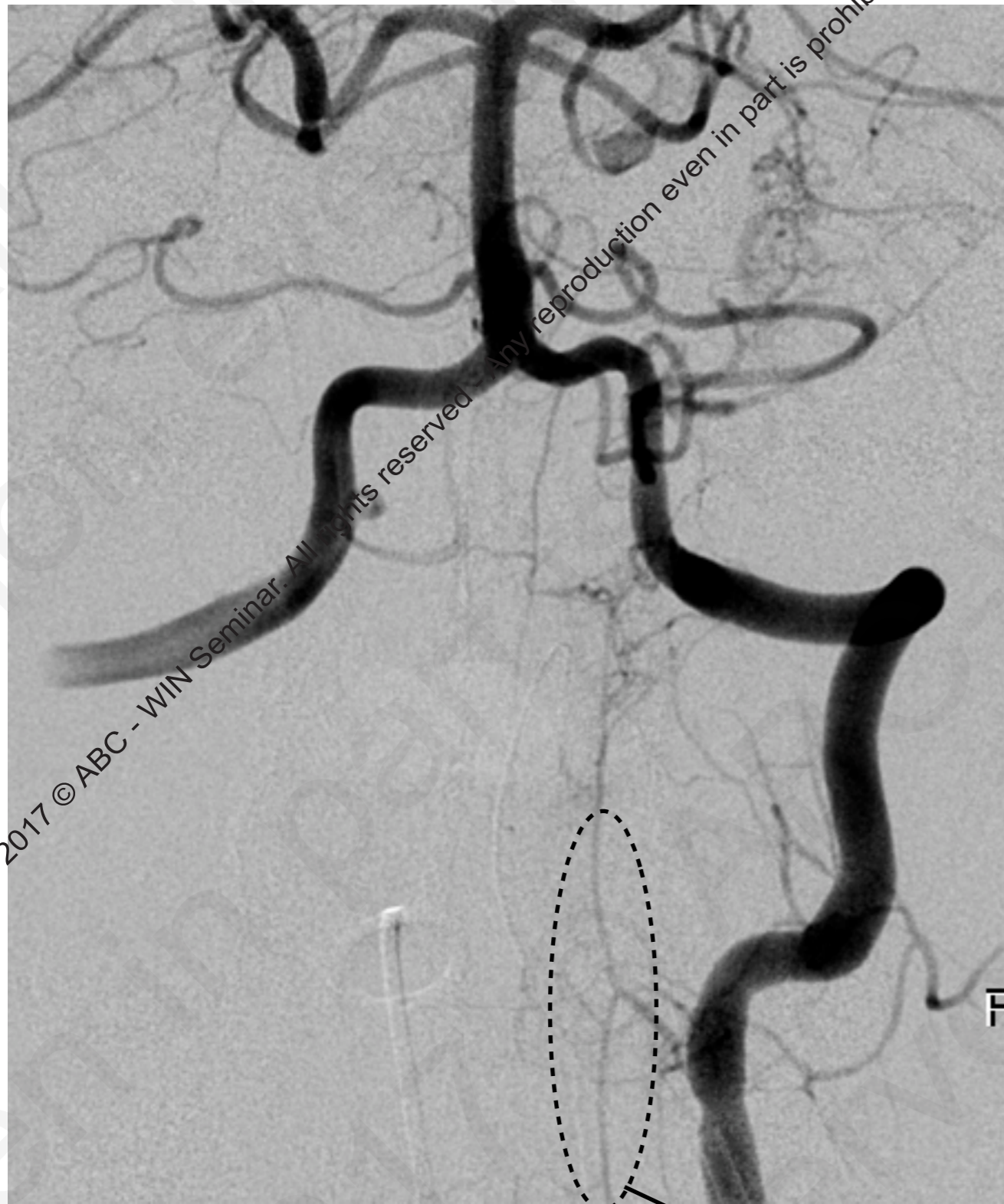
Frontal view of VR in stereoscopic view showing the odontoid arch and its contributors, the anterior/ lateral spinal artery.



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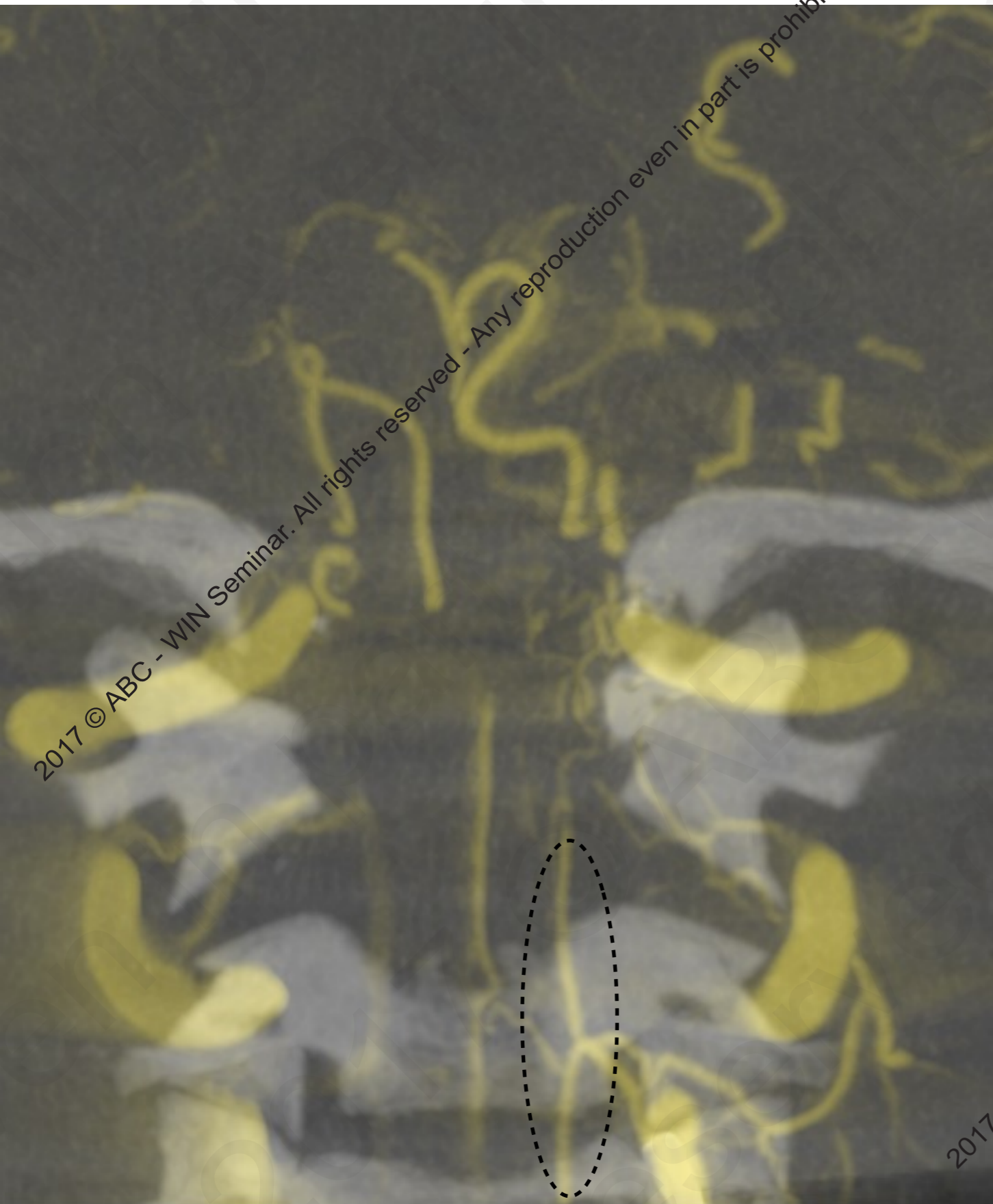
back to the 2D again



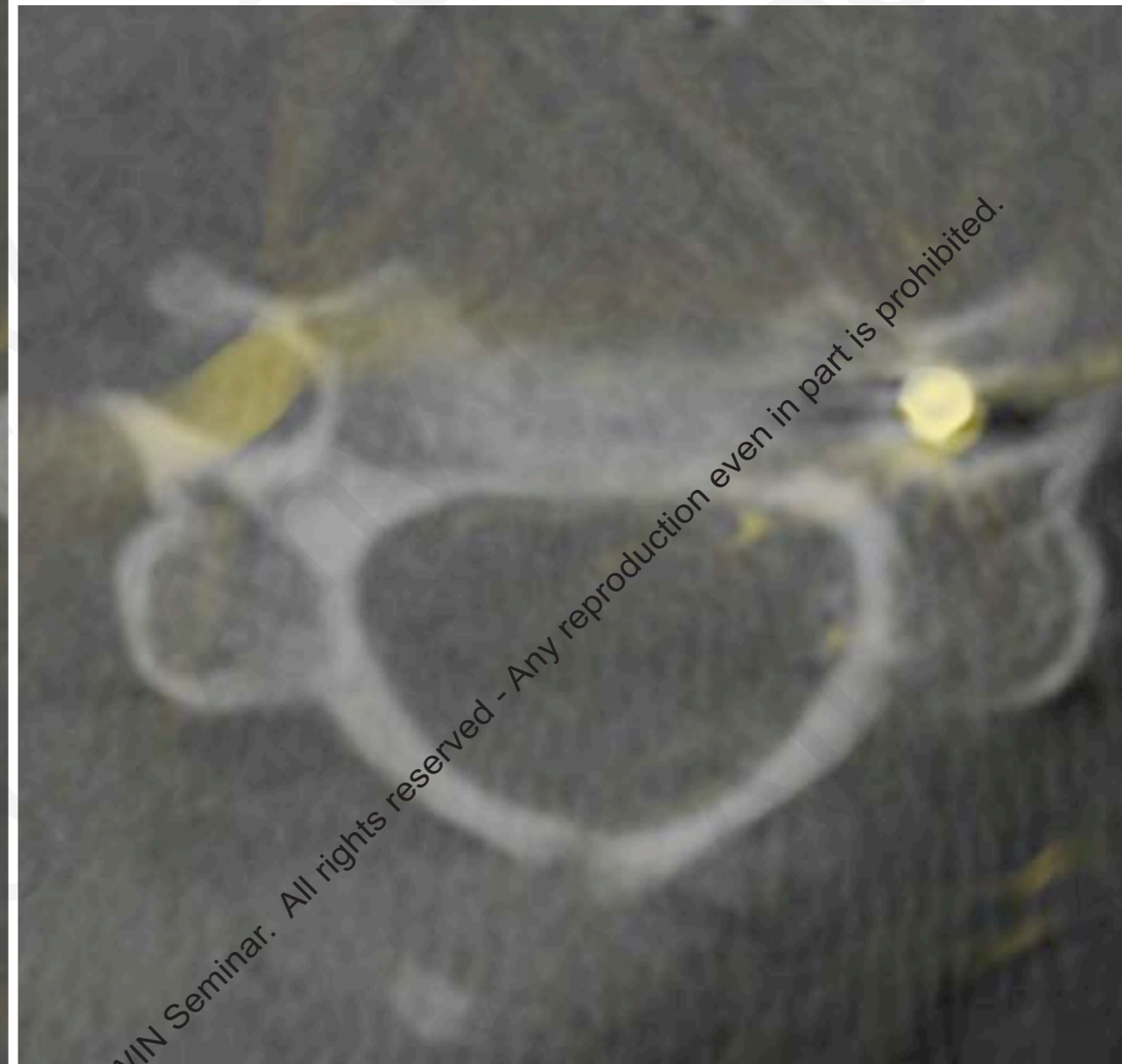
?

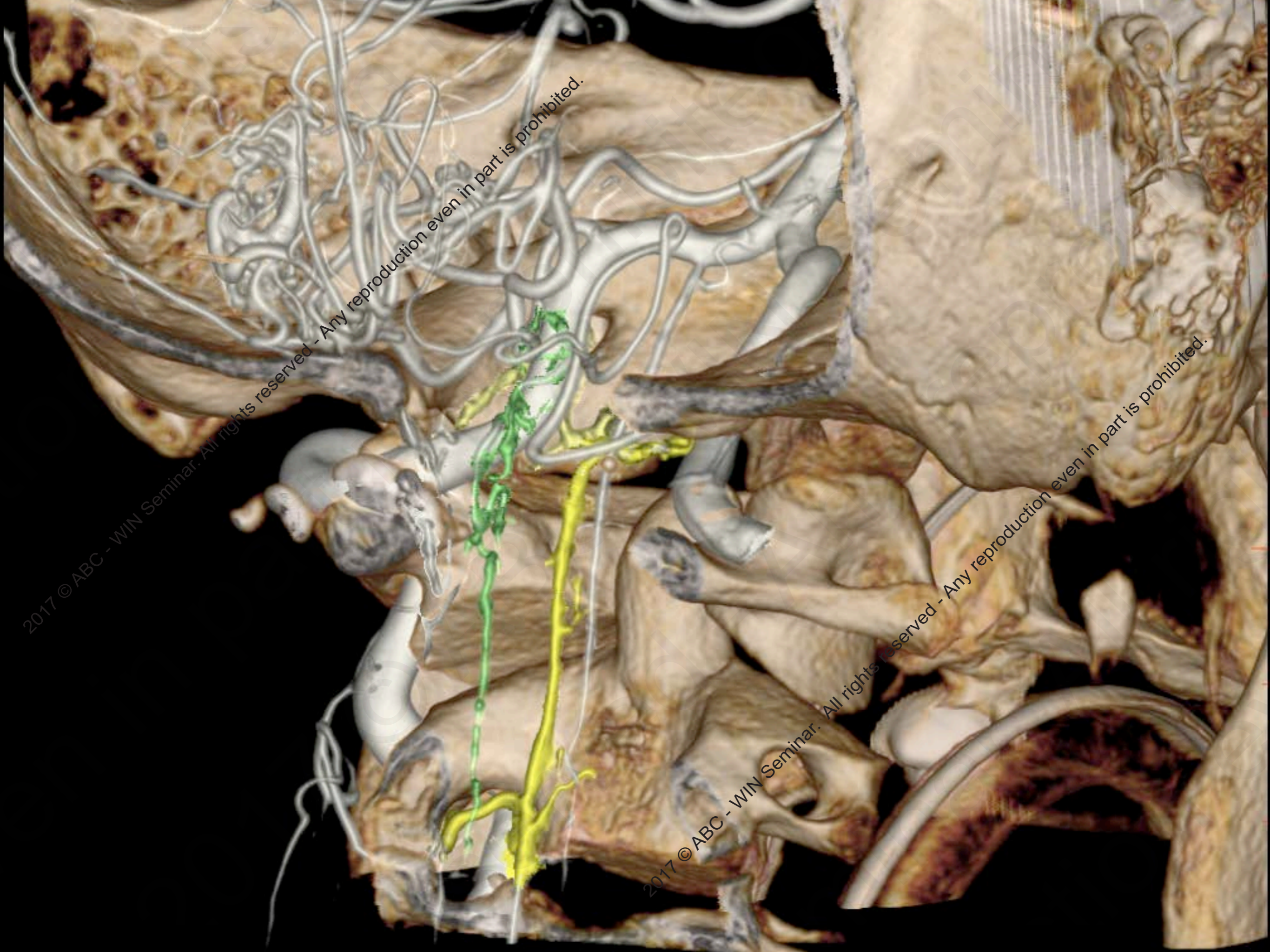


Coronal MIP



Axial MIP





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Spatial relationship of the arteries in the cervical spinal column

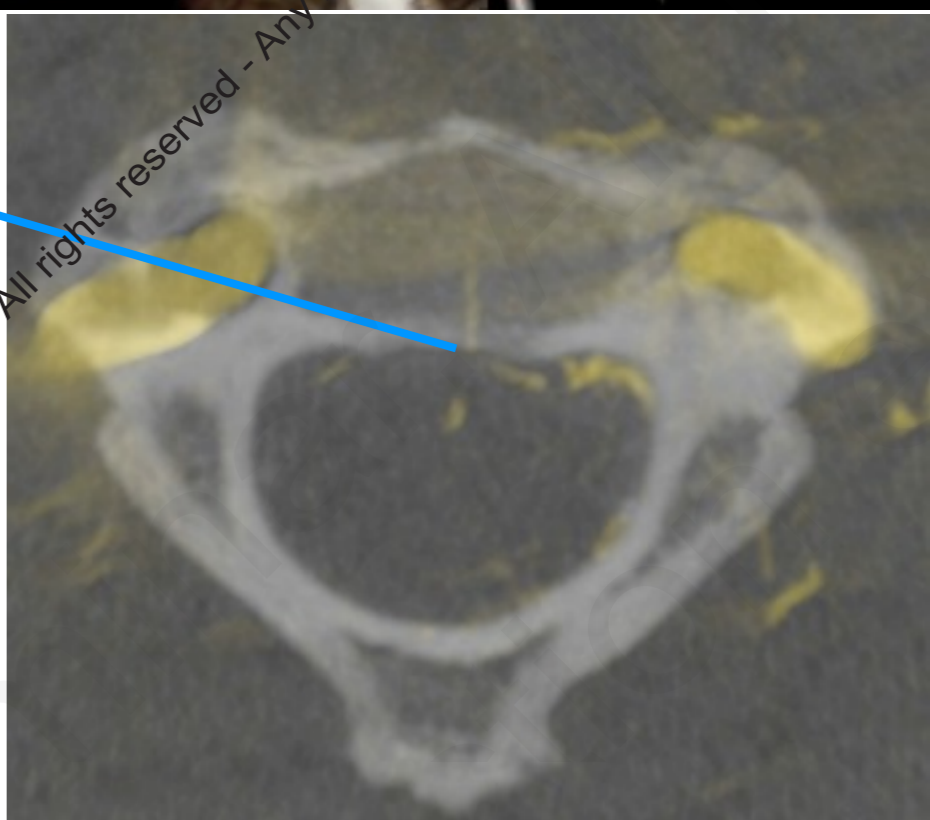
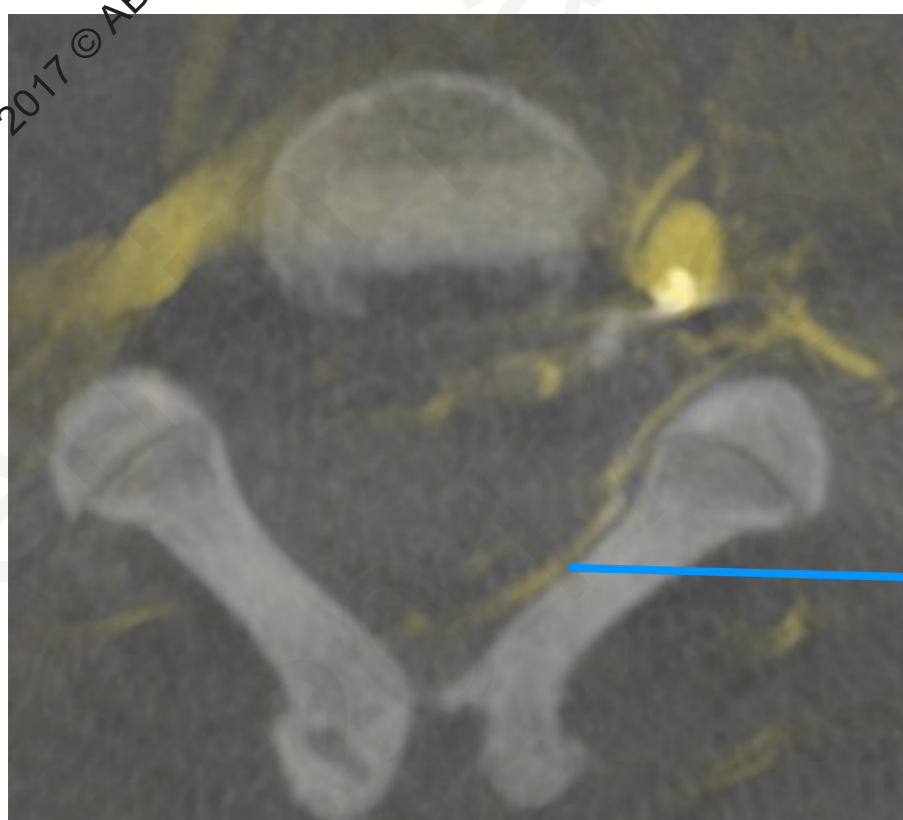
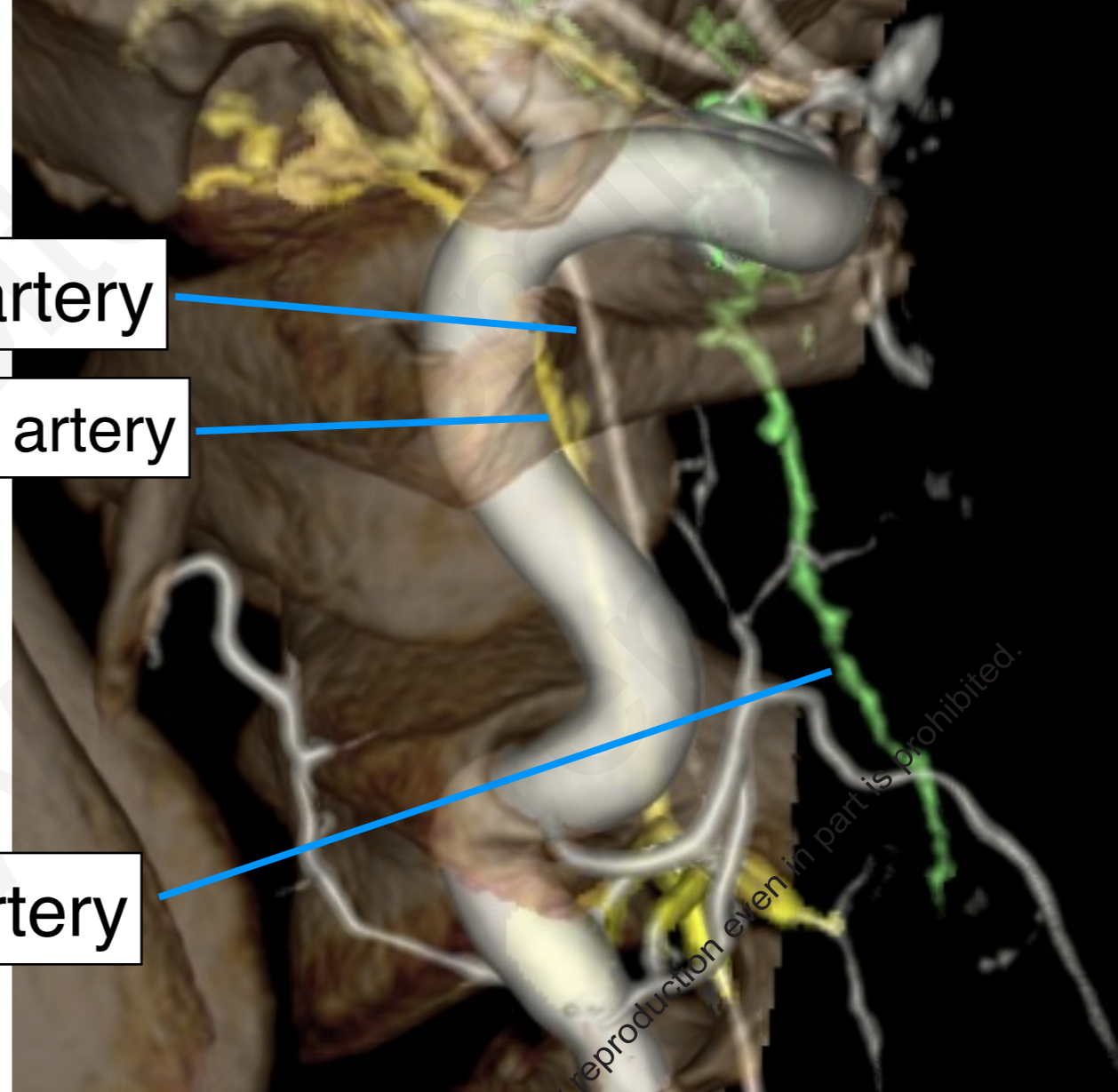
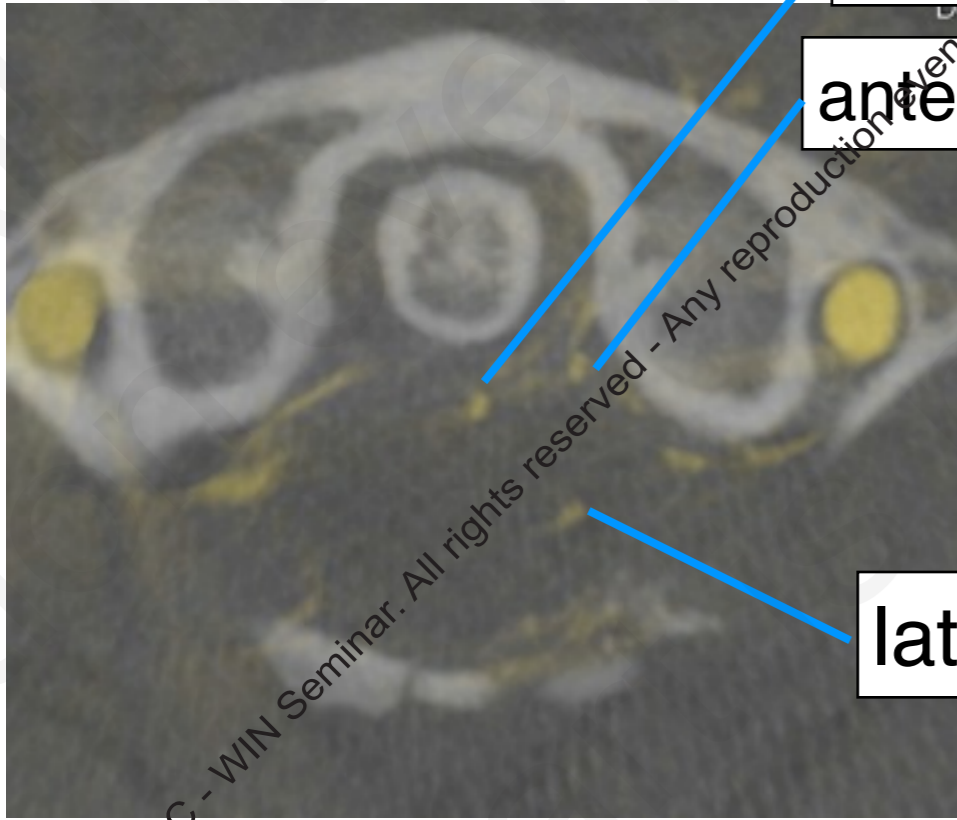
anterior spinal artery

anterior meningeal artery

lateral spinal artery

ventral dural branch

dorsal dural branch



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The origin of the VA part of the odontoid arch
can be dominant at other levels...

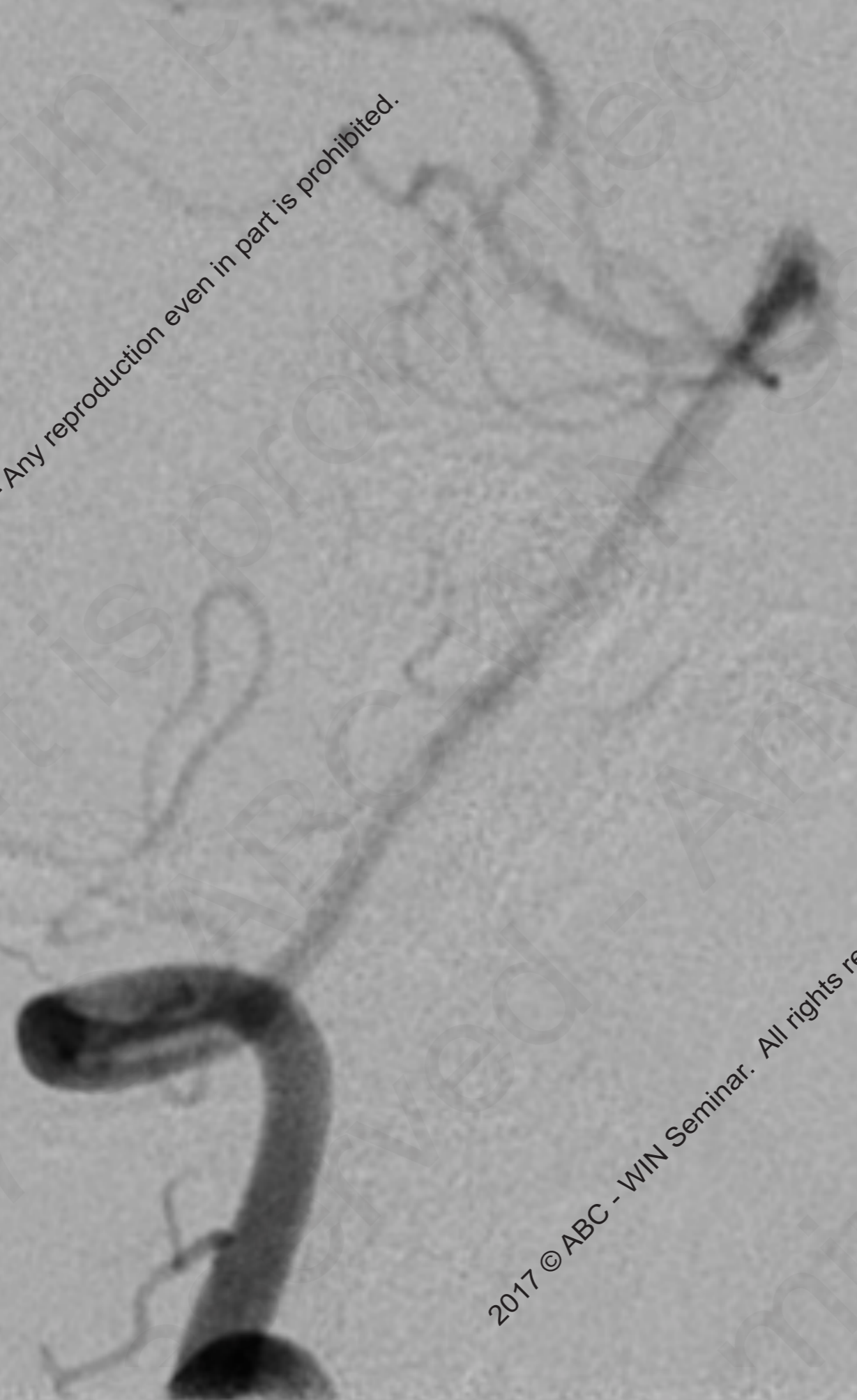
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68 M, basilar top aneurysm



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(FIG. 5)

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MASK = 1

WW: 4098 WL: 2048

Seq:2
No cut
Volume Rendering
DFOV 11.6cm

MOVIE file

U
T
S

R
A
I

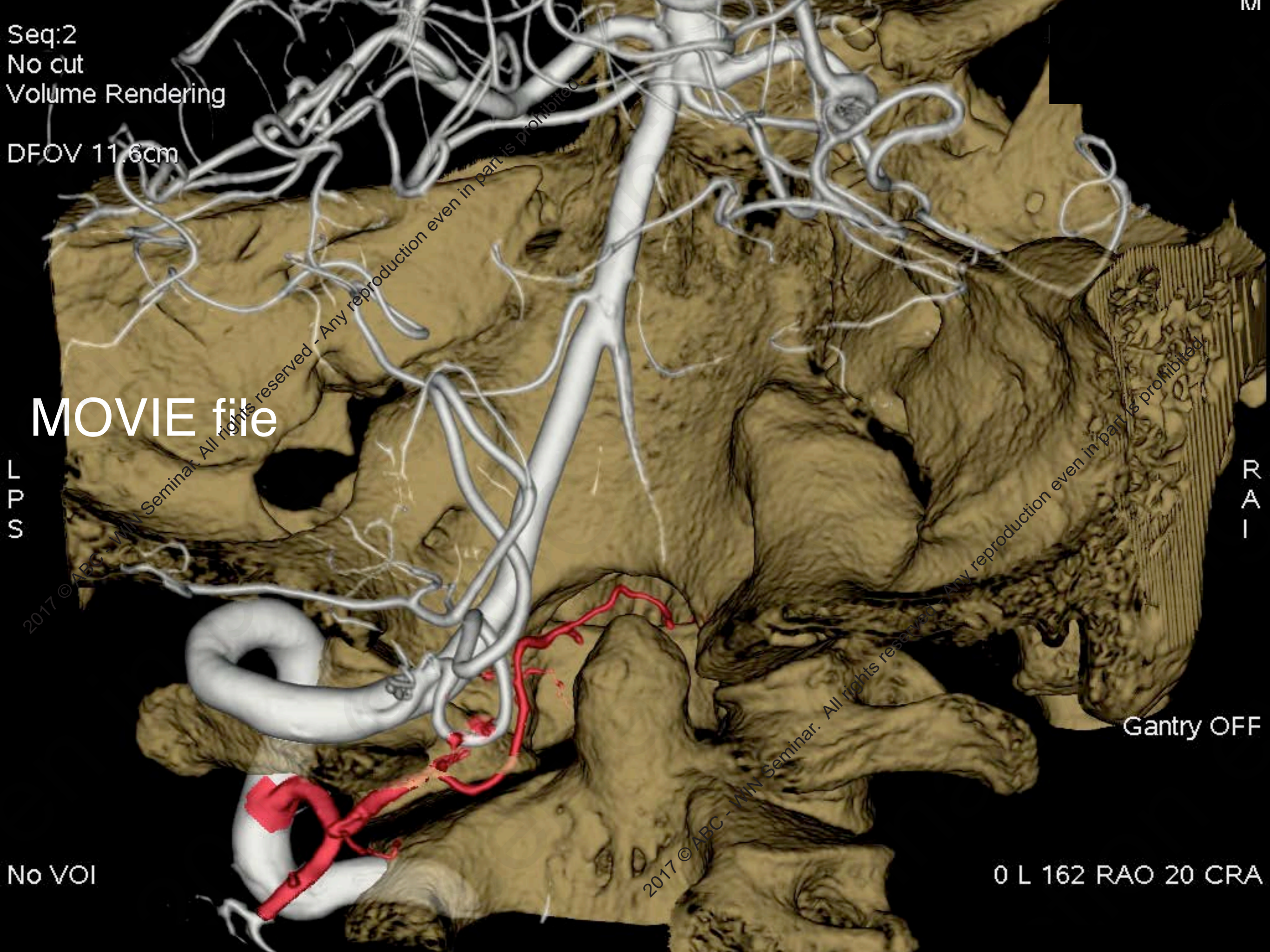
Gantry OFF

No VOI

0 L 162 RAO 20 CRA

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+C
Seq:2
No cut
Volume Rendering
DFOV 5.7cm

13:17

L
P
S

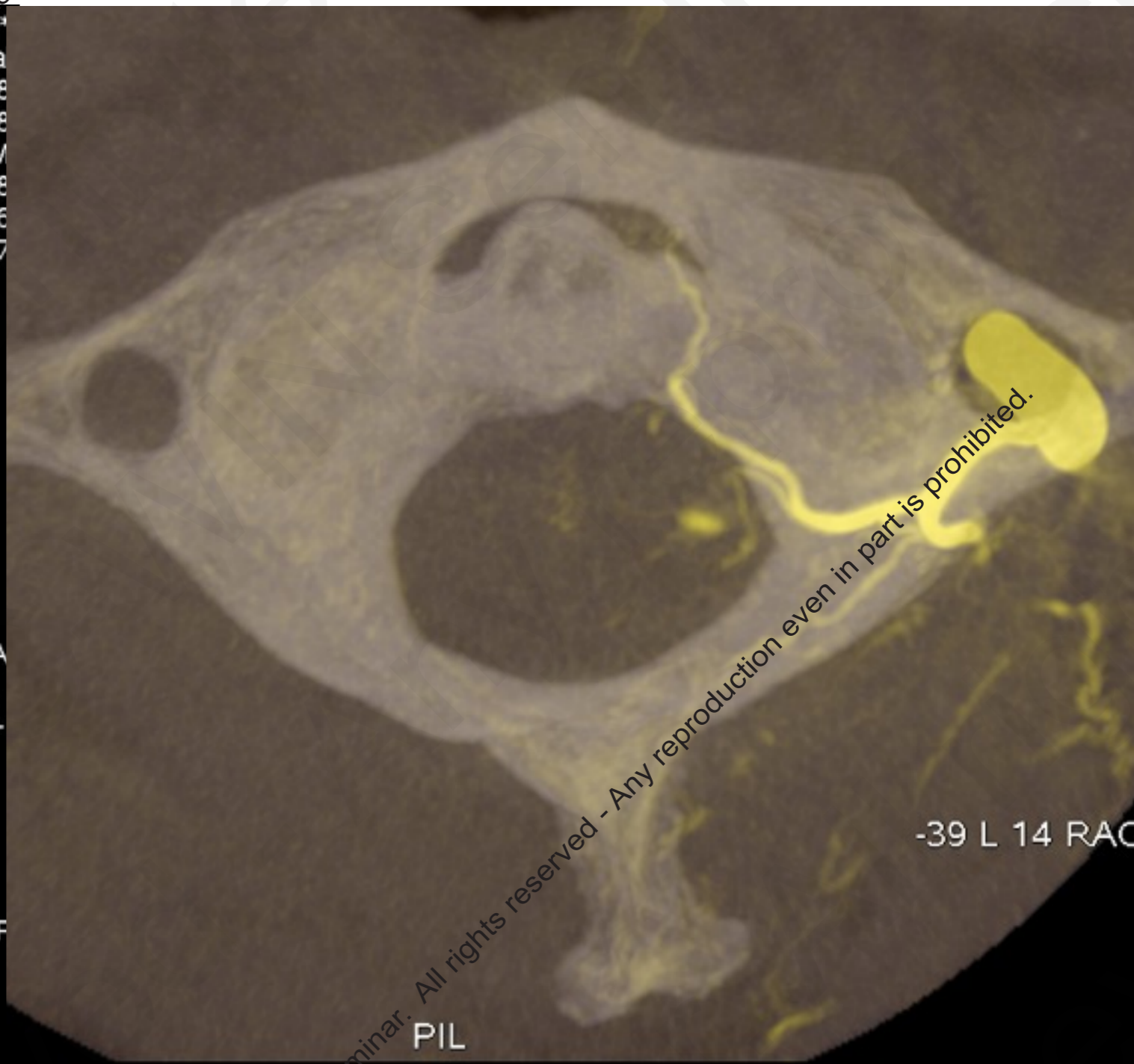
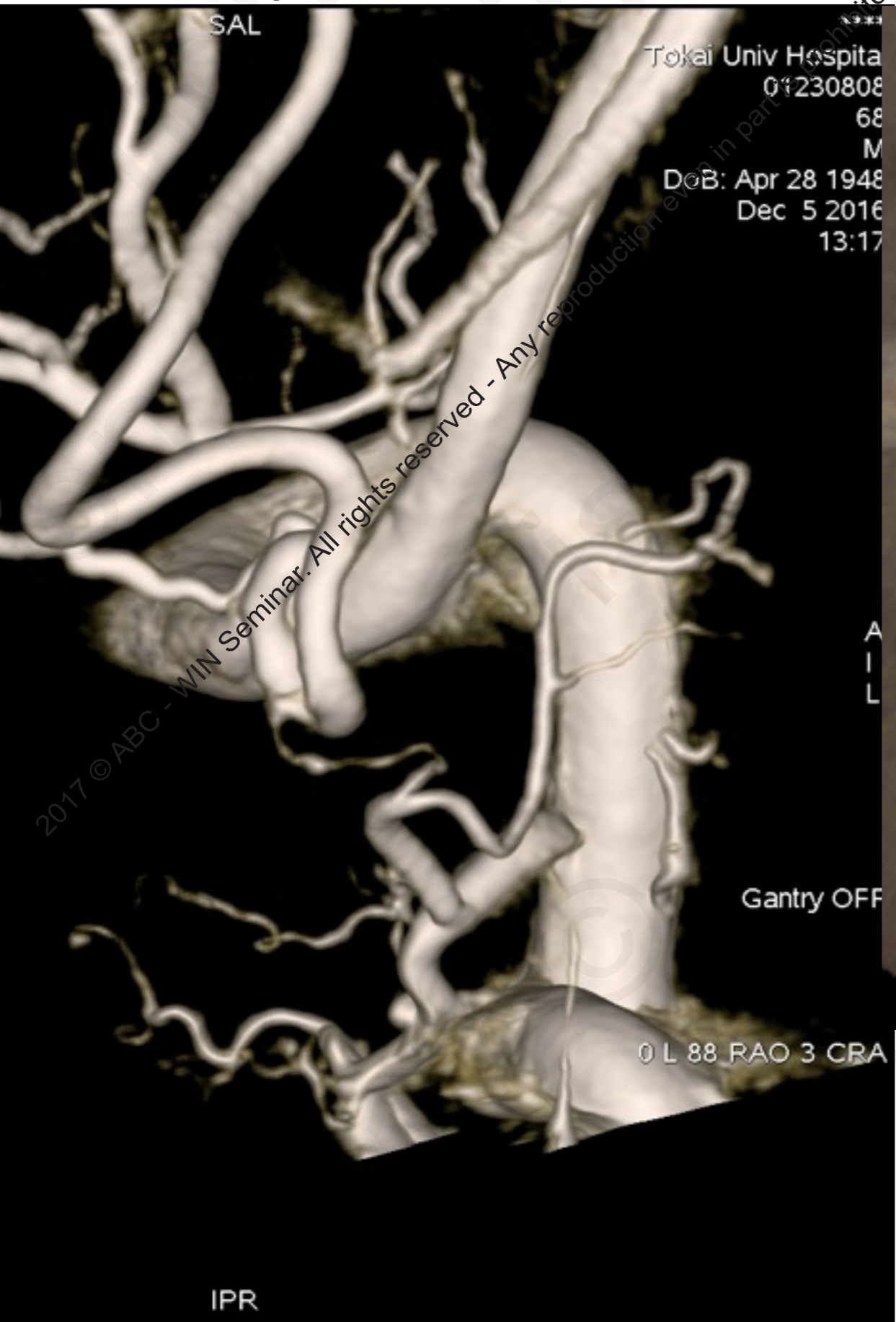
R
A
I

Gantry OFF

In this case, we can also see a connection to the caudal loop of the PICA.
(A branch of the lateral spinal artery system also arises from the C2
segment.)

Xray Angiography

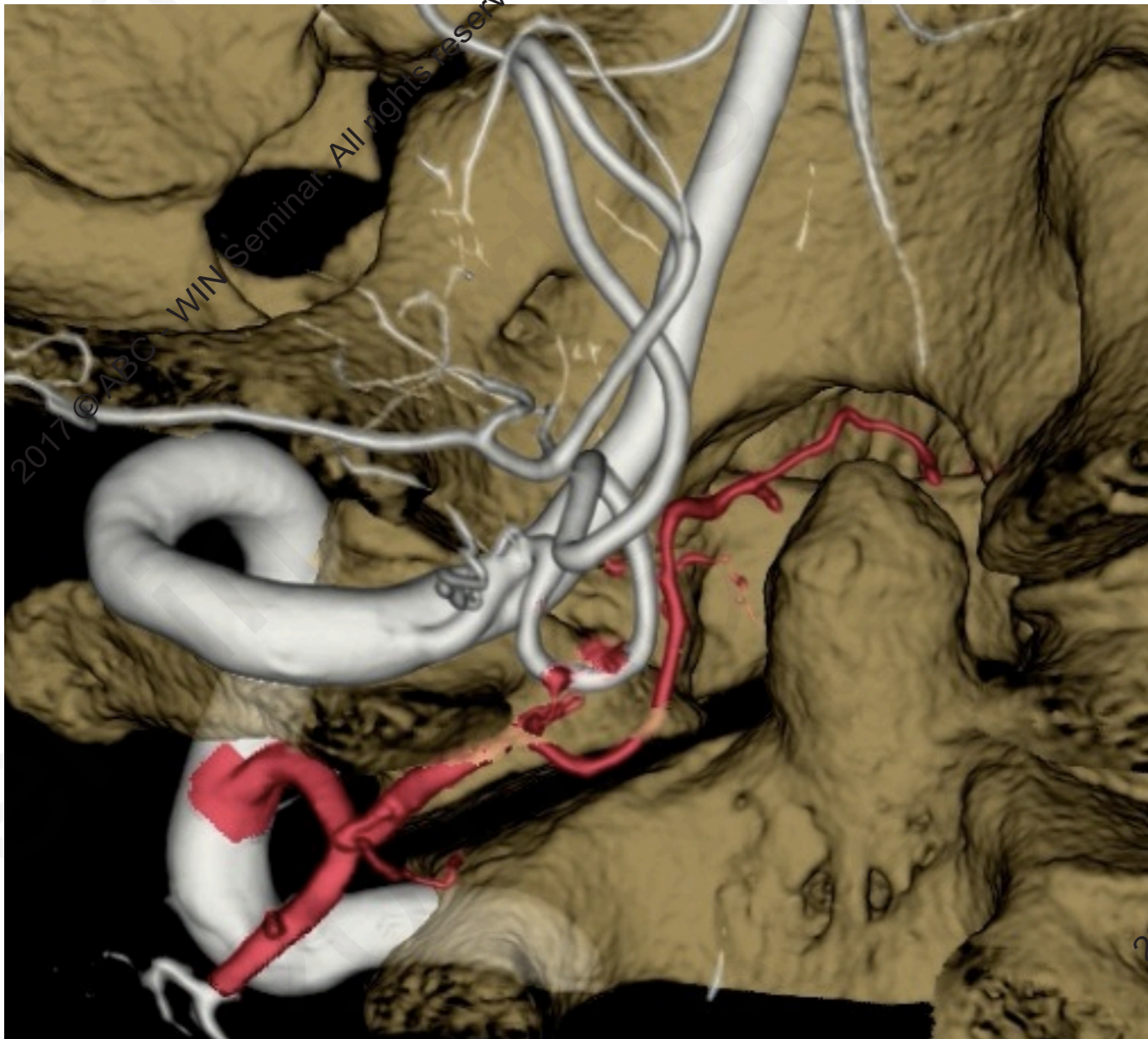
In this case the anterior meningeal artery arises from the C3 cervical space.



Similar arrangement as in the spinal cord level. (but with the VA as the main supply)

Odontoid arch system

Dural branch arising usually from the C3 space but has potential connection to the C2, and C1 segment arteries (ie. the VA itself) too. It can give of branches that participate in the lateral spinal artery system.



The dural branches around the CCJ

Posterior meningeal artery/ The artery of the falx cerebelli

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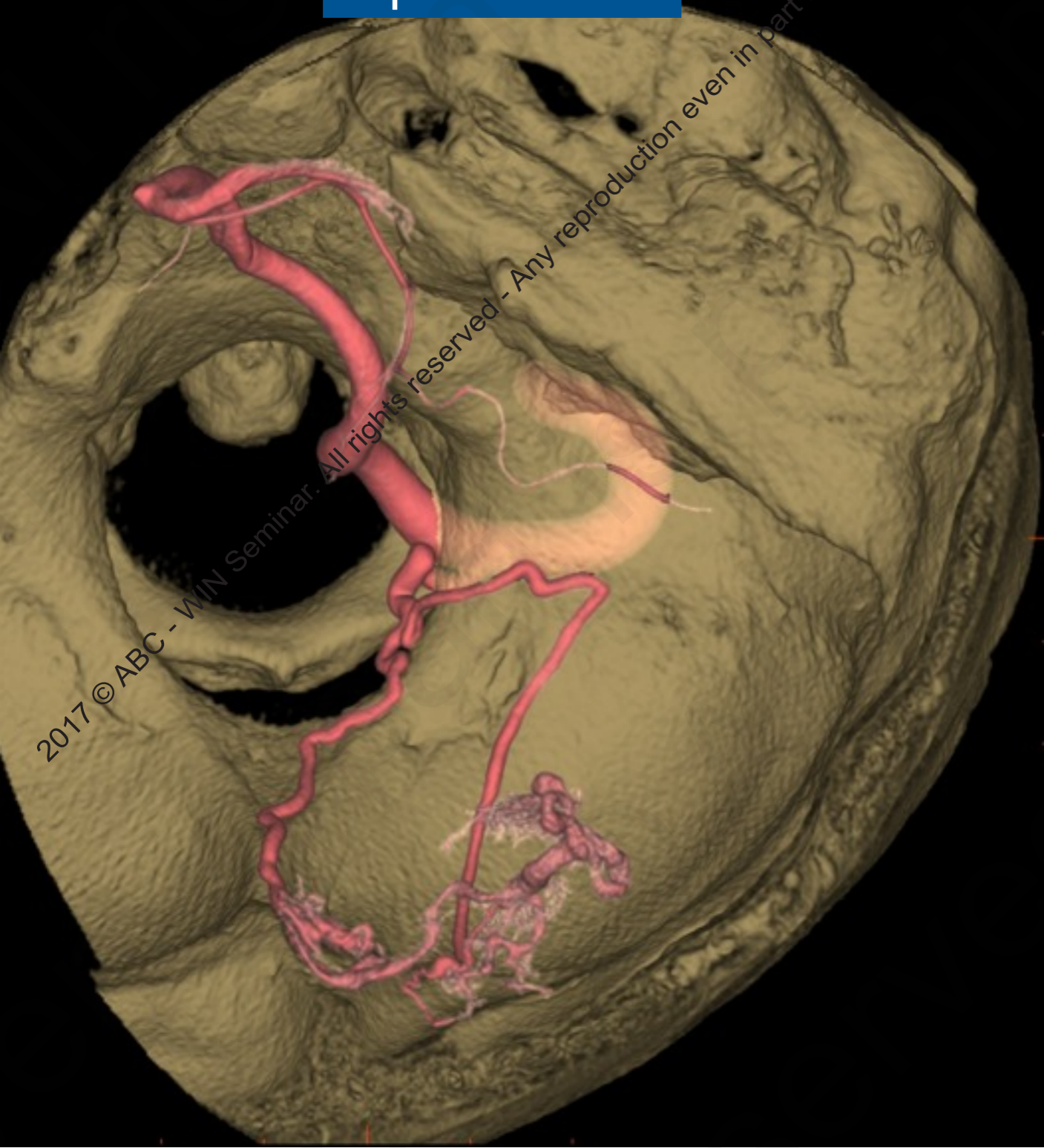
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42 M, AVM

Typical origin of the posterior meningeal artery from the VA at its' entrance of the dura.

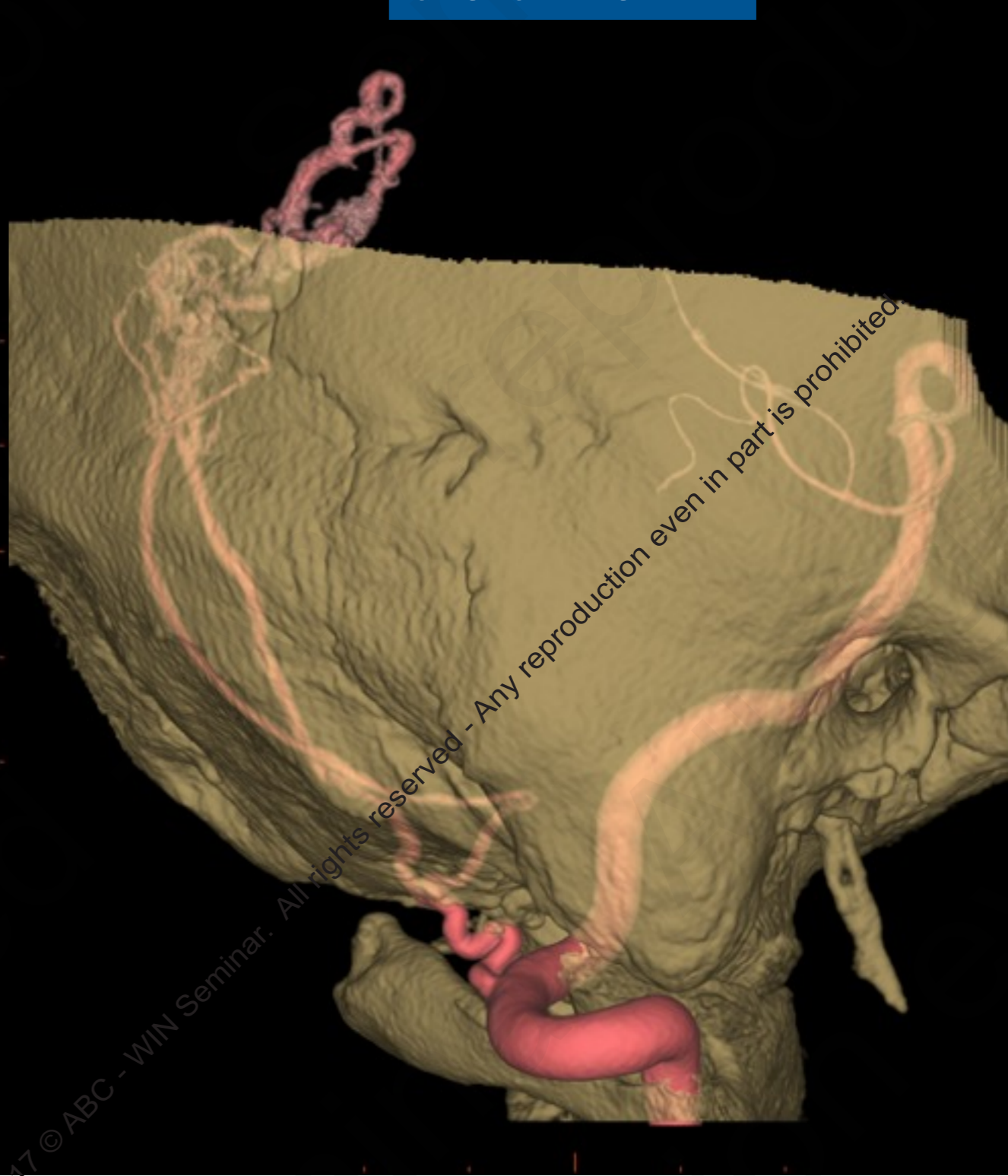


superior view



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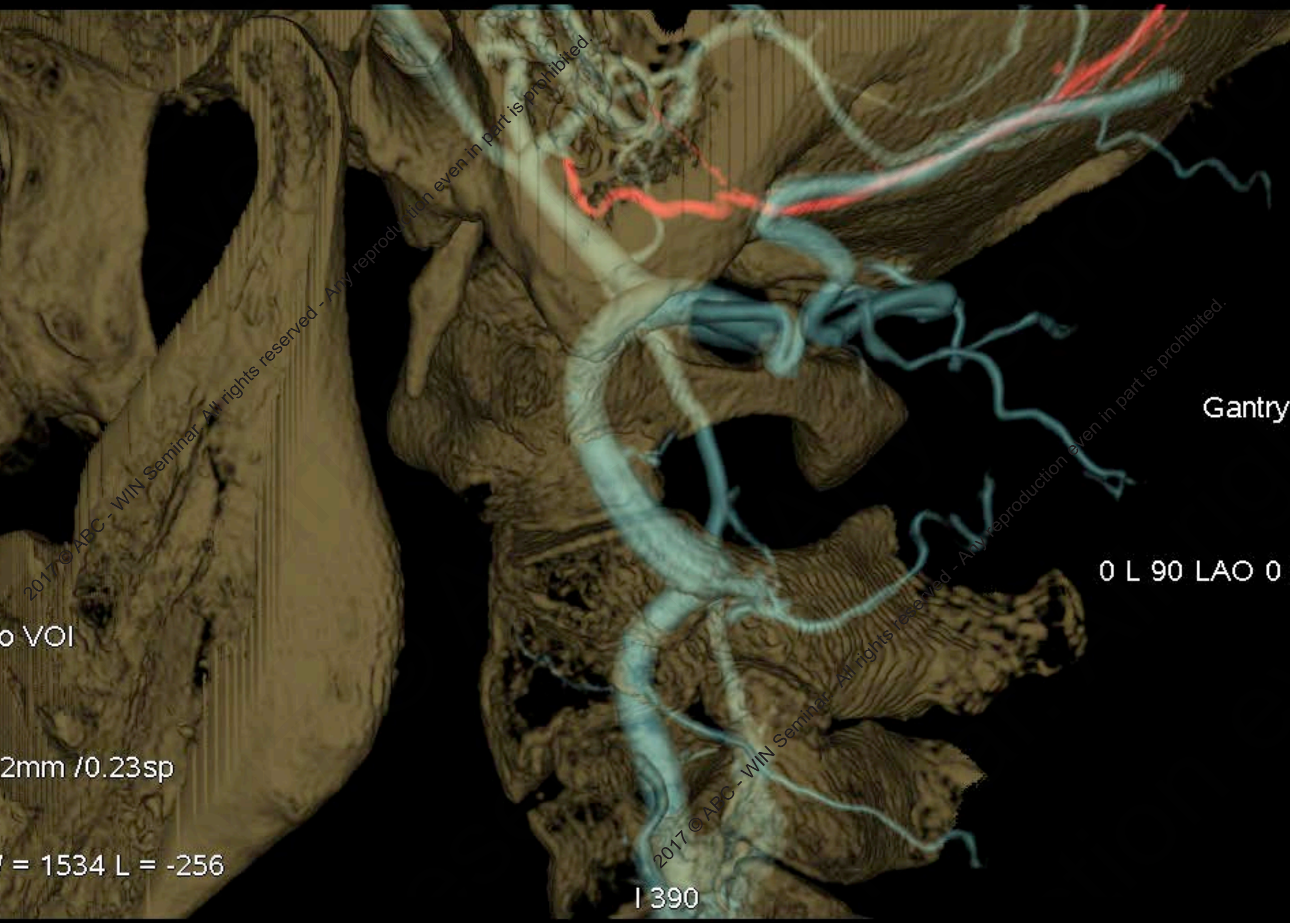
lateral view



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73 F, dAVF(falx cerebri), left C4 root AVM





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o VOI

2mm /0.23sp

I = 1534 L = -256

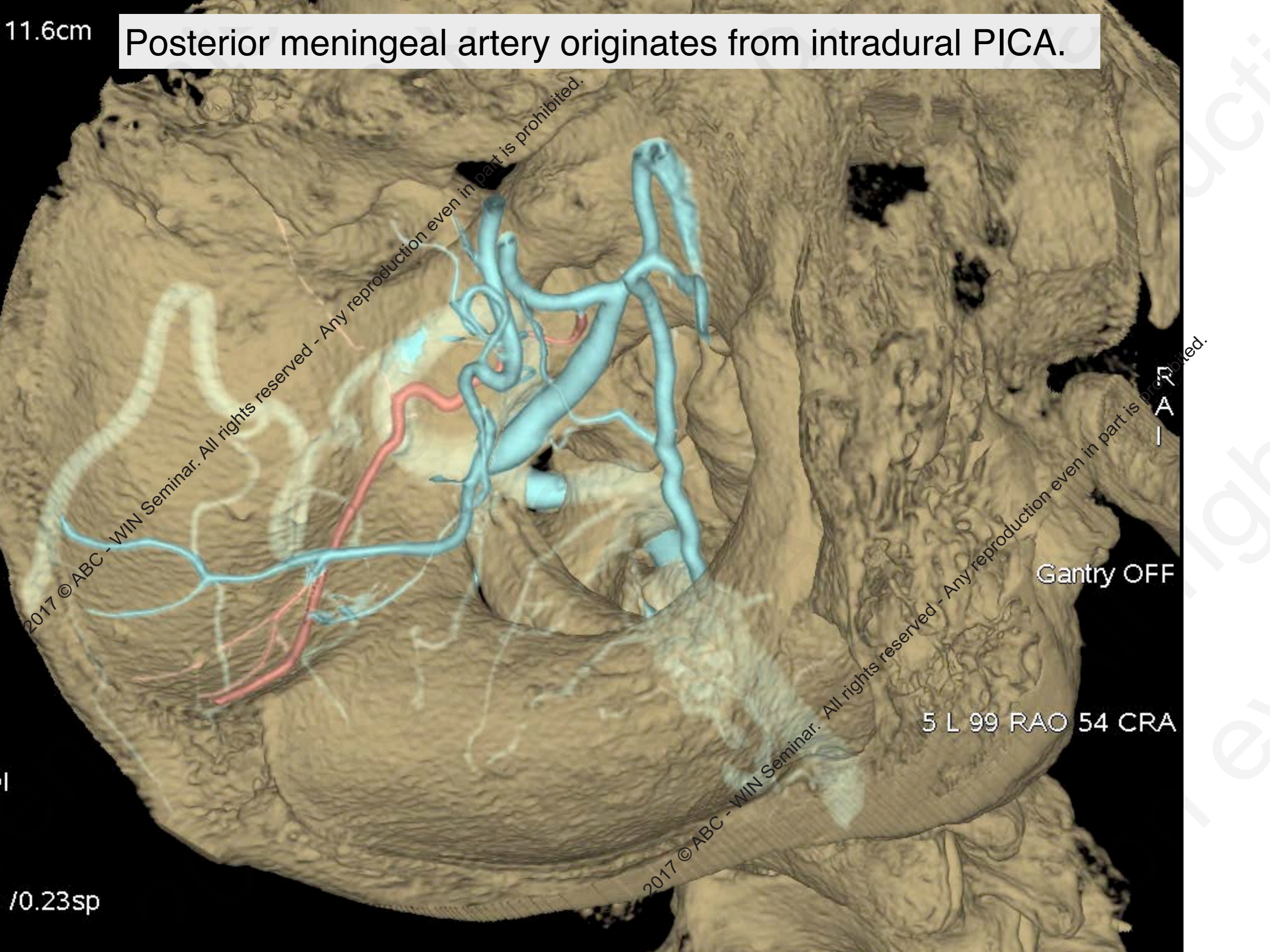
Gantry

0 L 90 LAO 0

I 390

11.6cm

Posterior meningeal artery originates from intradural PICA.



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Gantry OFF

5 L 99 RAO 54 CRA

/0.23sp

18 M, f/u angio for AVM



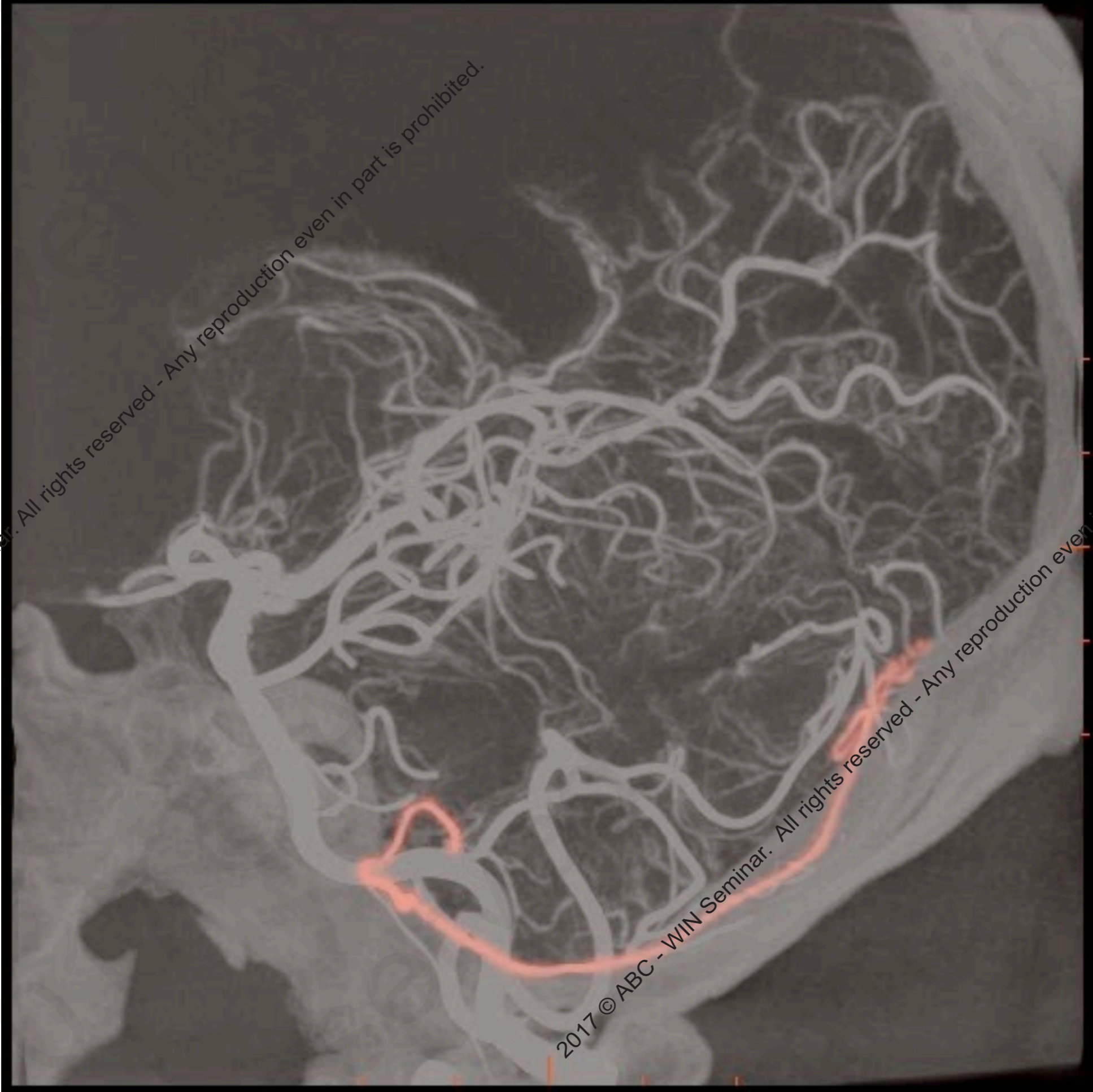
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FRAME = 9
MASK

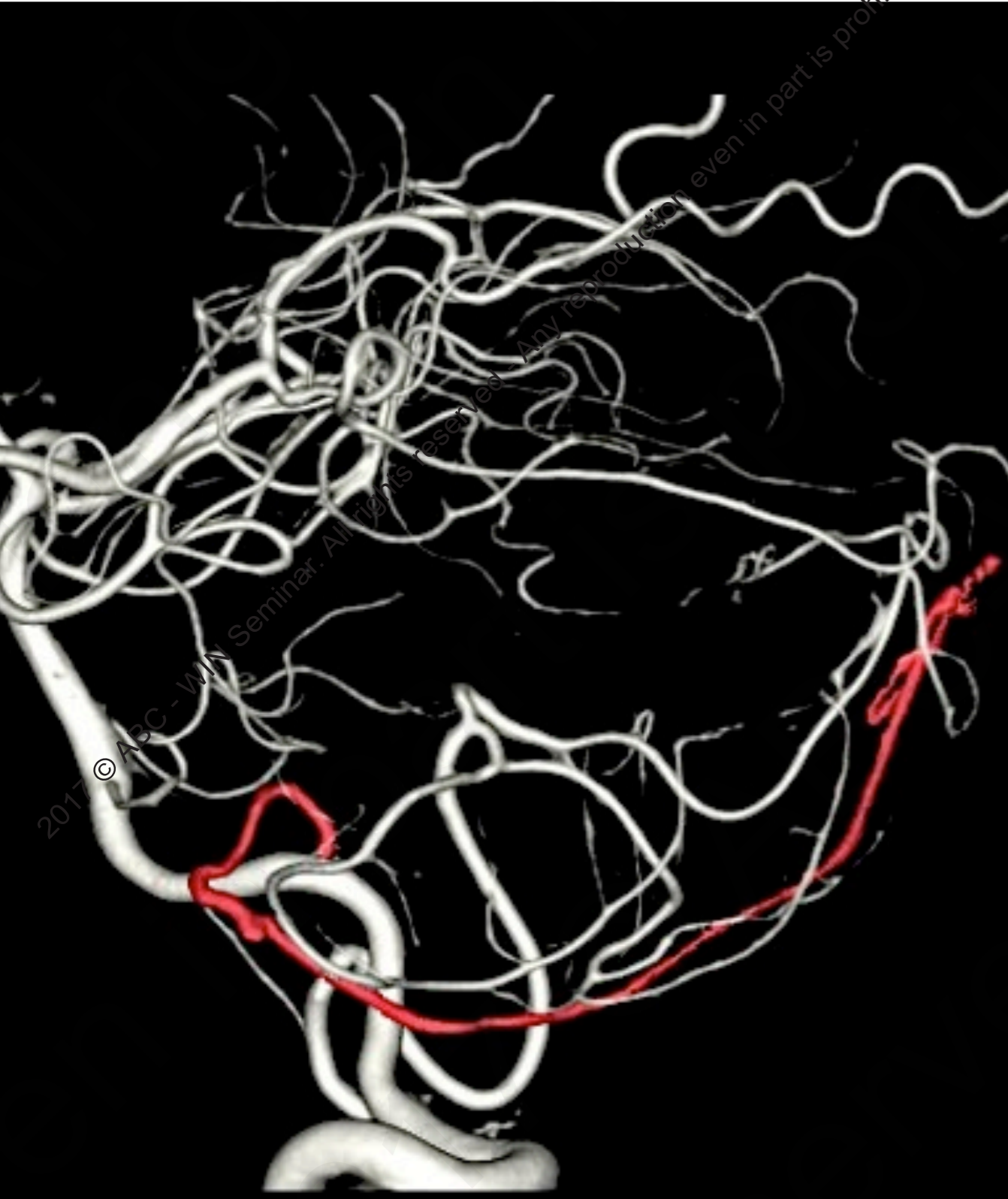
(F)

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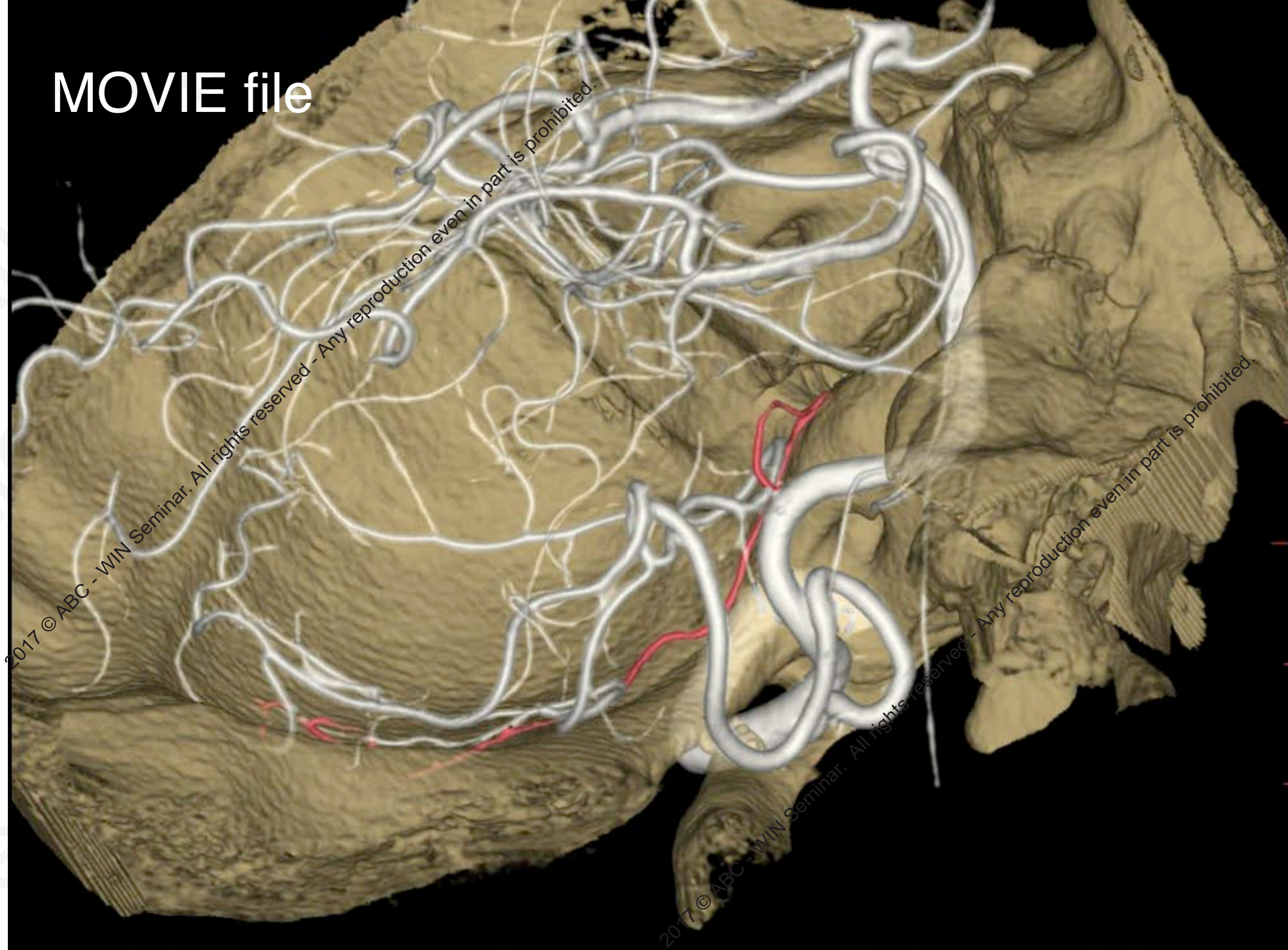


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A posterior meningeal artery arises from the intradural VA.



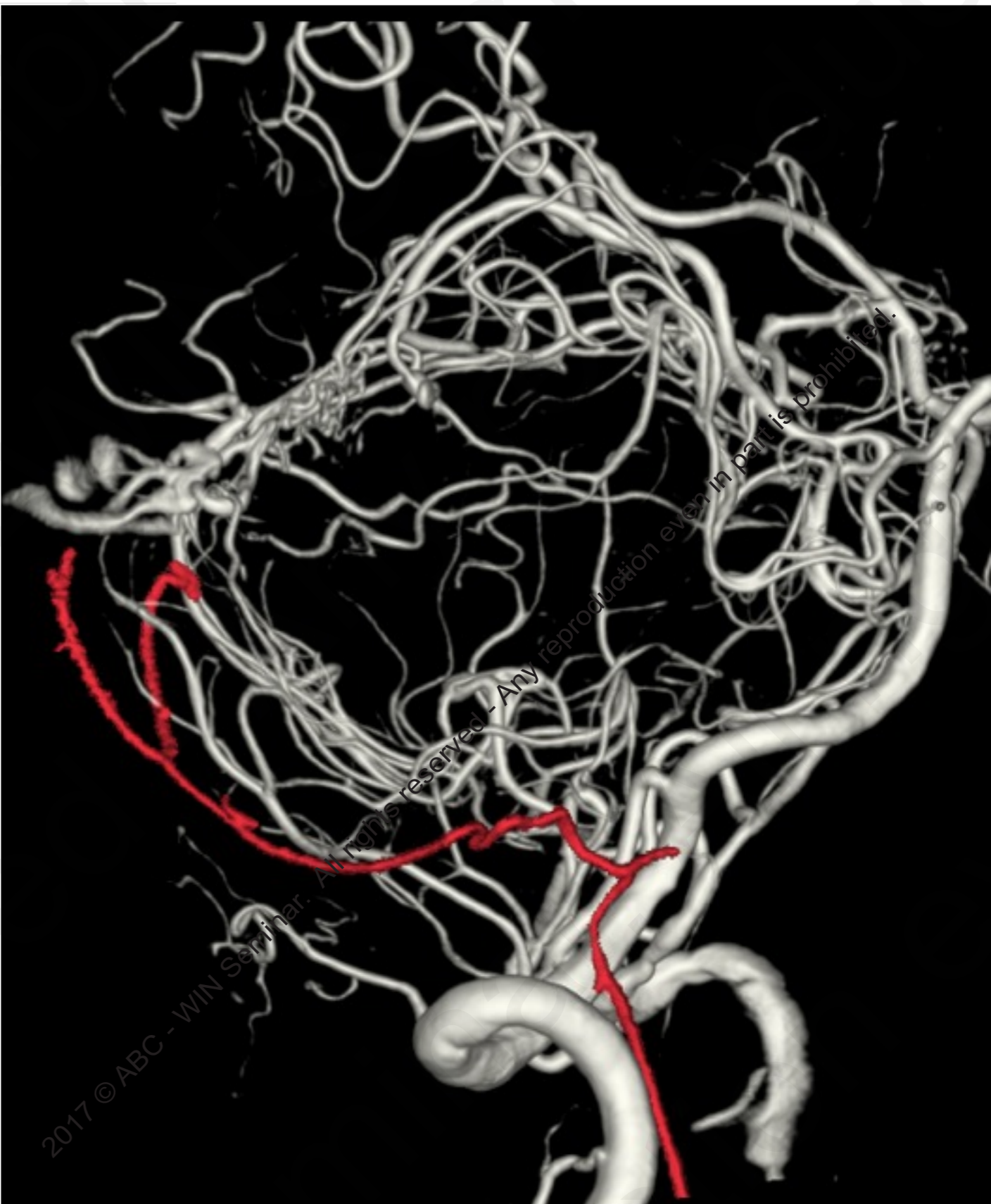
MOVIE file



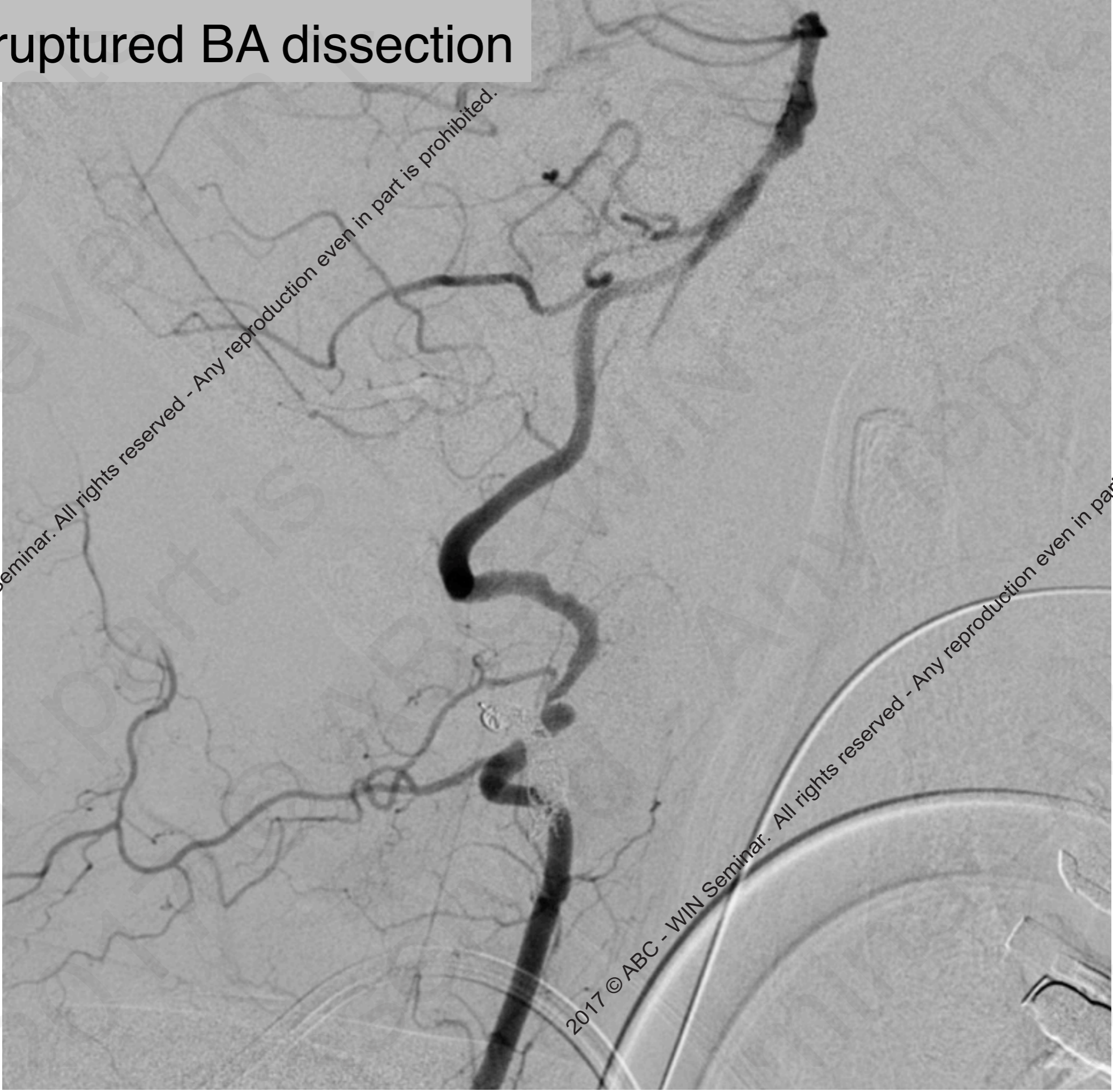
87 M, ruptured cerebellar AVM



the posterior meningeal artery arises from the odontoid arterial arch system



45 F, ruptured BA dissection



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Yellow: the odontoid arch (connection with VA at C1)

Red: small branch of PICA with posterior meningeal artery



A branch of PICA arises from the posterior meningeal artery?

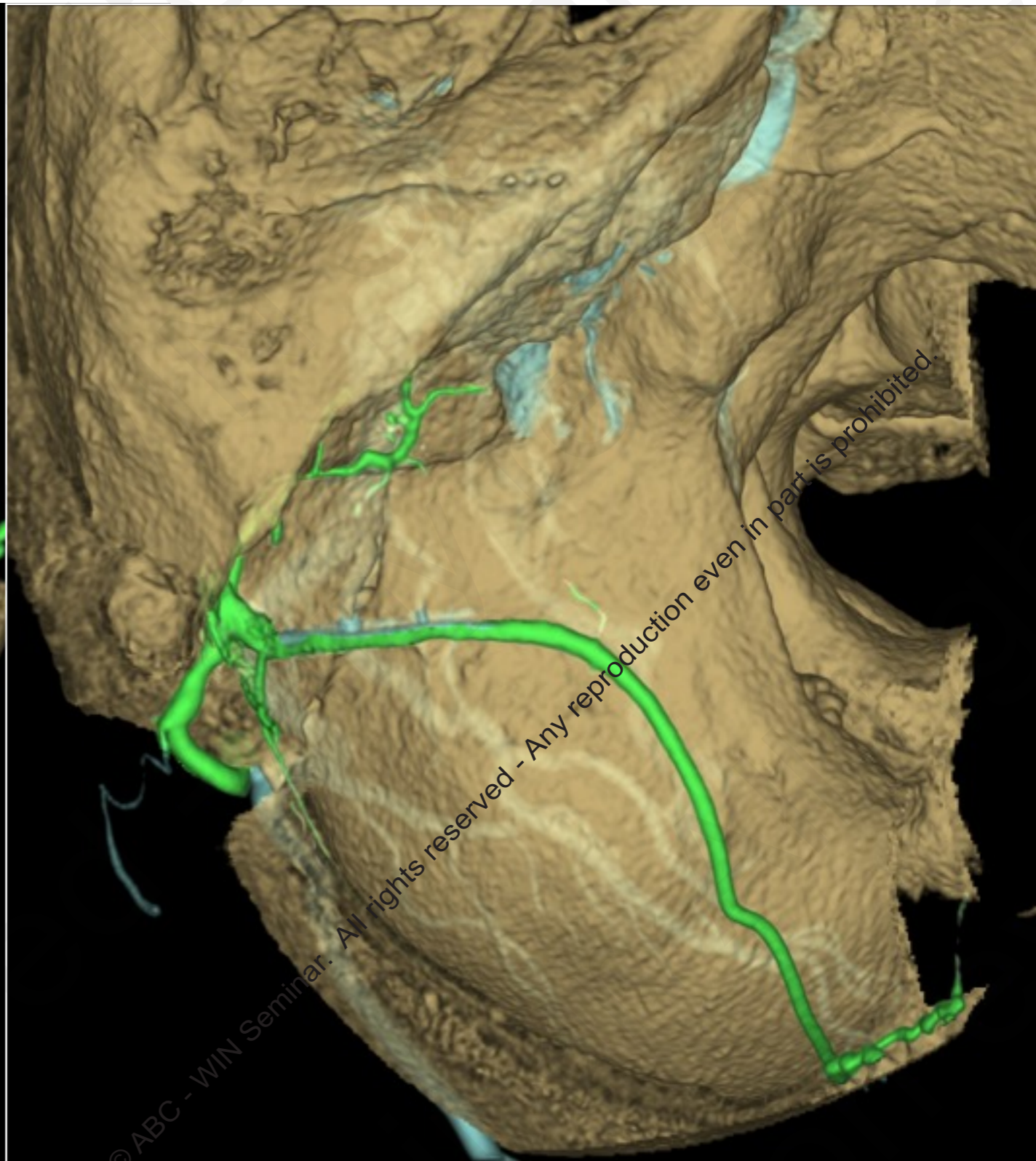
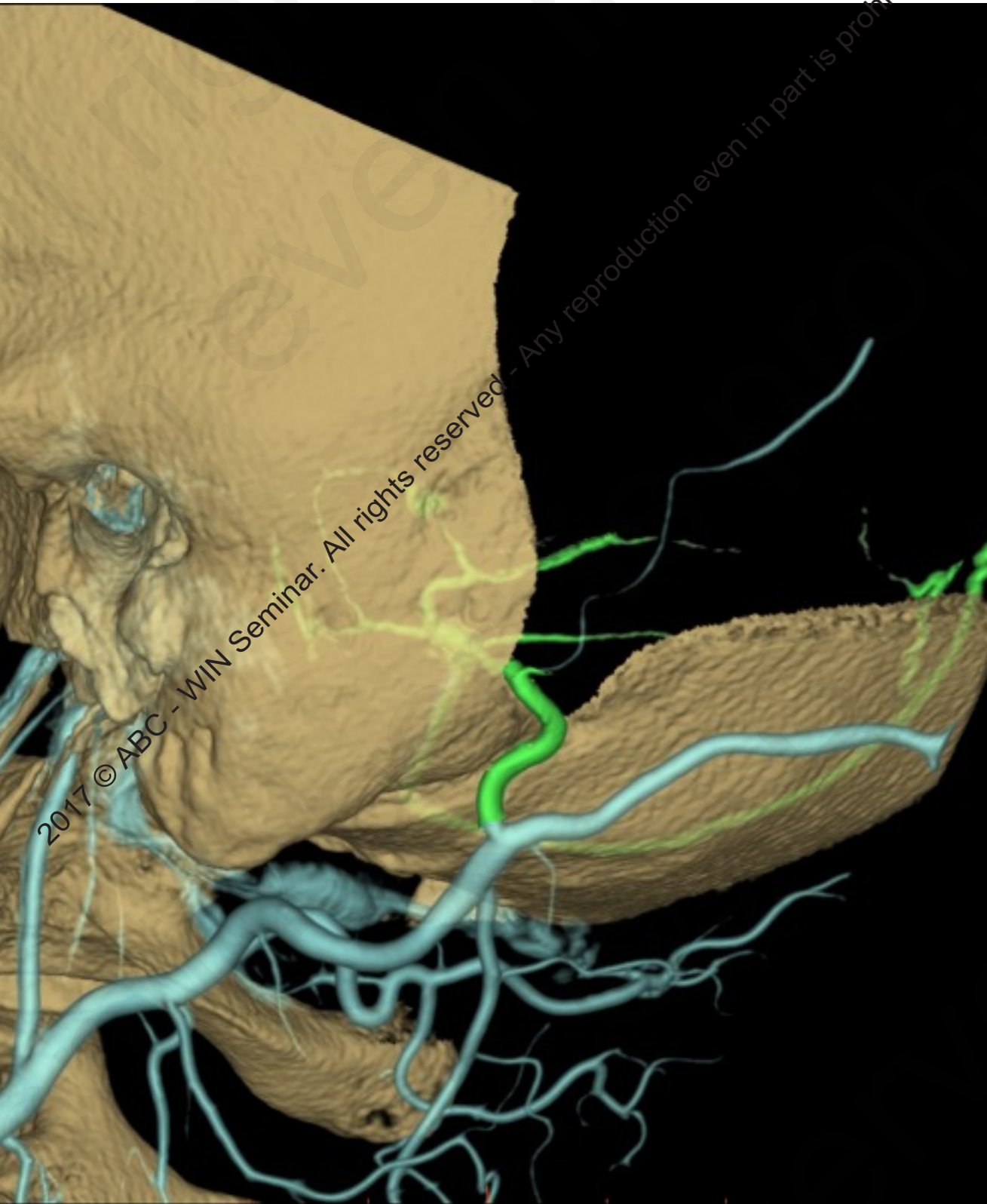
or

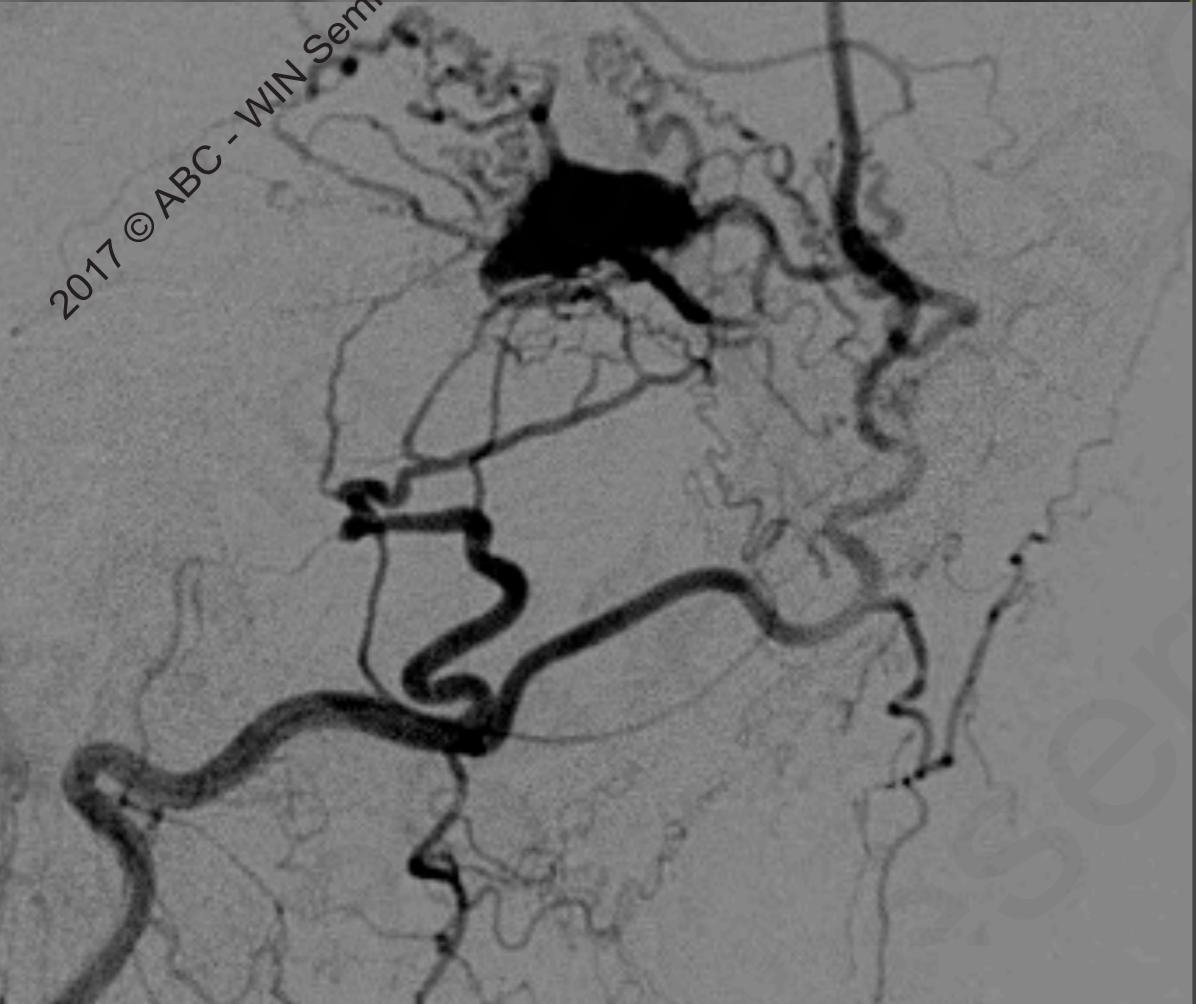
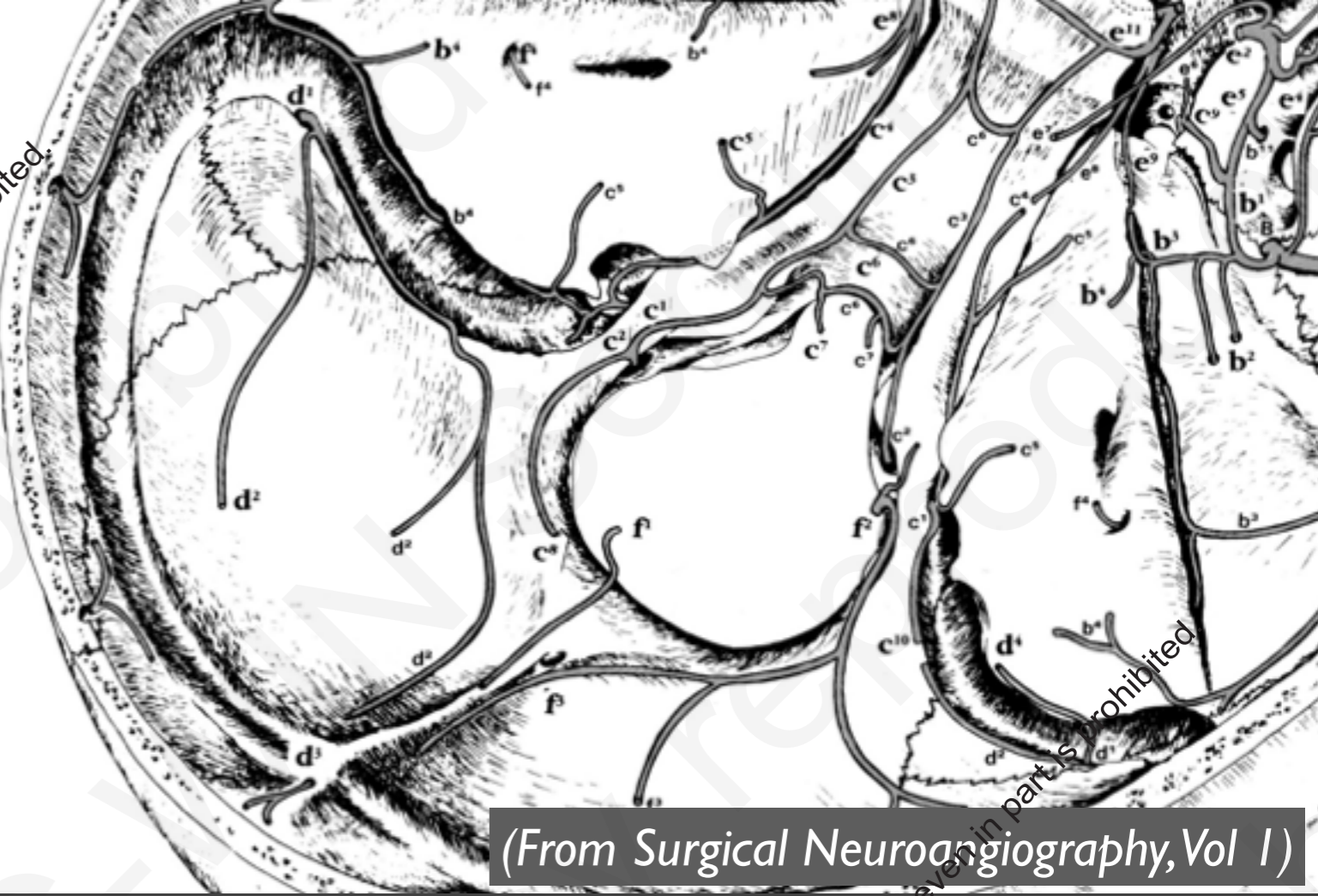
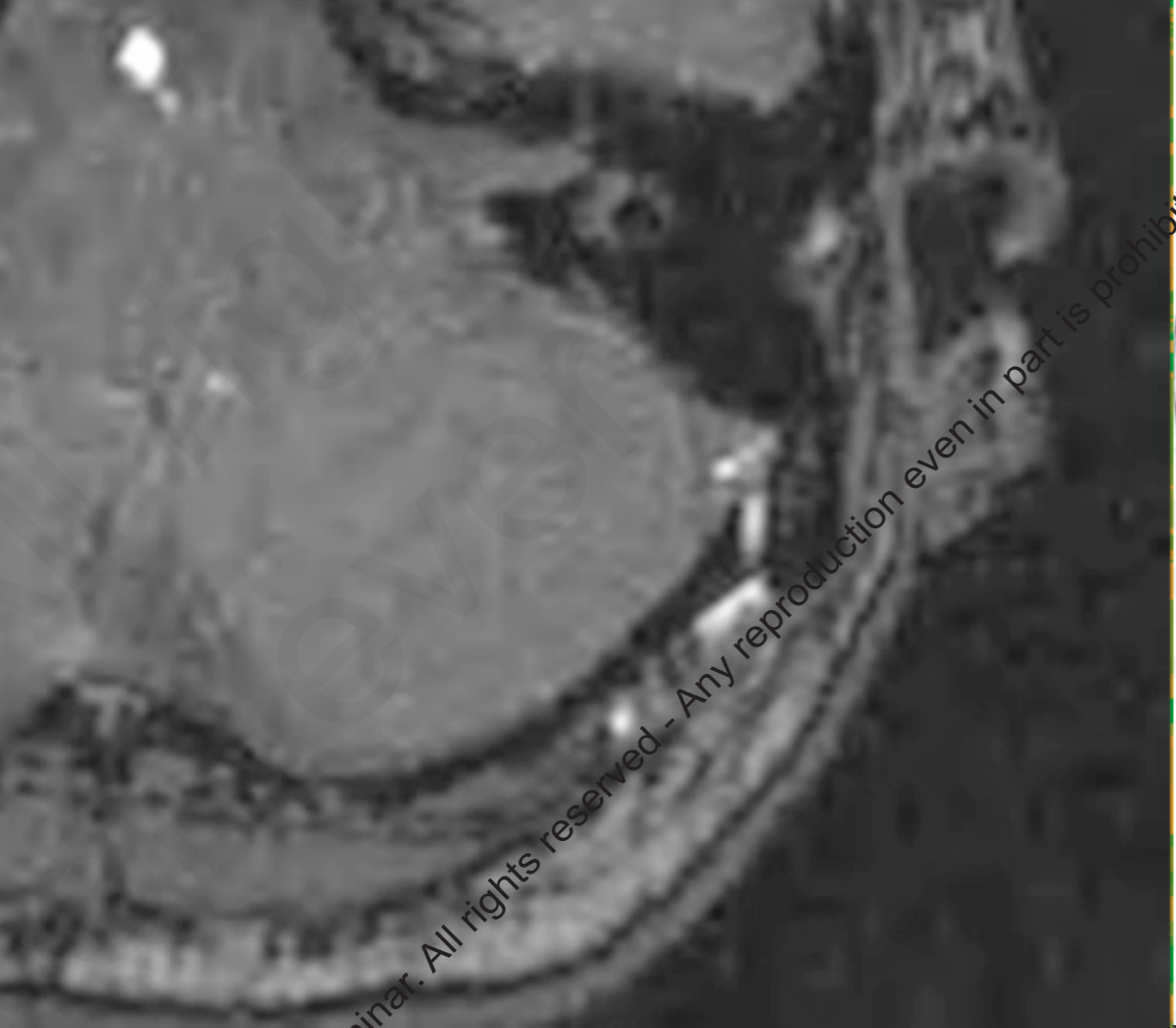
A posterior meningeal artery arises from the PICA?

or

The posterior meningeal artery and a PICA branch shares a common trunk?

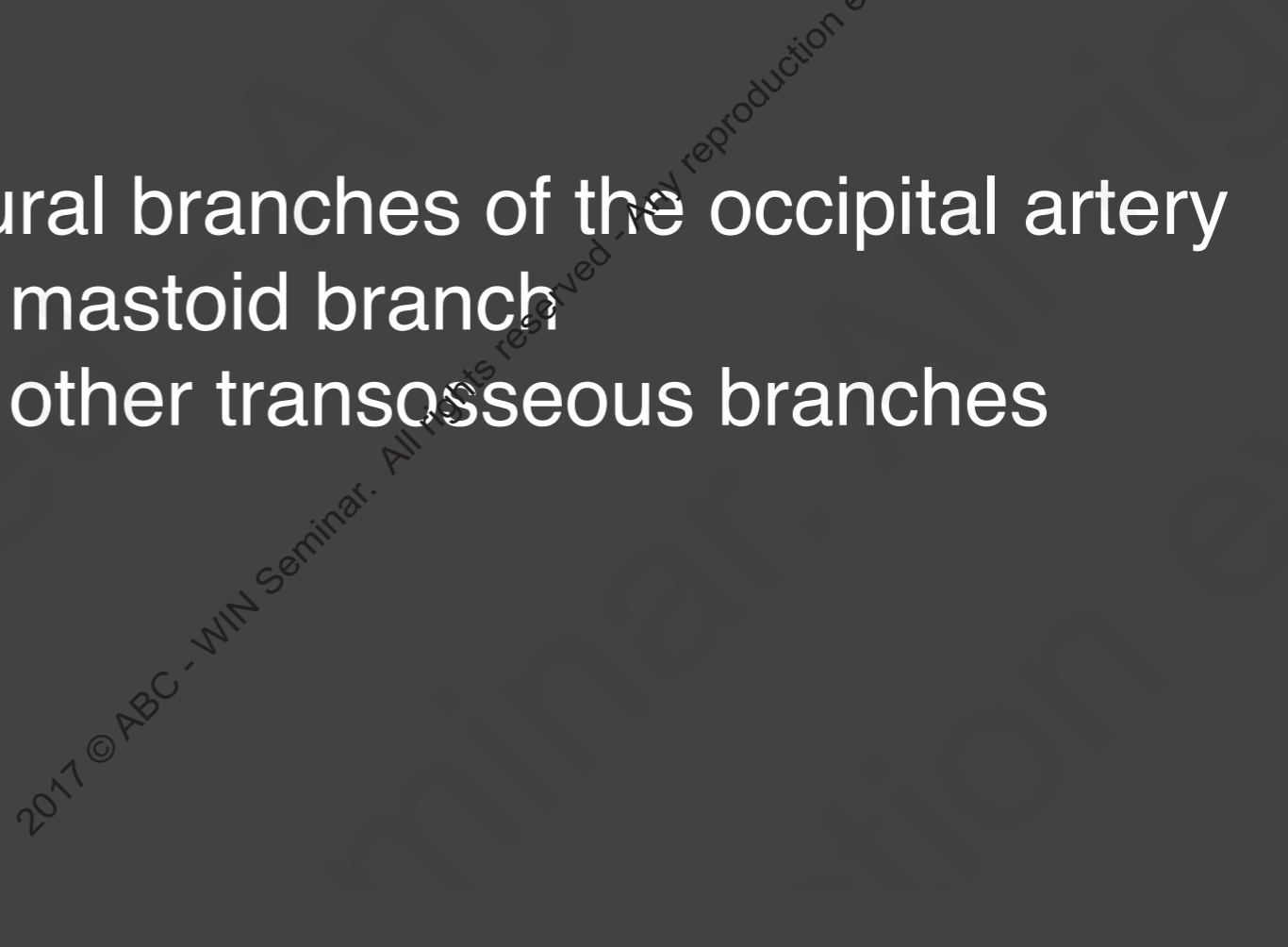
The mastoid branch of the occipital artery

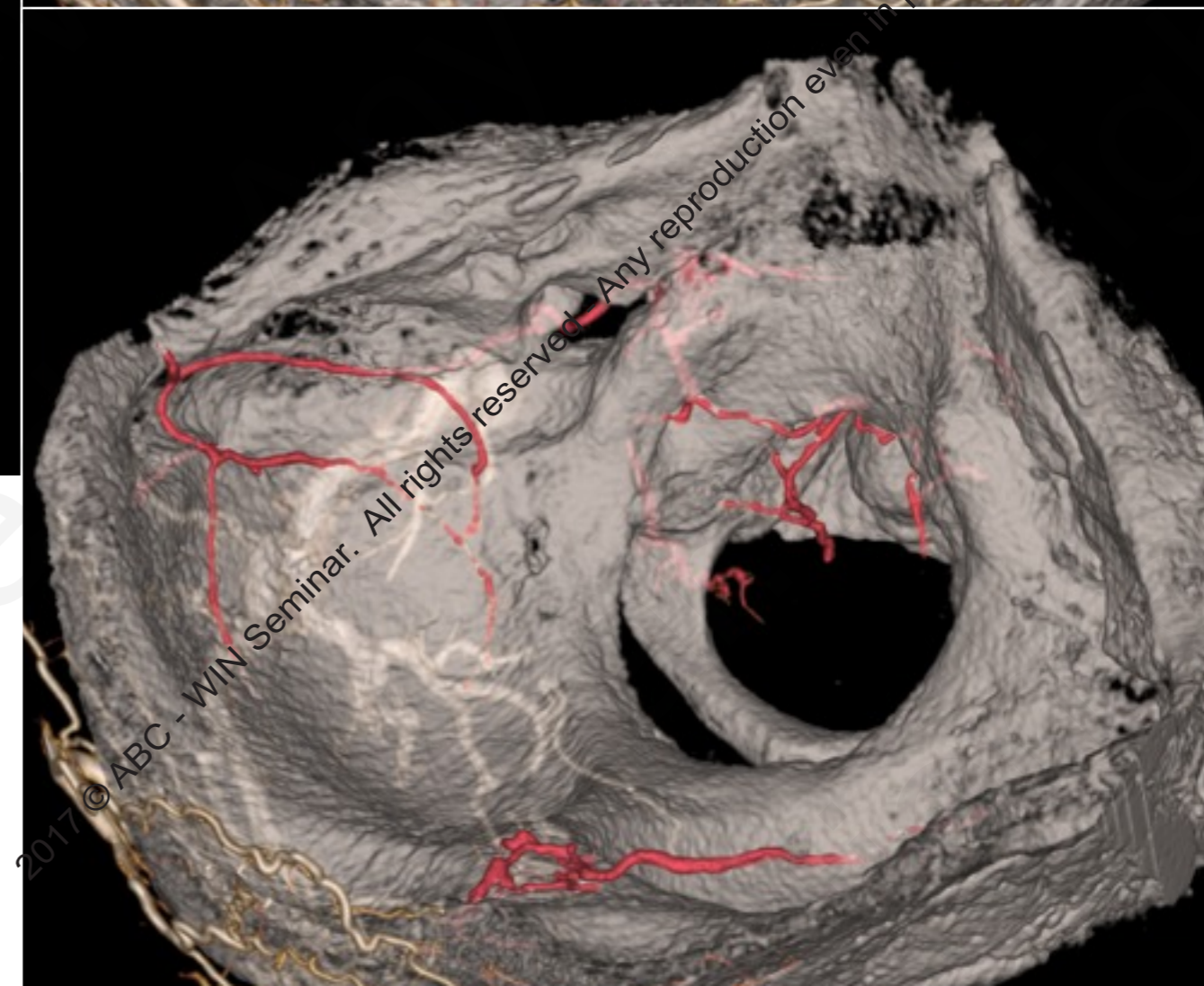
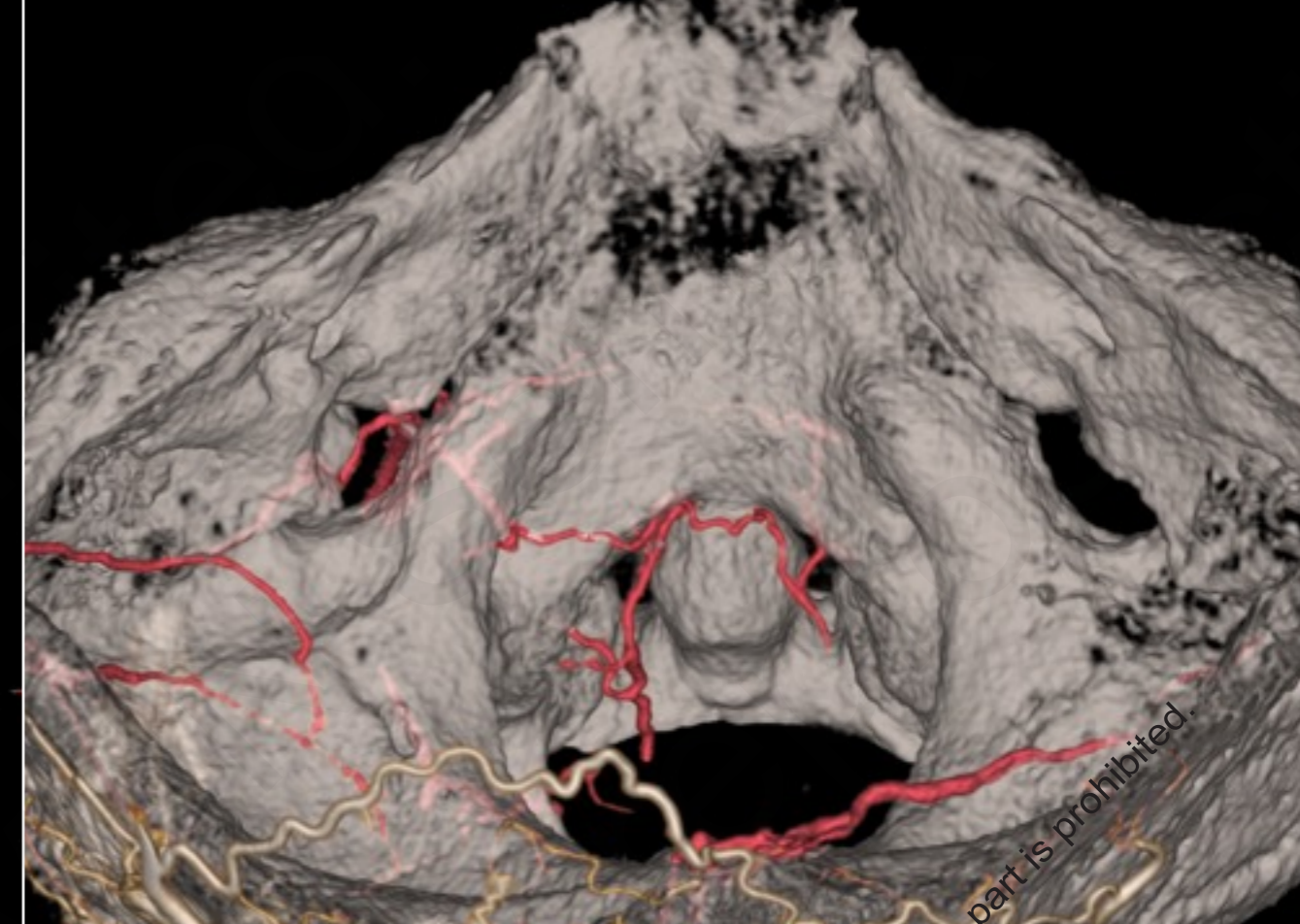




Dural branches of the occipital artery

- mastoid branch
- other transosseous branches





The path and the connections of the mastoid br. to the posterior fossa dural artery system

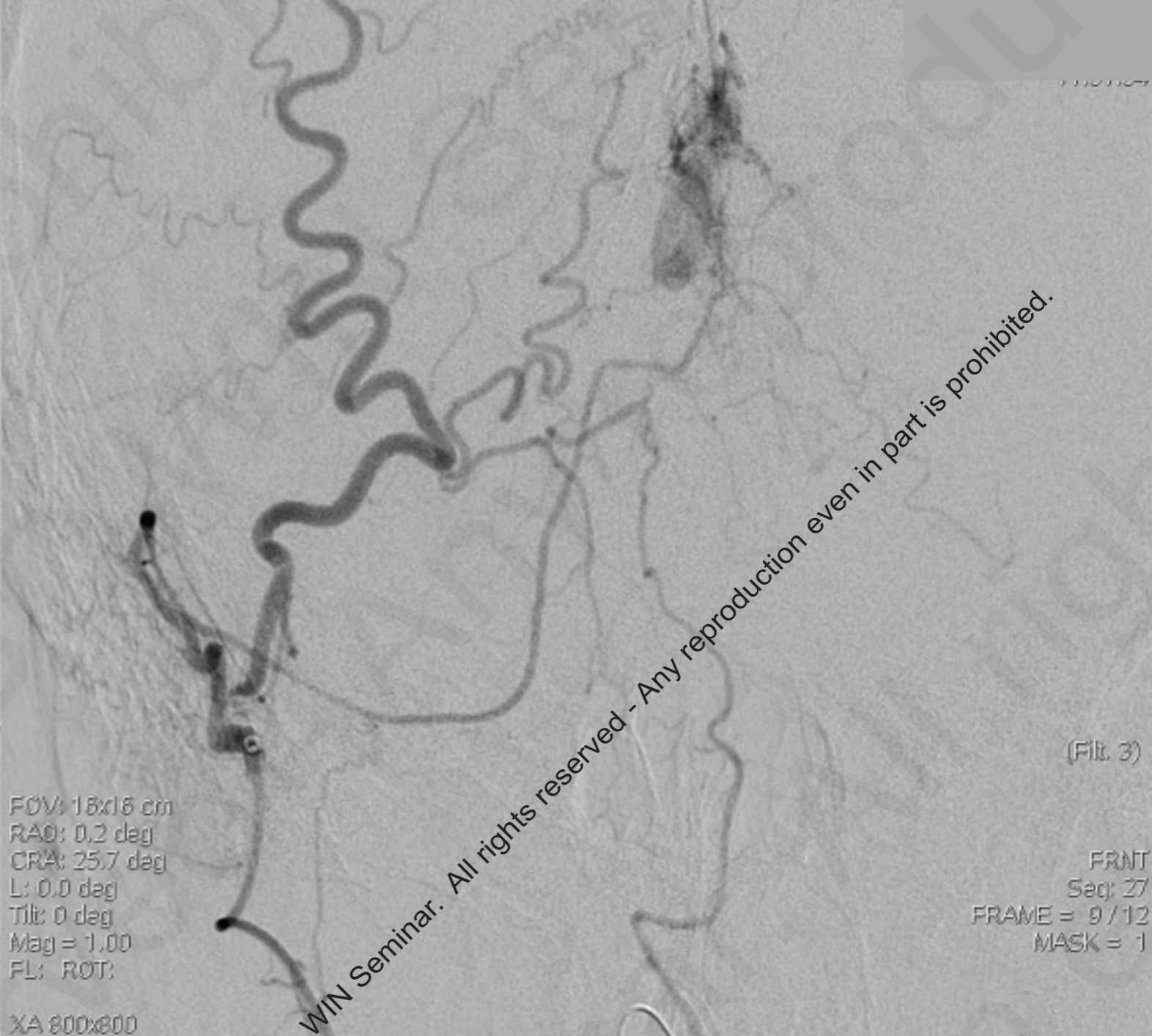
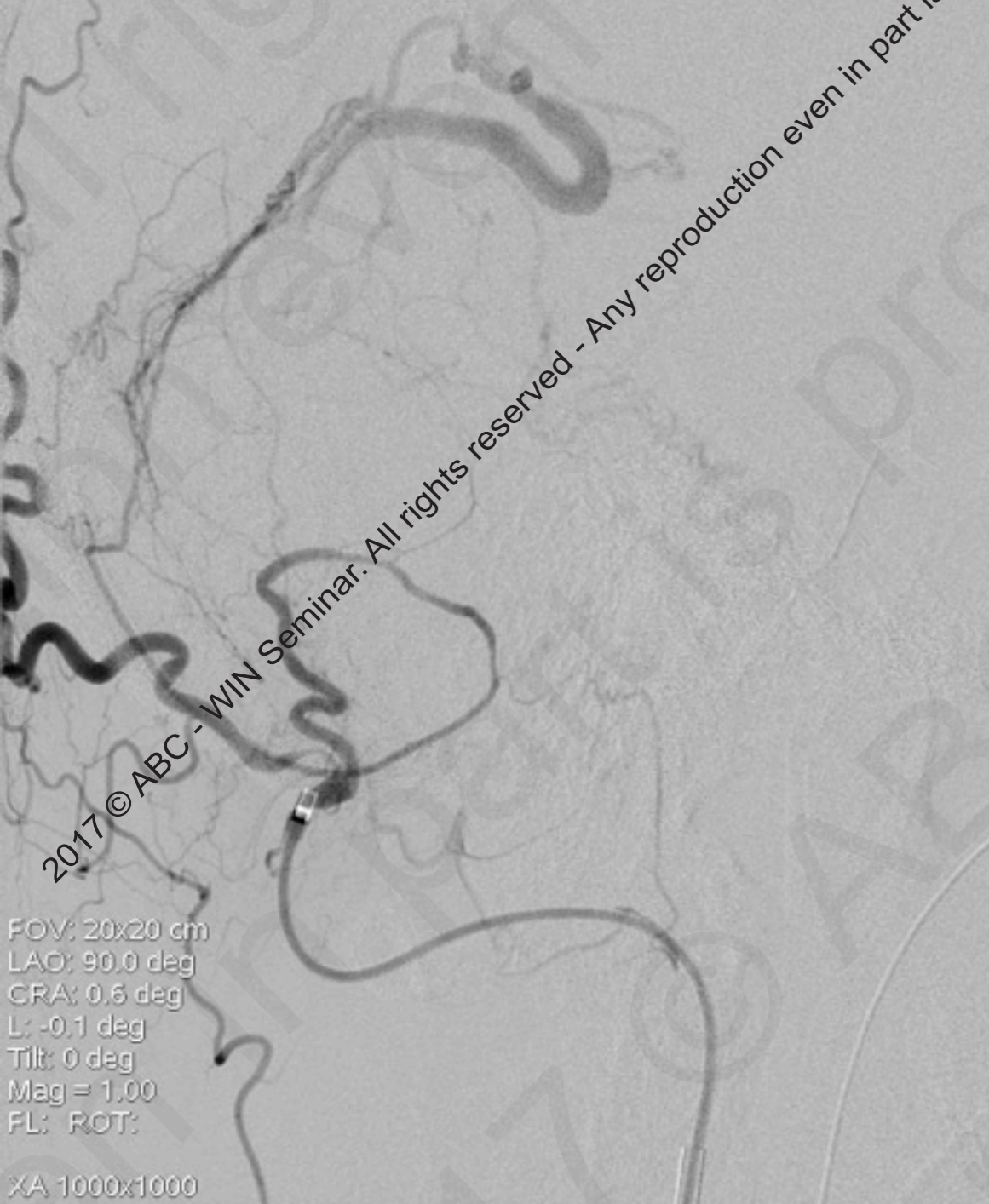
58 M, tentorial dAVF

THE MEDICAL SYSTEMS
kai Univ Hospital



injection from the mastoid branch shows connection to the jugular branch of the ascending pharyngeal artery





FOV: 20x20 cm
LAO: 90.0 deg
CRA: 0.6 deg
L: -0.1 deg
Tilt: 0 deg
Mag = 1.00
FL: ROT:
XA 1000x1000

(Filt. 3)

LAT
Seq: 28
FRAME = 18 / 18
MASK = 1

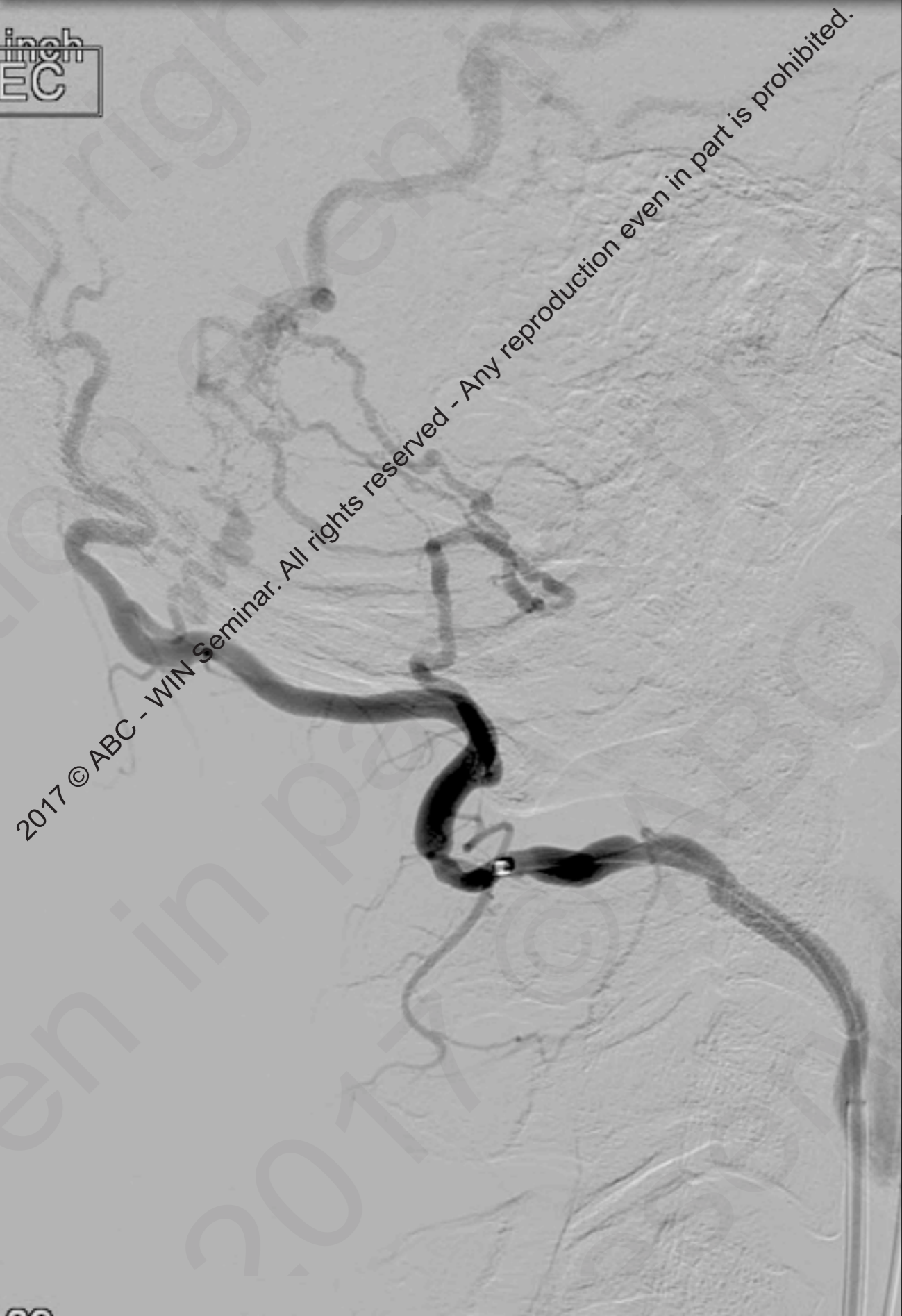
GE MEDICAL SYSTEMS
Tokai Univ Hospital

FOV: 20x20 cm
LAO: 90.0 deg
CRA: 0.6 deg
L: -0.1 deg
Tilt: 0 deg
Mag = 1.00
FL: ROT:

56 M, dAVF of the transverse sinus

superselective angio of the mastoid br.

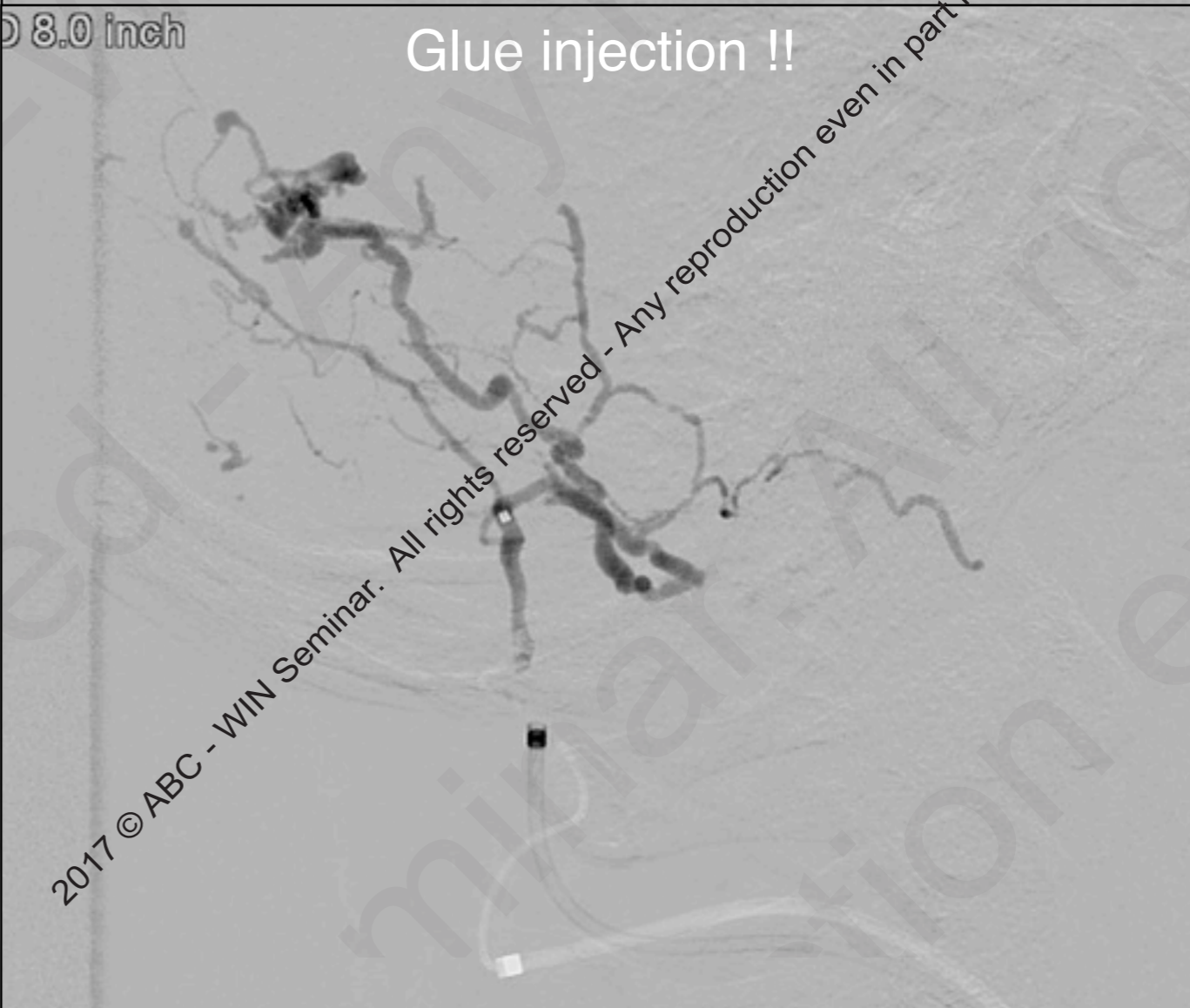
8.0 inch
-EC

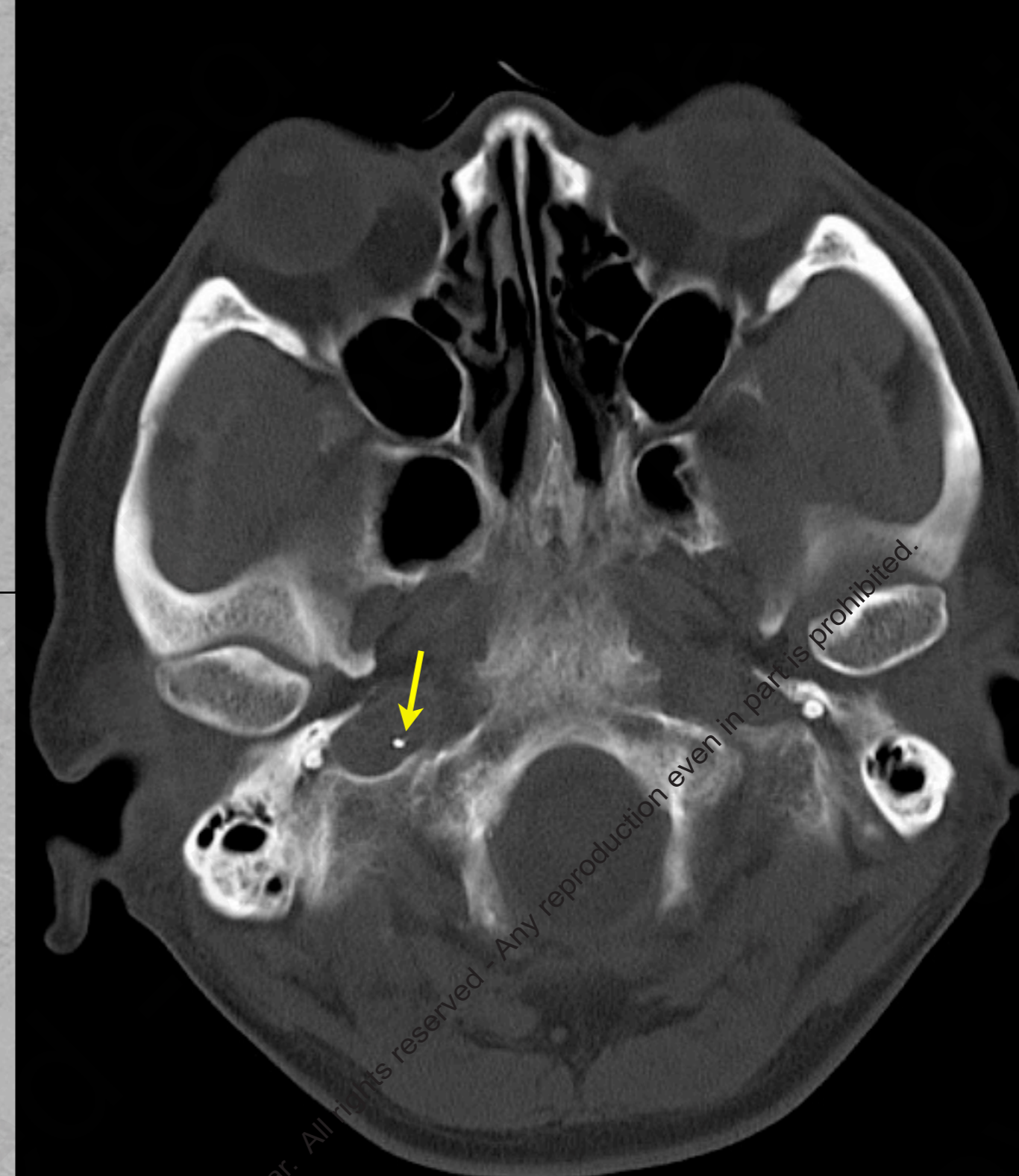
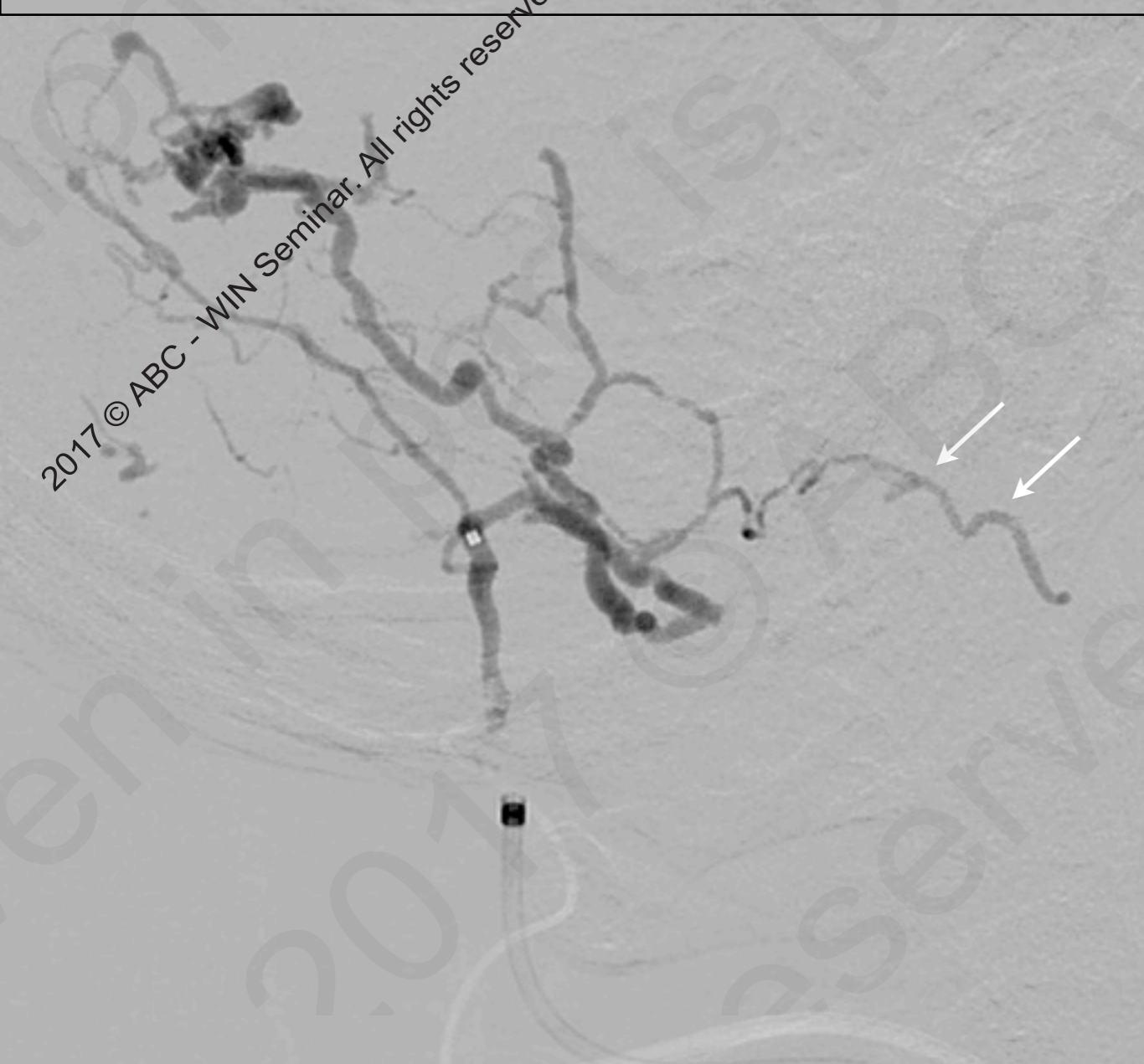
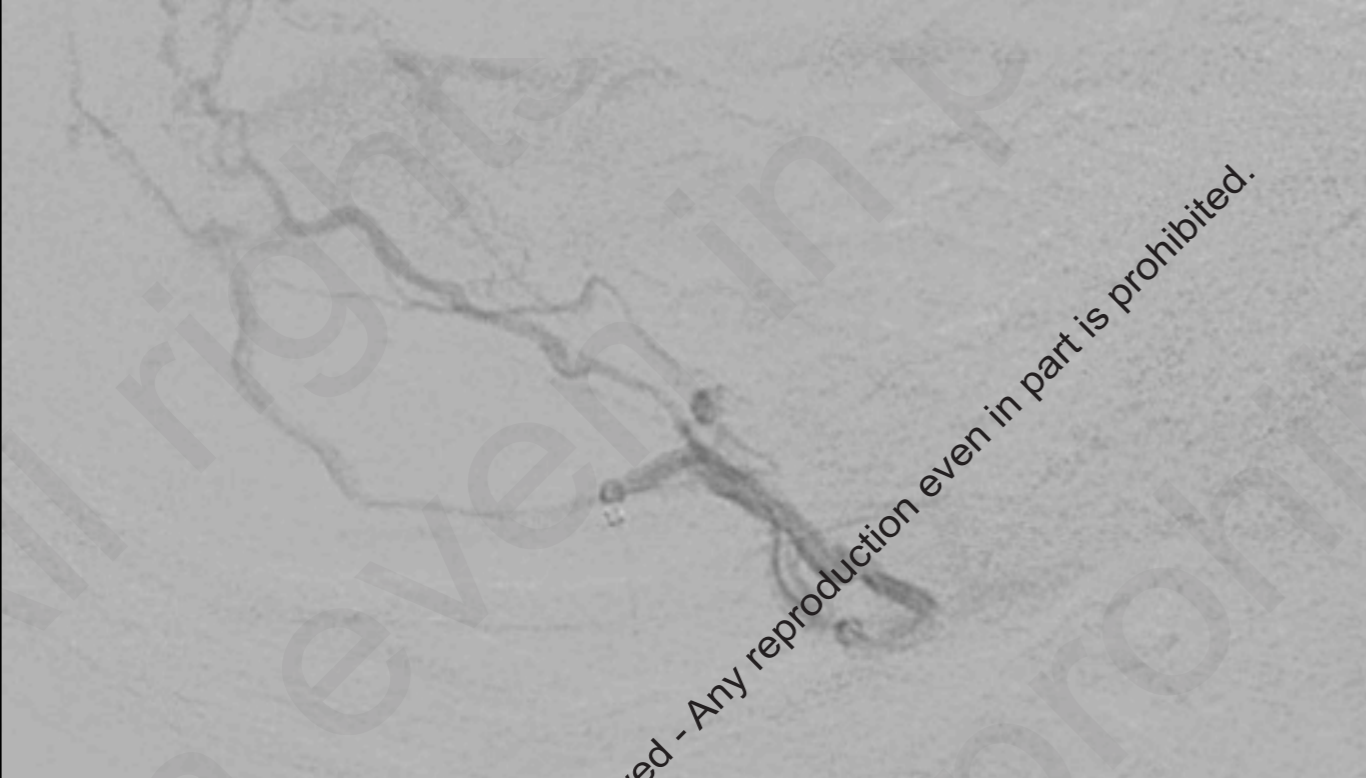


8.0 inch



Glue injection !!

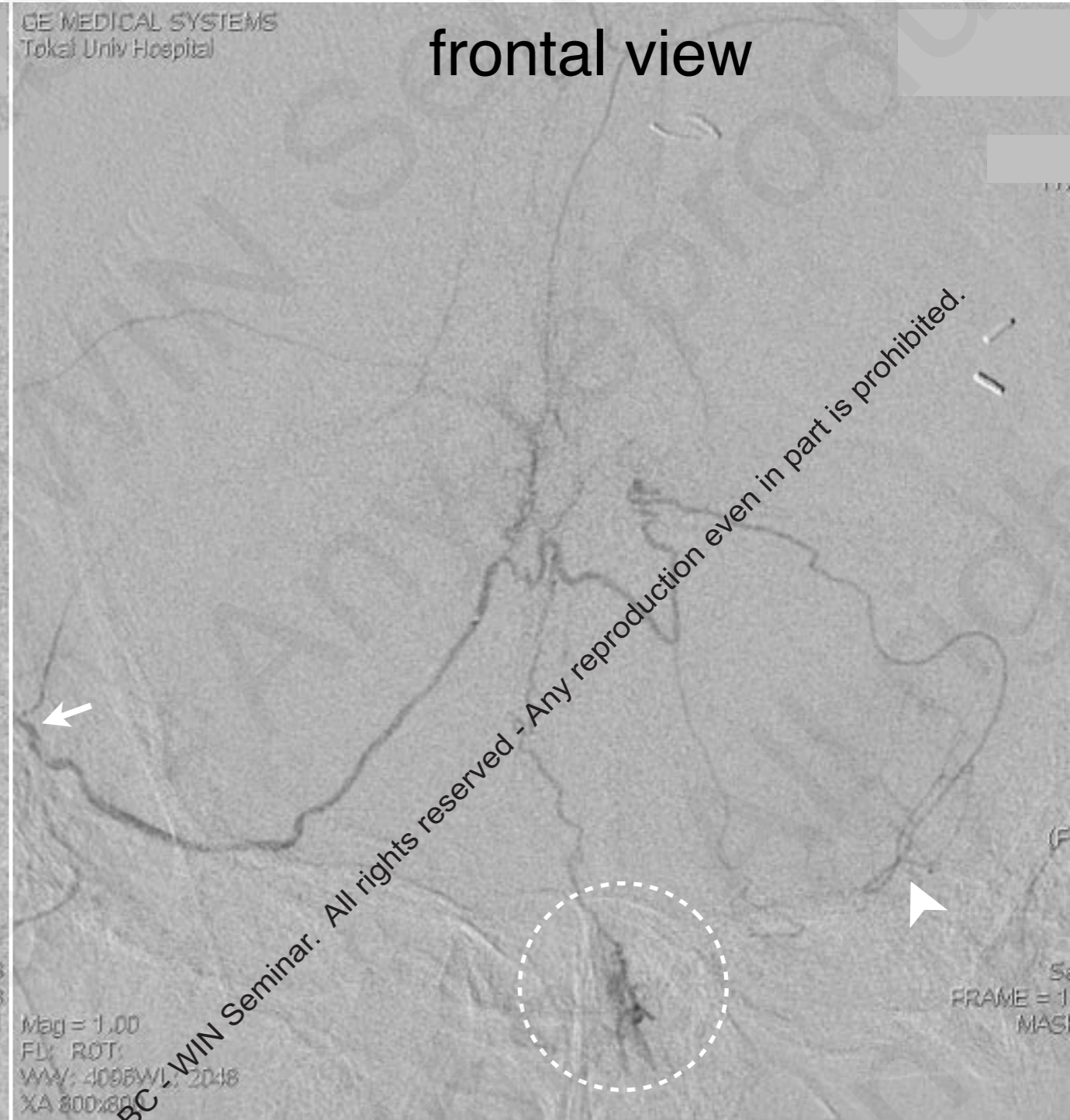


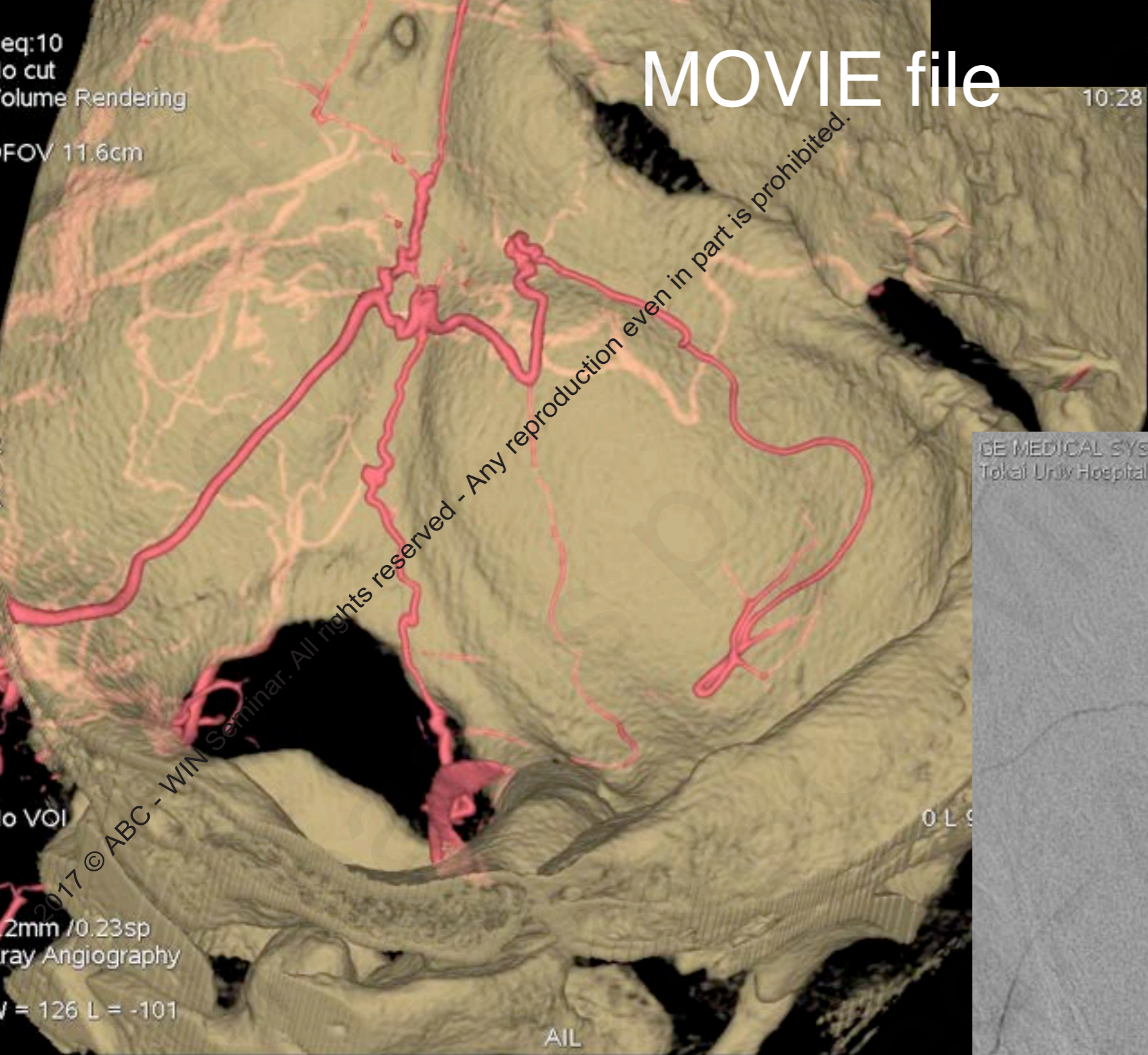


In this case, there was some glue penetration into the jugular branch of OA. The injection was stopped immediately and there was no related symptoms.

60 M, investigated for multiple intracranial shunts

Selective injection of mastoid br of right OA





- connections to the
- VA, AICA
- supratentorial dural br



The posterior meningeal artery can have origins from

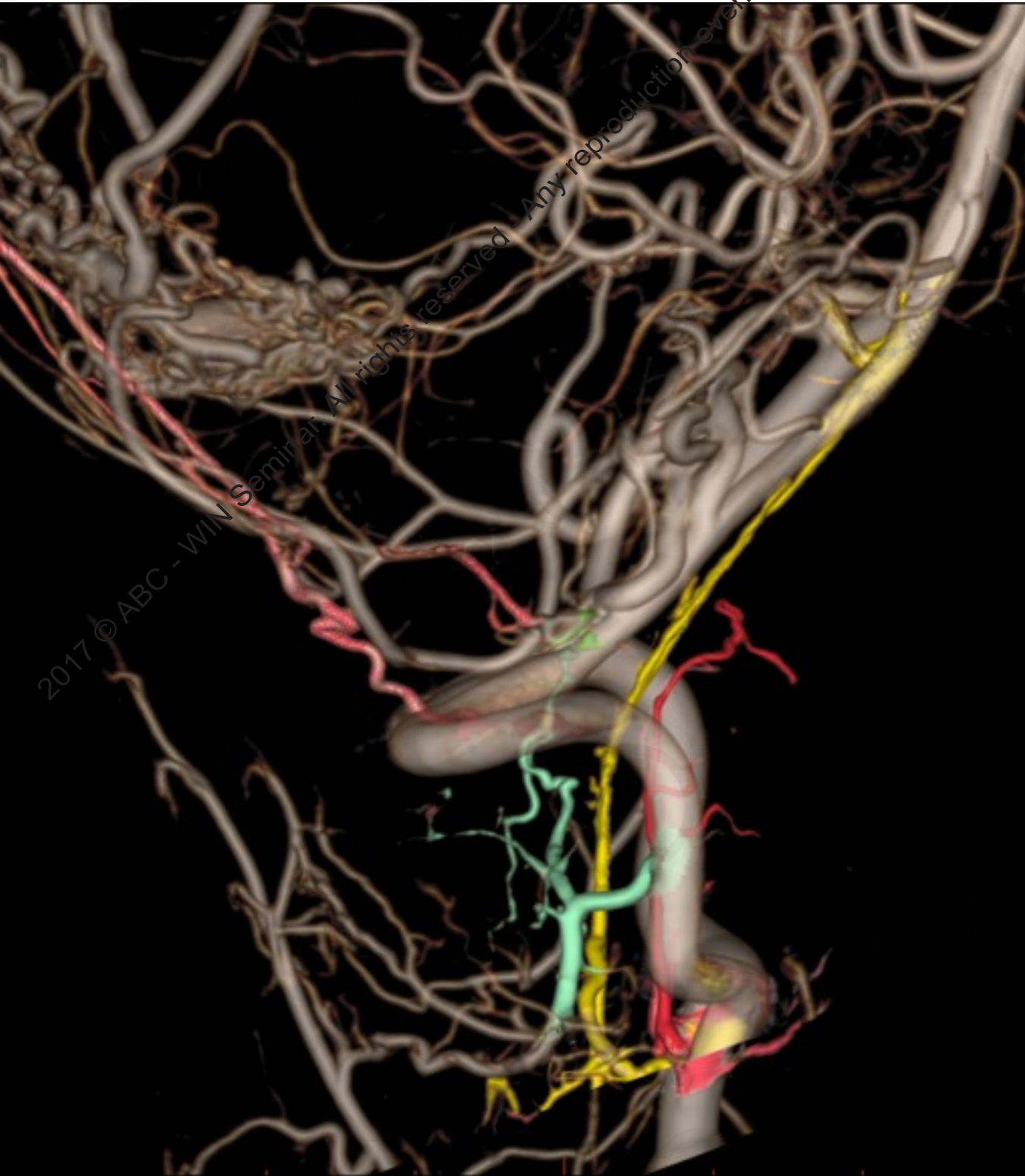
- various parts of the VA (near its entrance to the dura mater)
- PICA
- ascending pharyngeal artery
- mastoid branch of the occipital artery
- the odontoid arterial arcade system

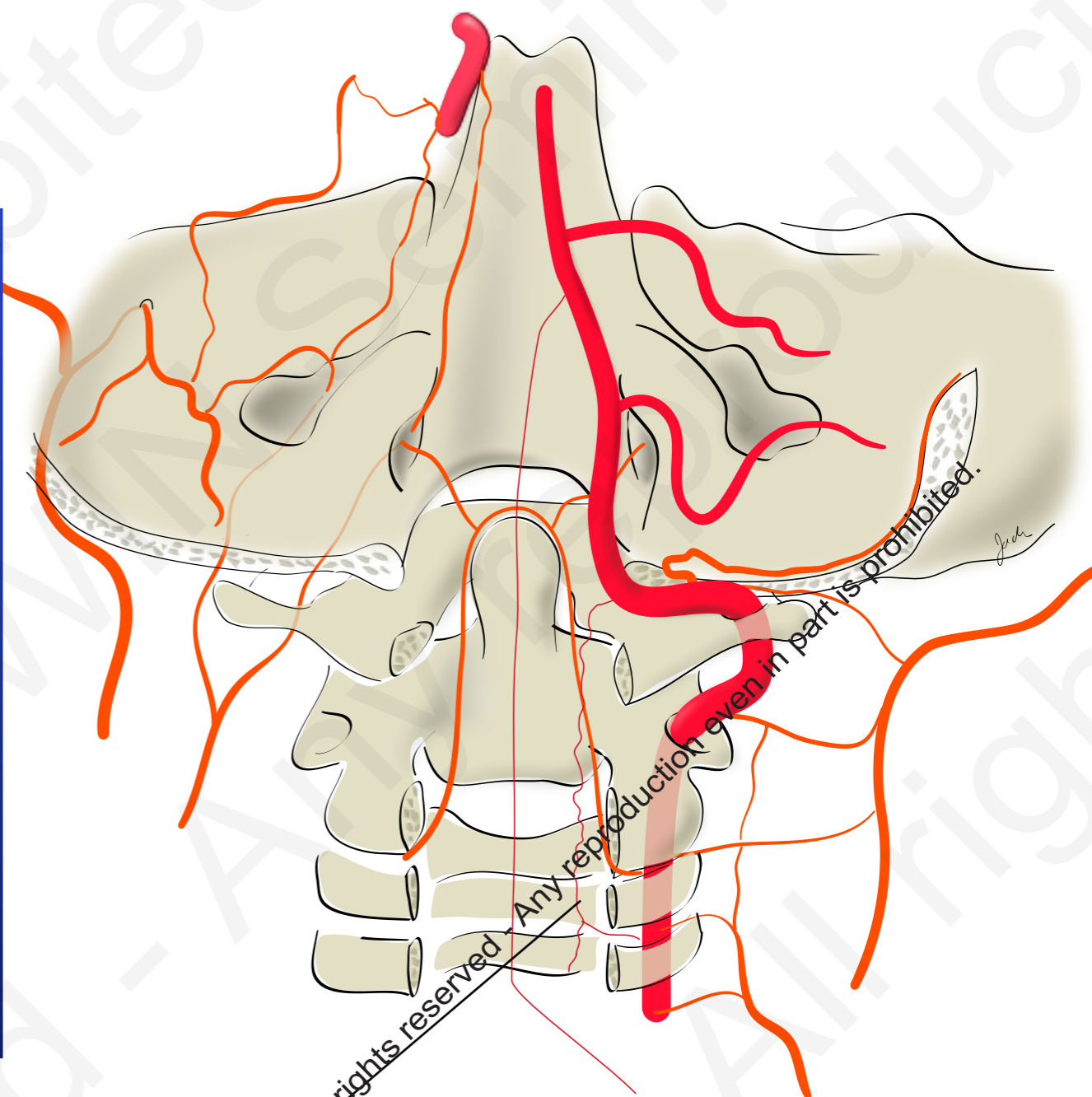
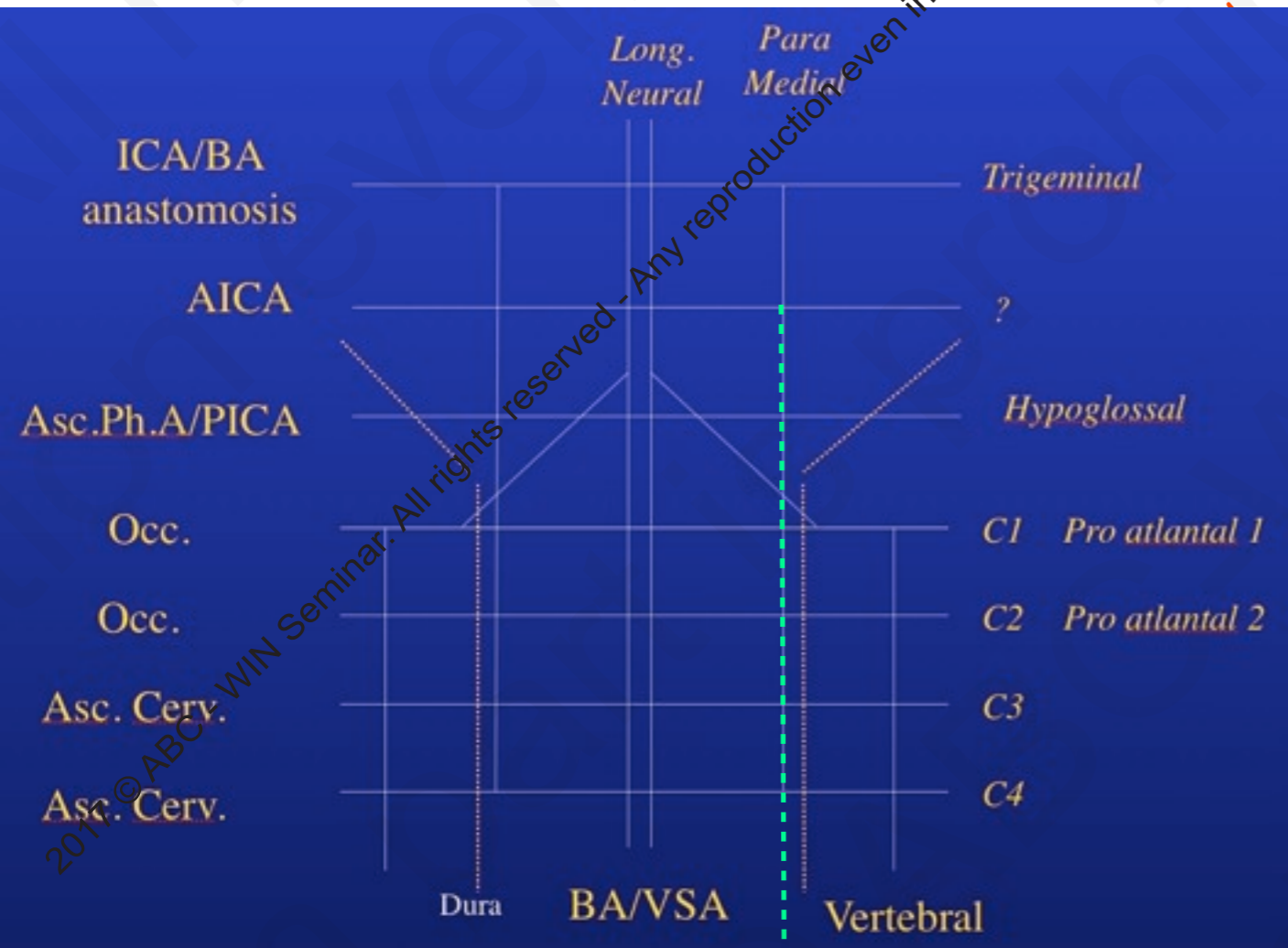
The posterior meningeal artery can have communication with

- all of those mentioned in the left row
- the middle meningeal artery
- the clival branches of the ICA
- AICA

The lateral spinal artery system...

...and the PICA





The lateral spinal artery system is a longitudinal intradural paramedian arterial network. Ventral to the dorsal root, posterior to the dentate ligament, along the accessory nerve. The PICA can be part of this system.

Visualization of lateral spinal artery system in normal anatomy is not easy



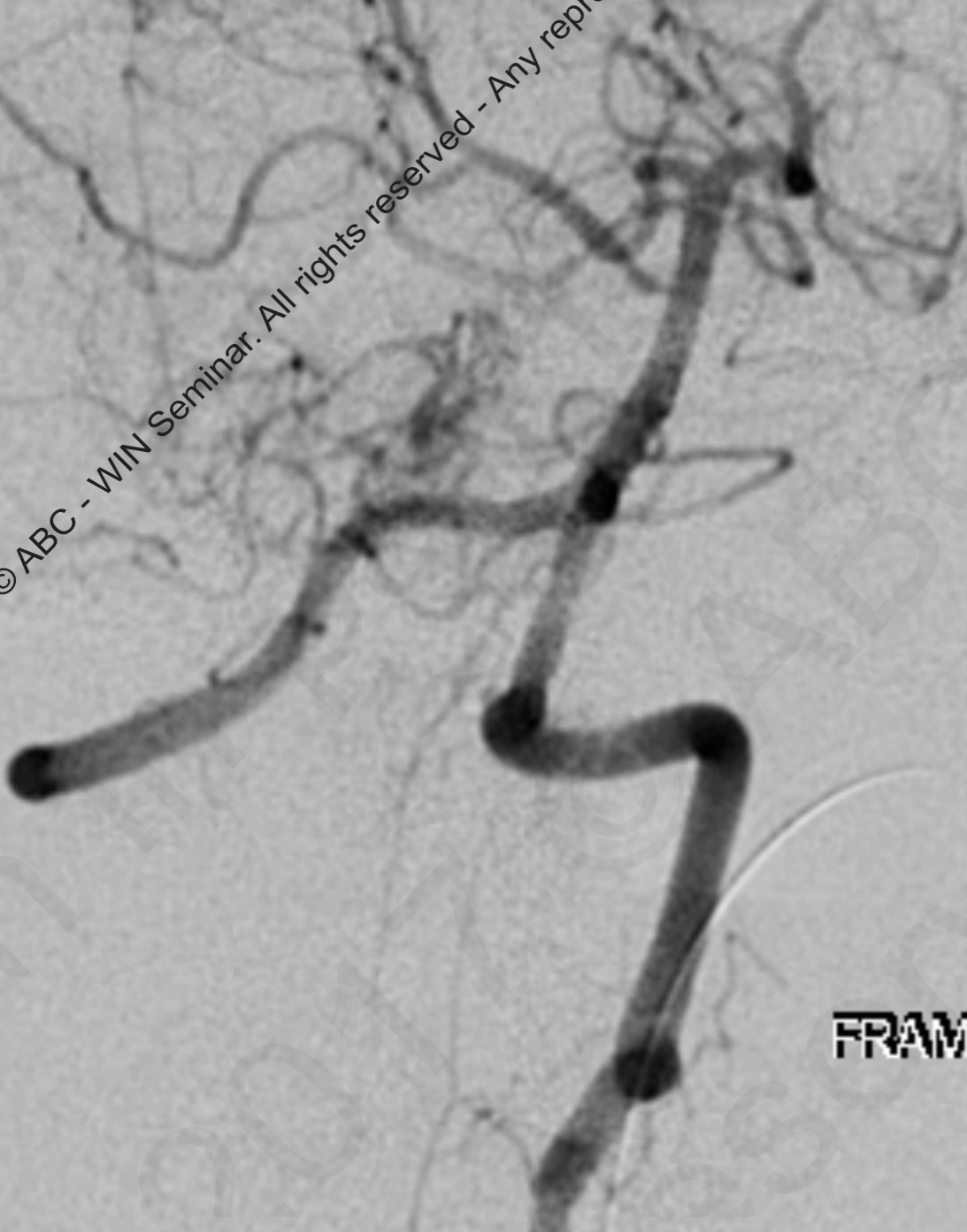
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11 F, cerebellar AVM with hemorrhage



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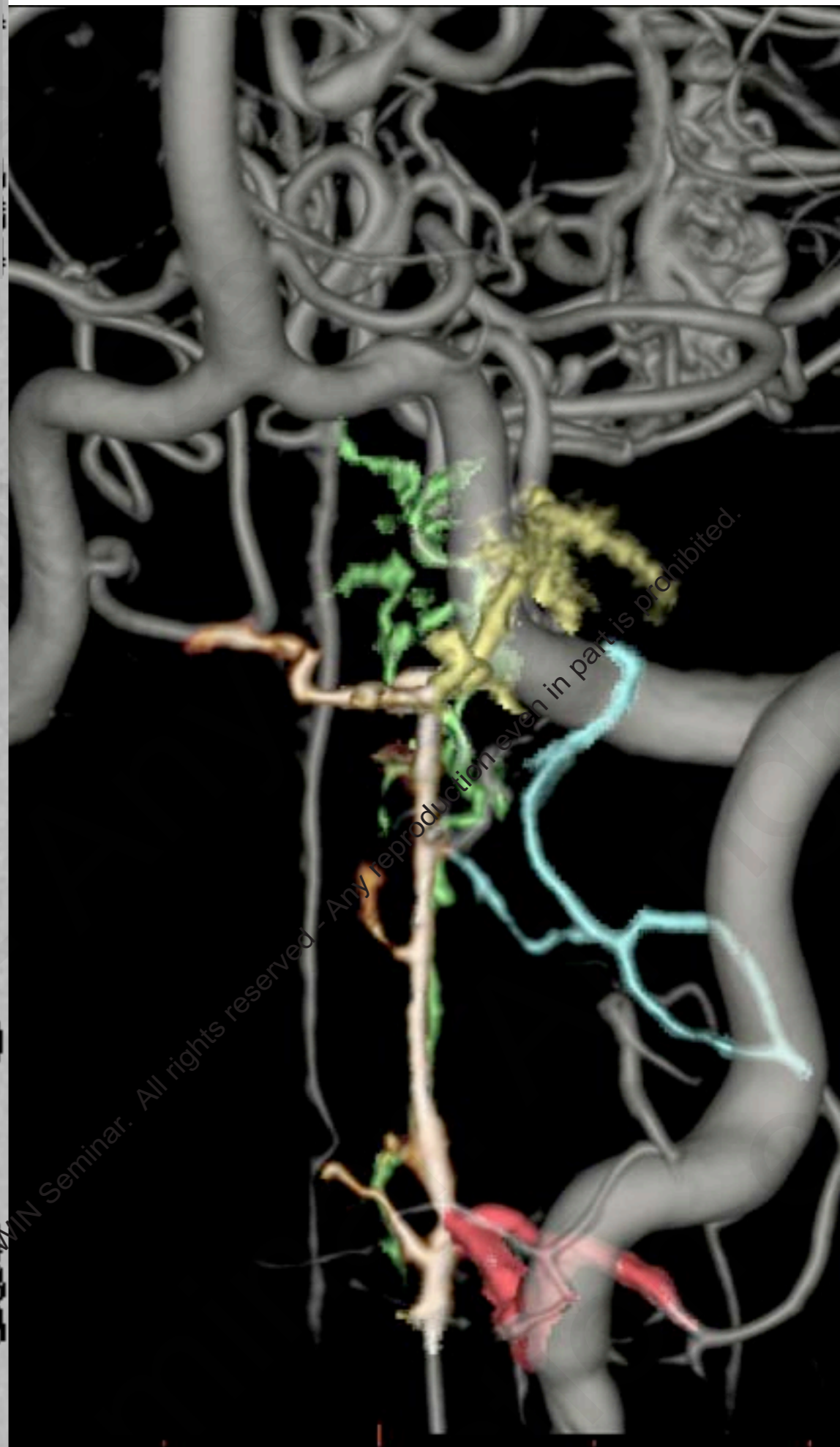


(File 6)

Seq 4
FRAME = 327 / 488
MASK = 83

2017

48



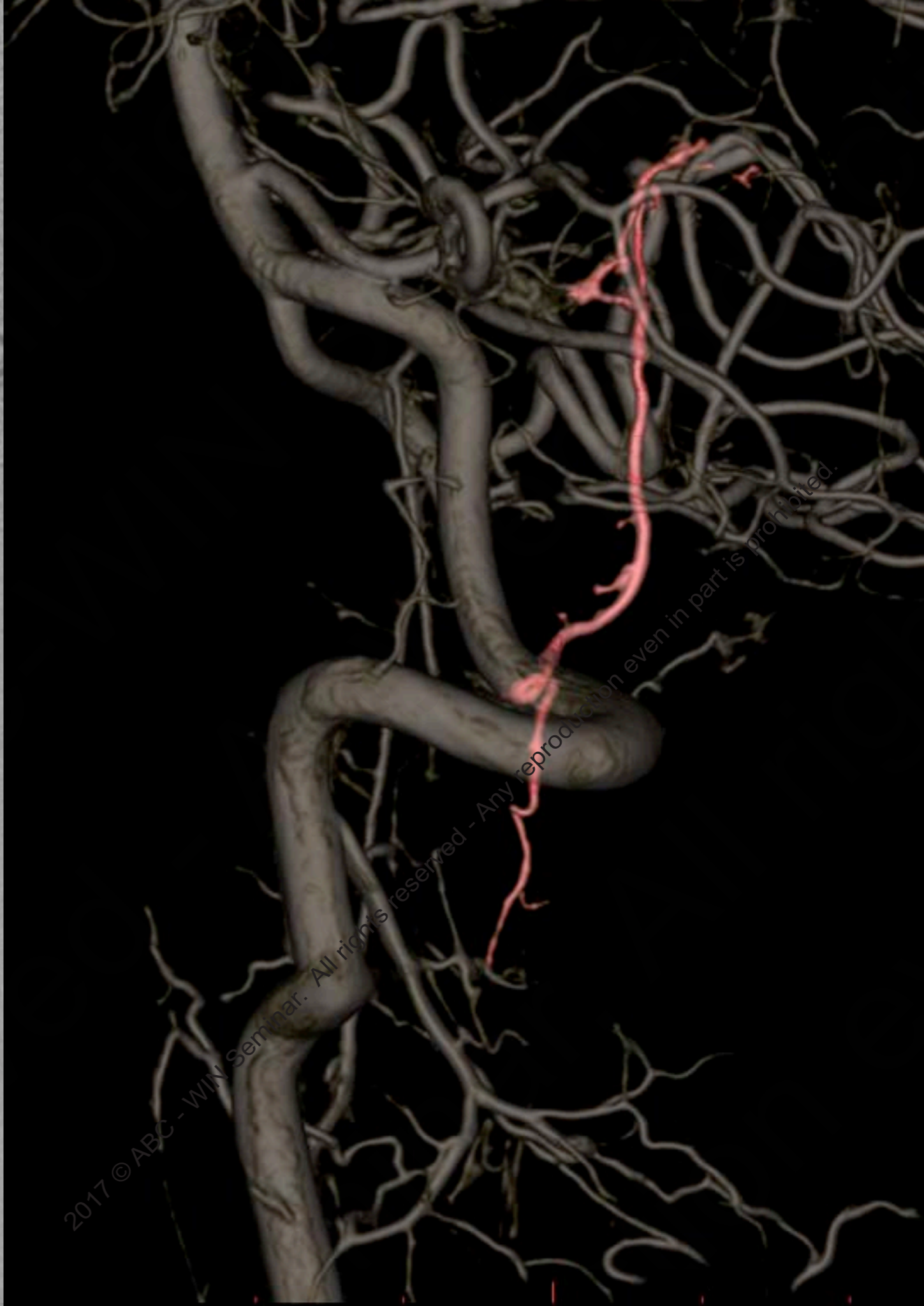
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32 M, tympanic paraganglioma





2155



anterior view



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posterior view



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“lateral spinal artery” originating from the C1 segment
The ascending branch supplies the choroid plexus of the 4th ventricle.



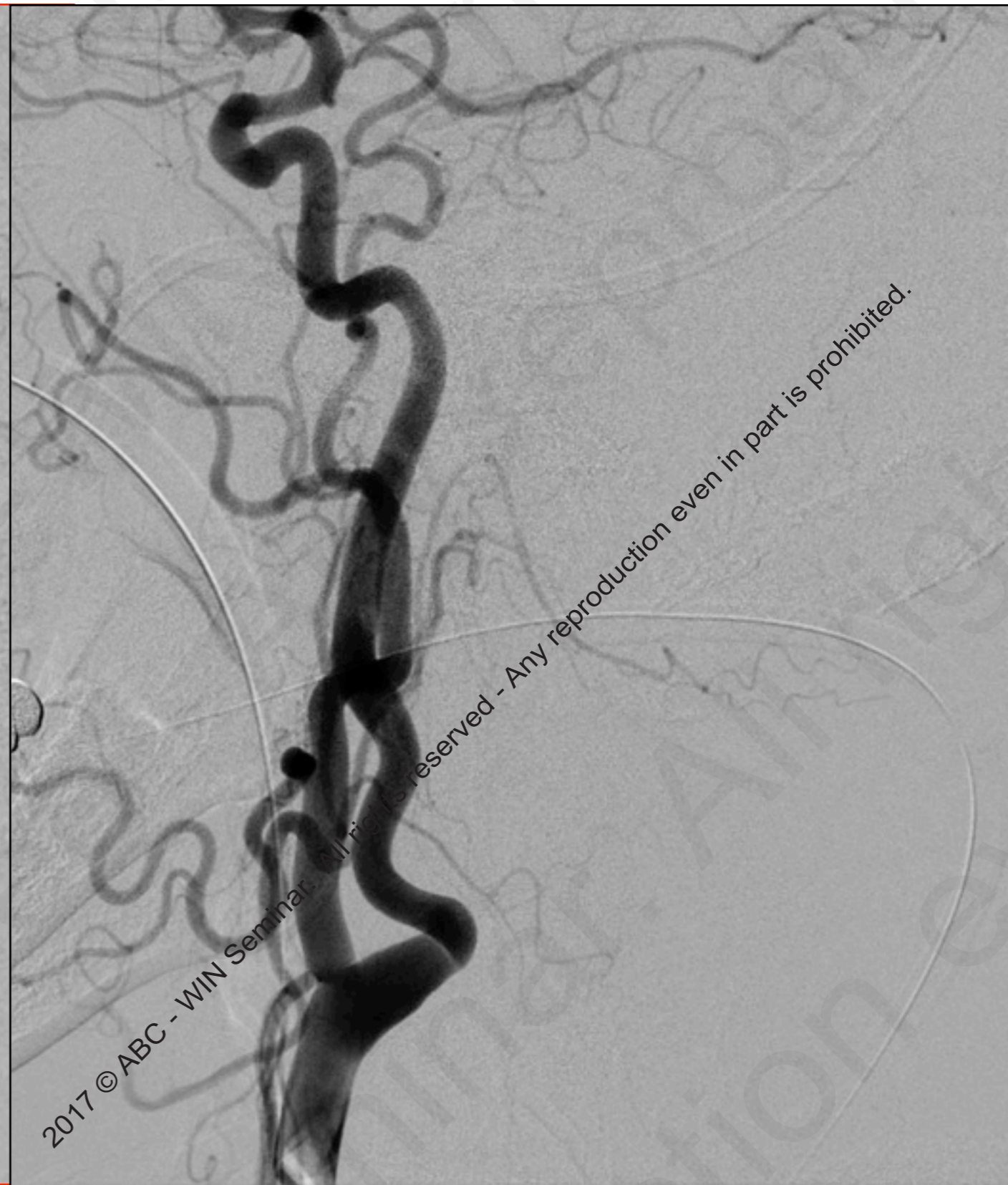
2017

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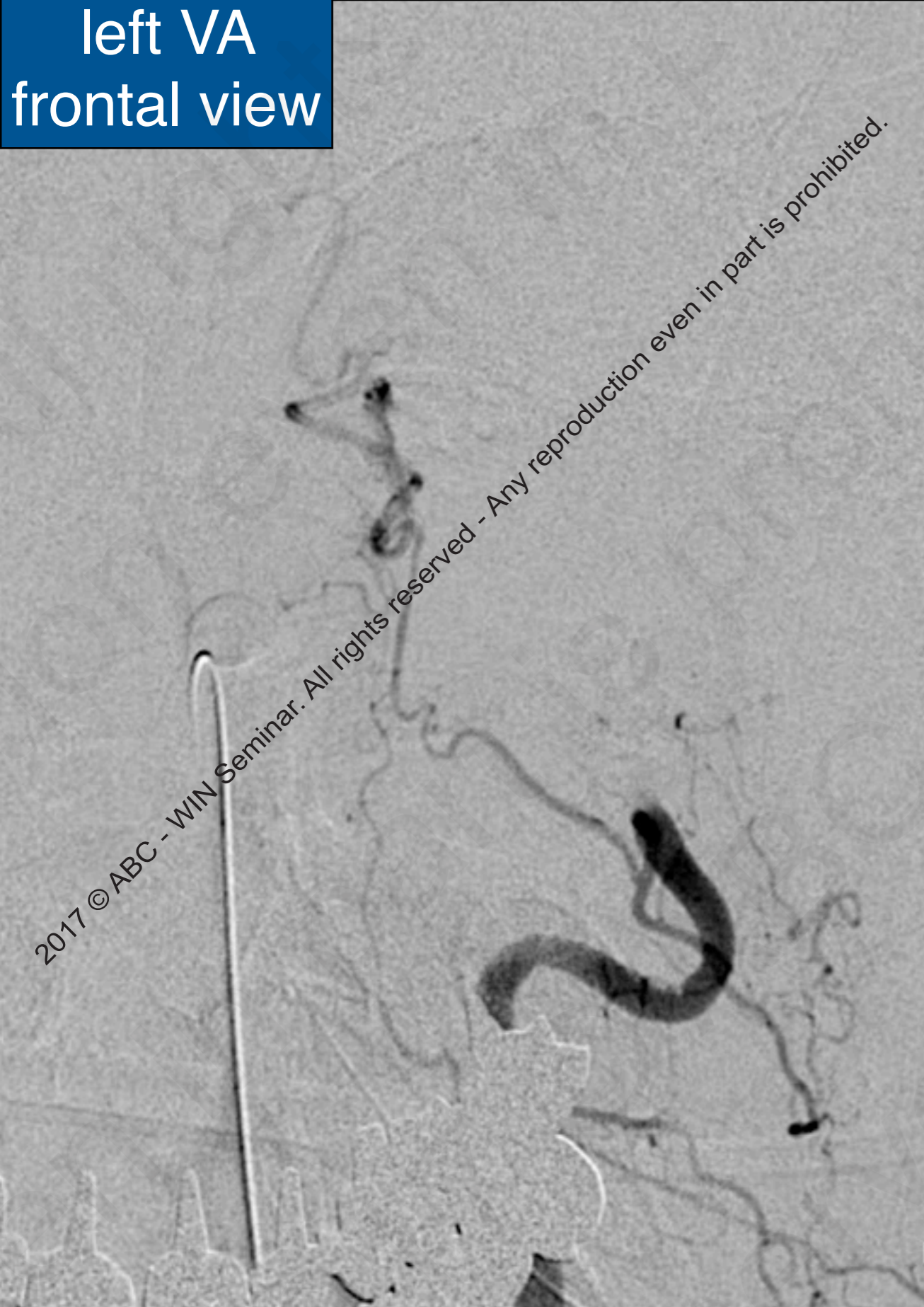
42 M, left VA dissection(SAH)



Trapping of the dissected part(with the PICA) with OA-PICA bypass was done. But the bypass artery has occluded.



left VA
frontal view

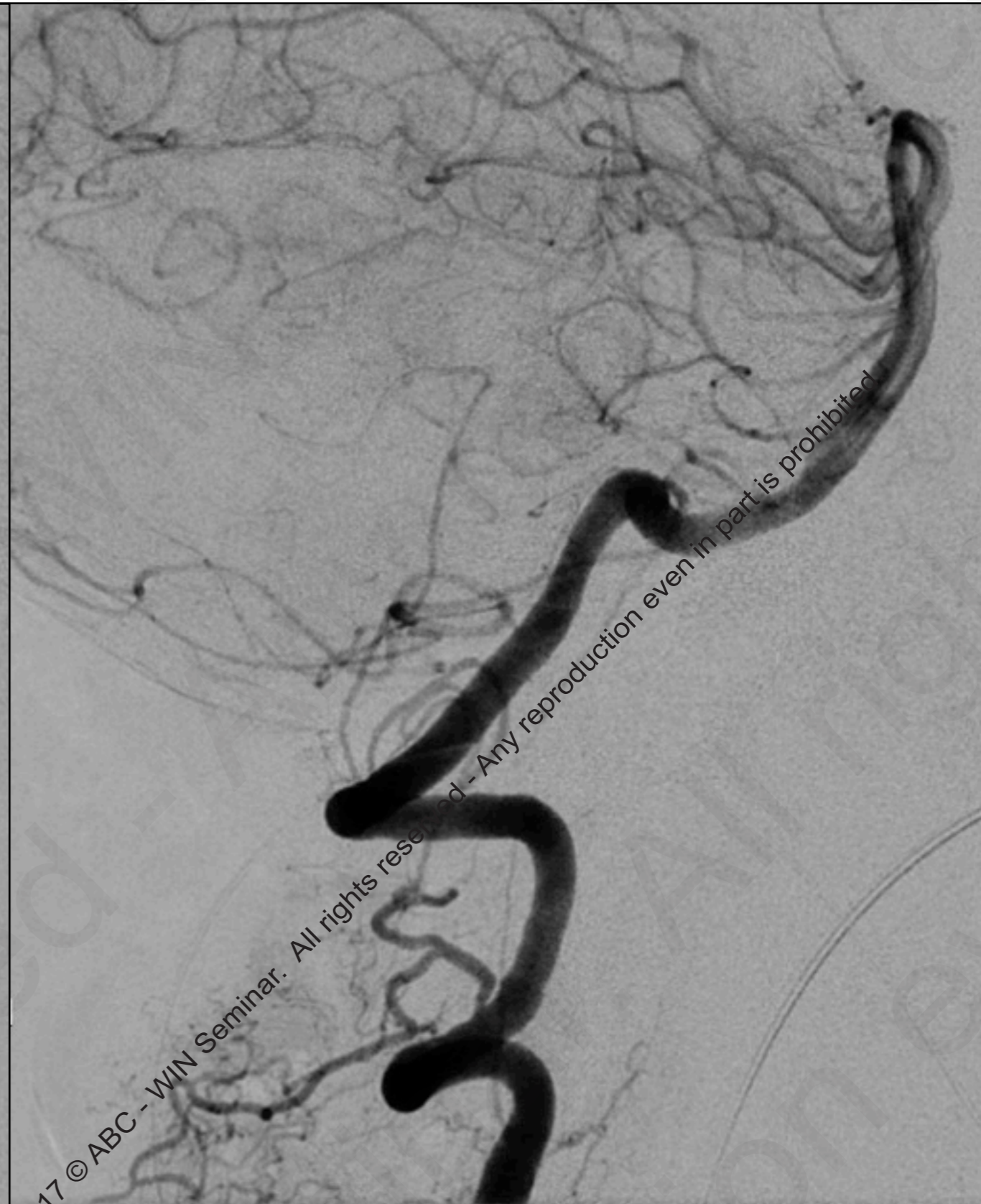


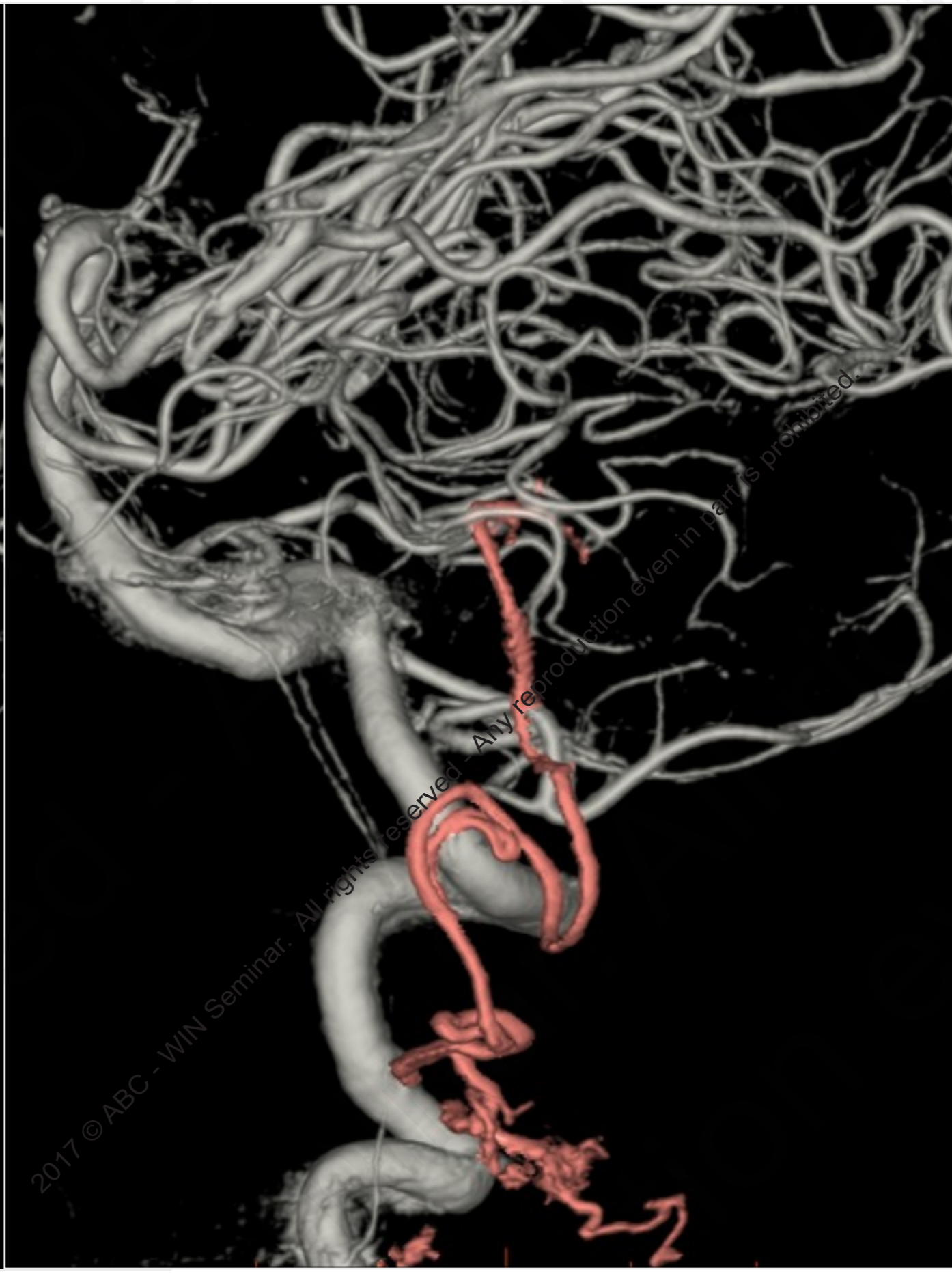
left VA
lateral view



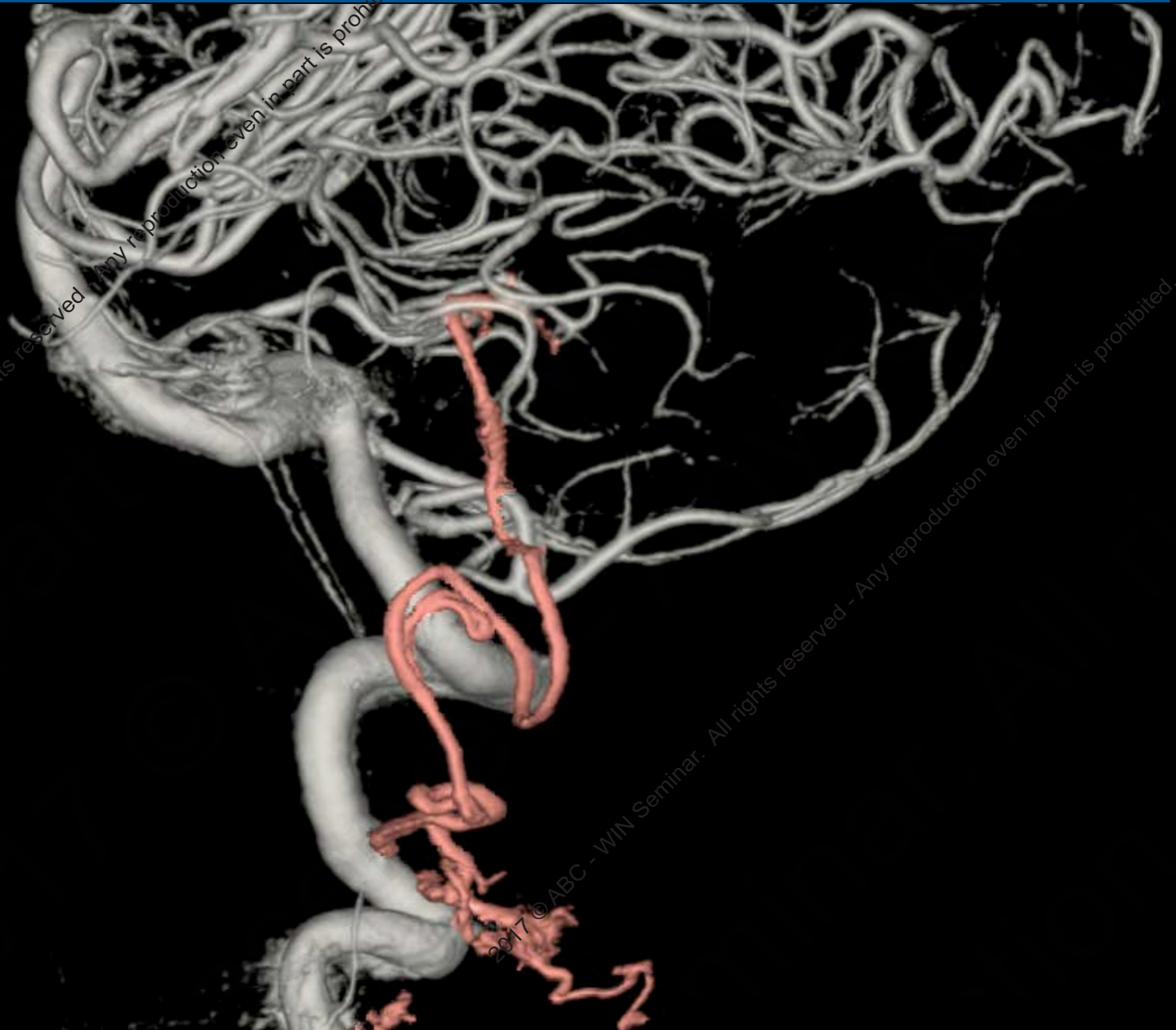
At the follow up angiogram, the PICA is reconstructed through the connection with the lateral spinal artery arising from C2 segment

62 F, left intracranial VA dissection





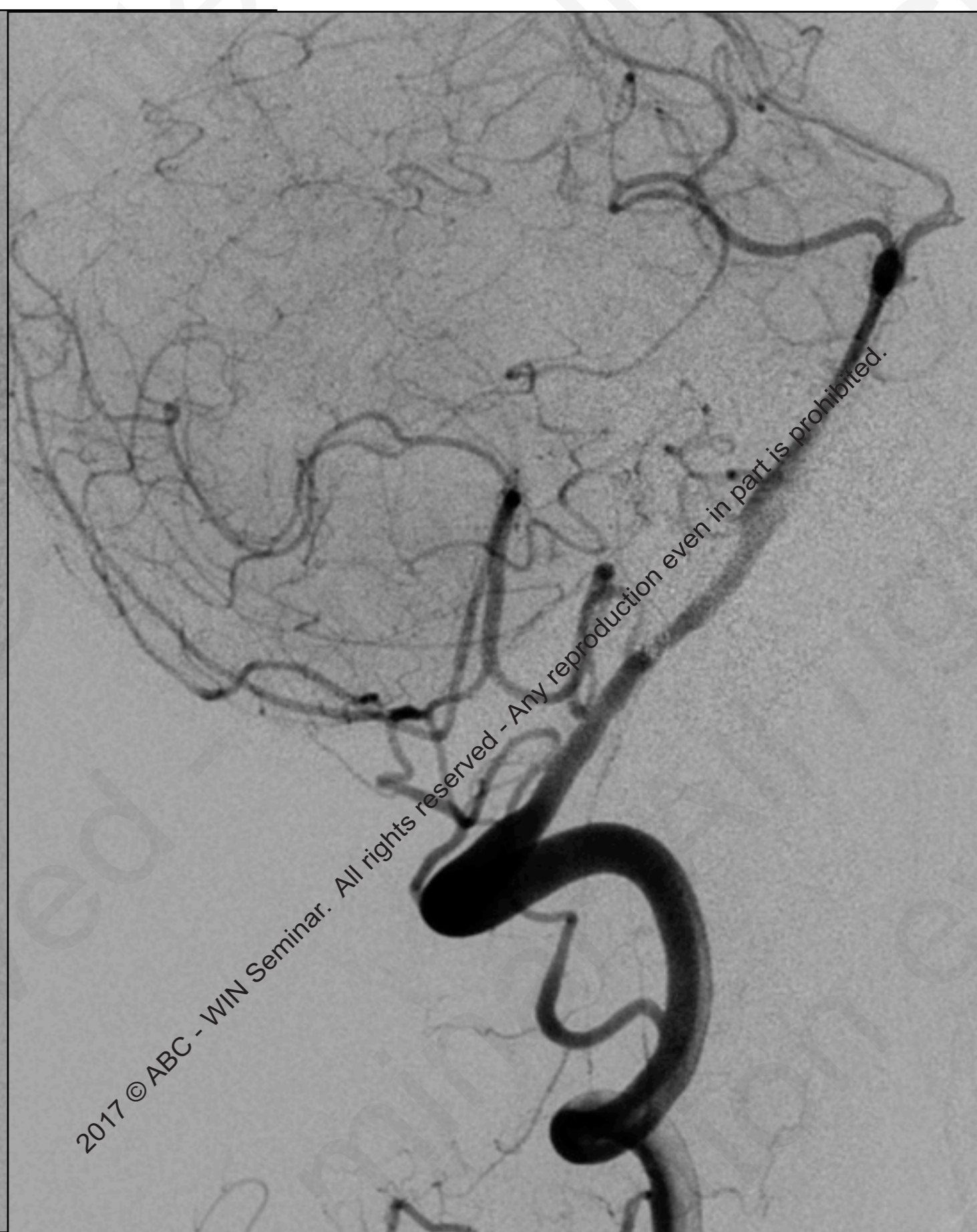
“lateral spinal artery” originating from the C2 segment giving out a branch functioning as part of the PICA.



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61 F, right VA-PICA aneurysm



“lateral spinal artery” as a “C2 PICA”.

Volume Rendering No cut

DFOV11.8cm

A
4
9

P
8
4

Gantry OFF

No VOI

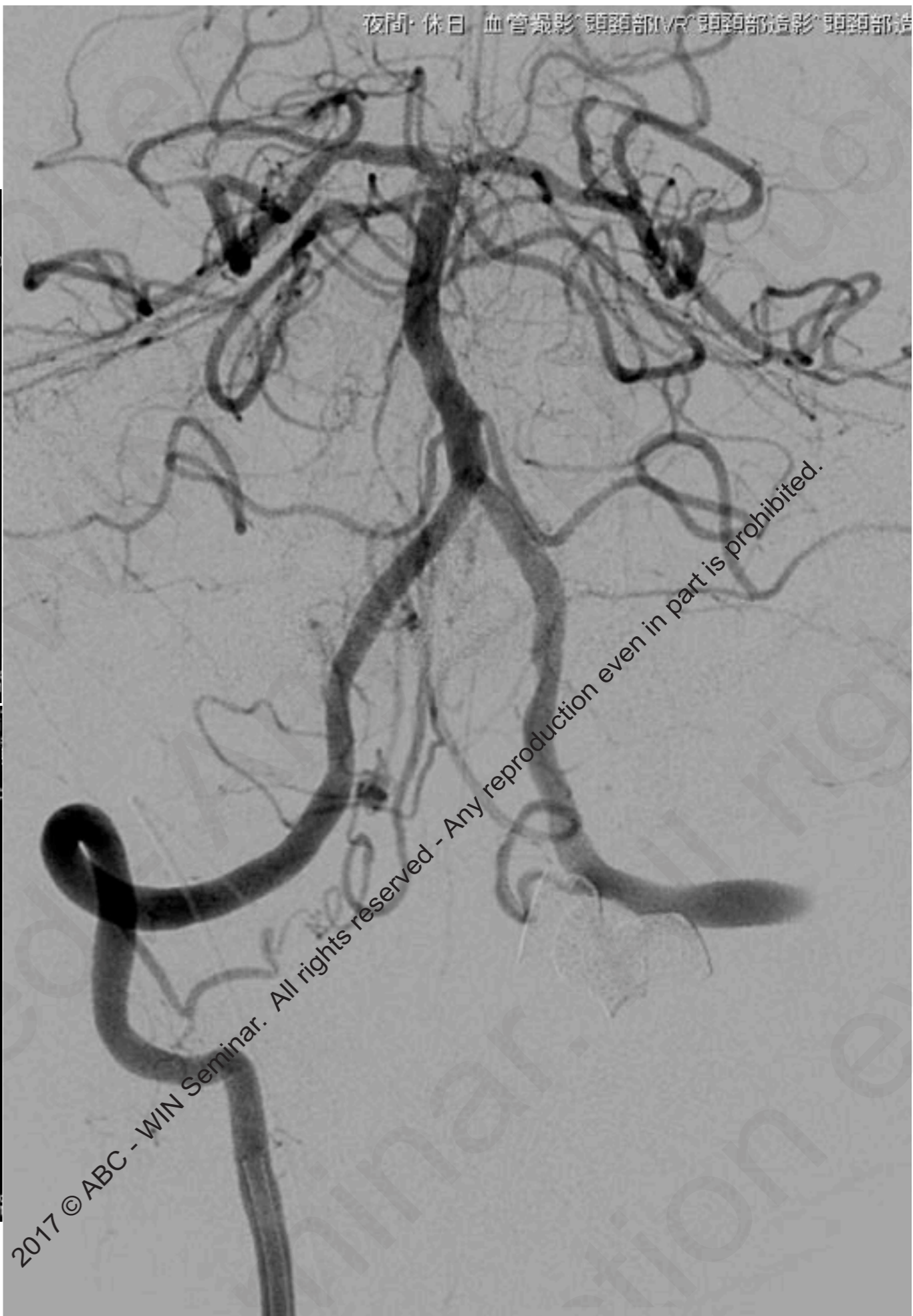
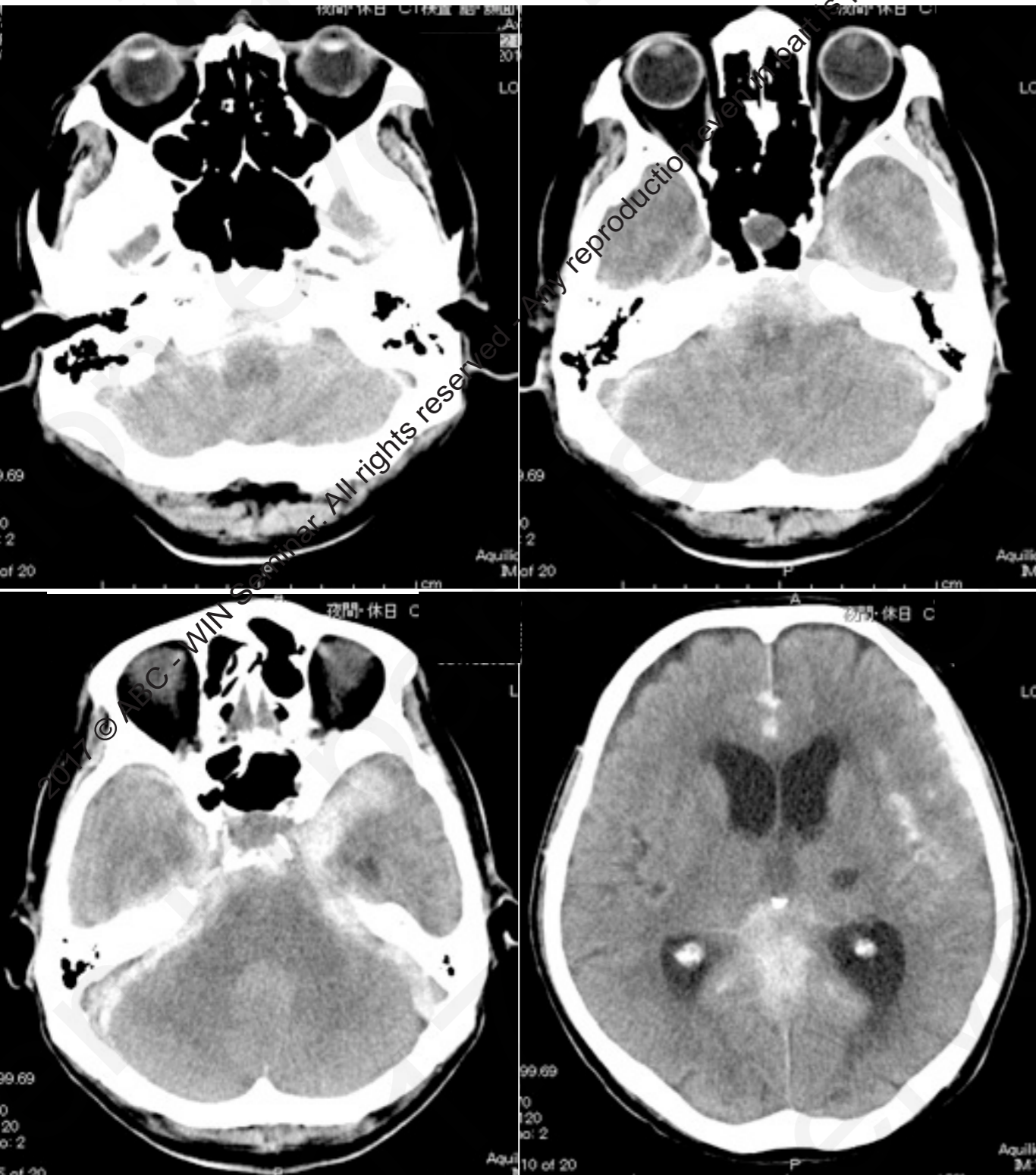
0 L90LAO0CRA



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81 M, SAH



Rot: -55°
Ang: -2°

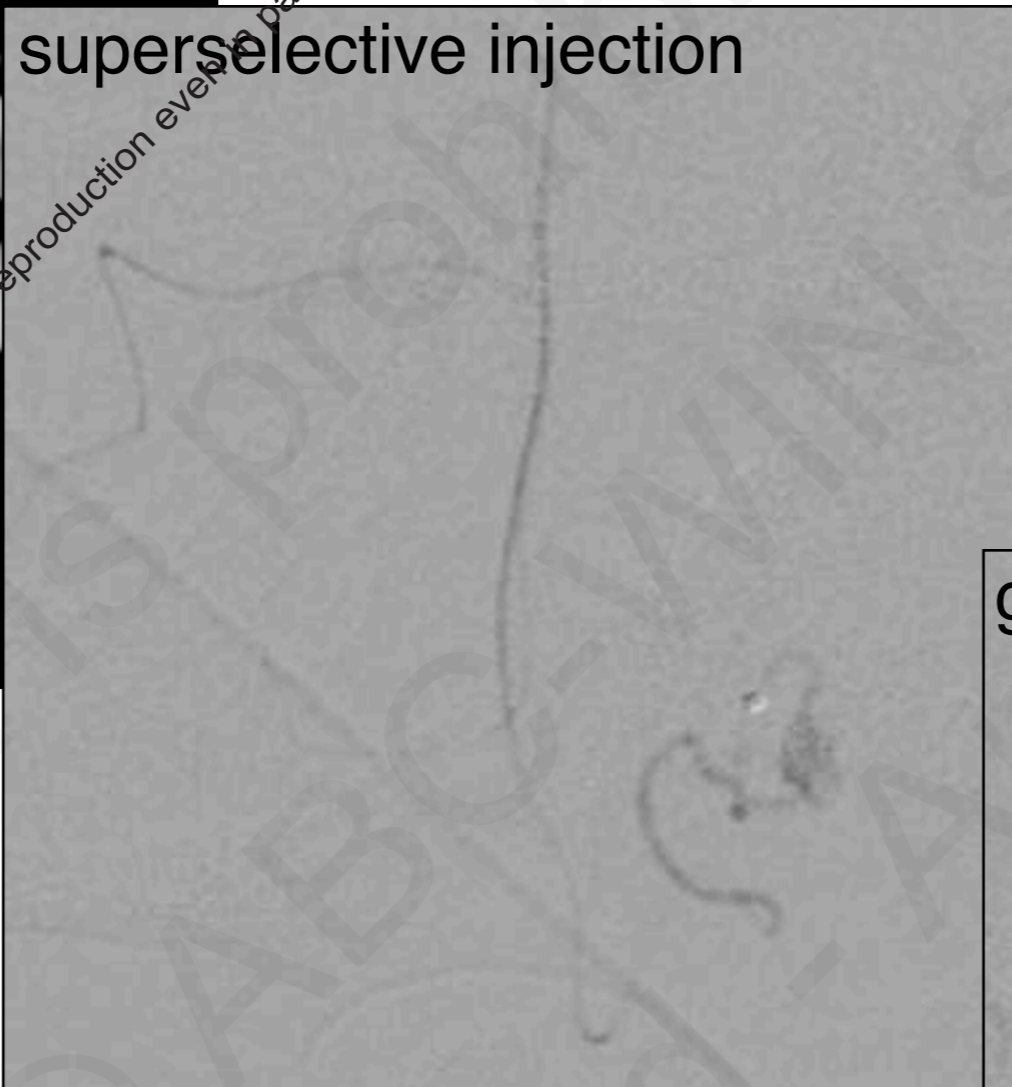
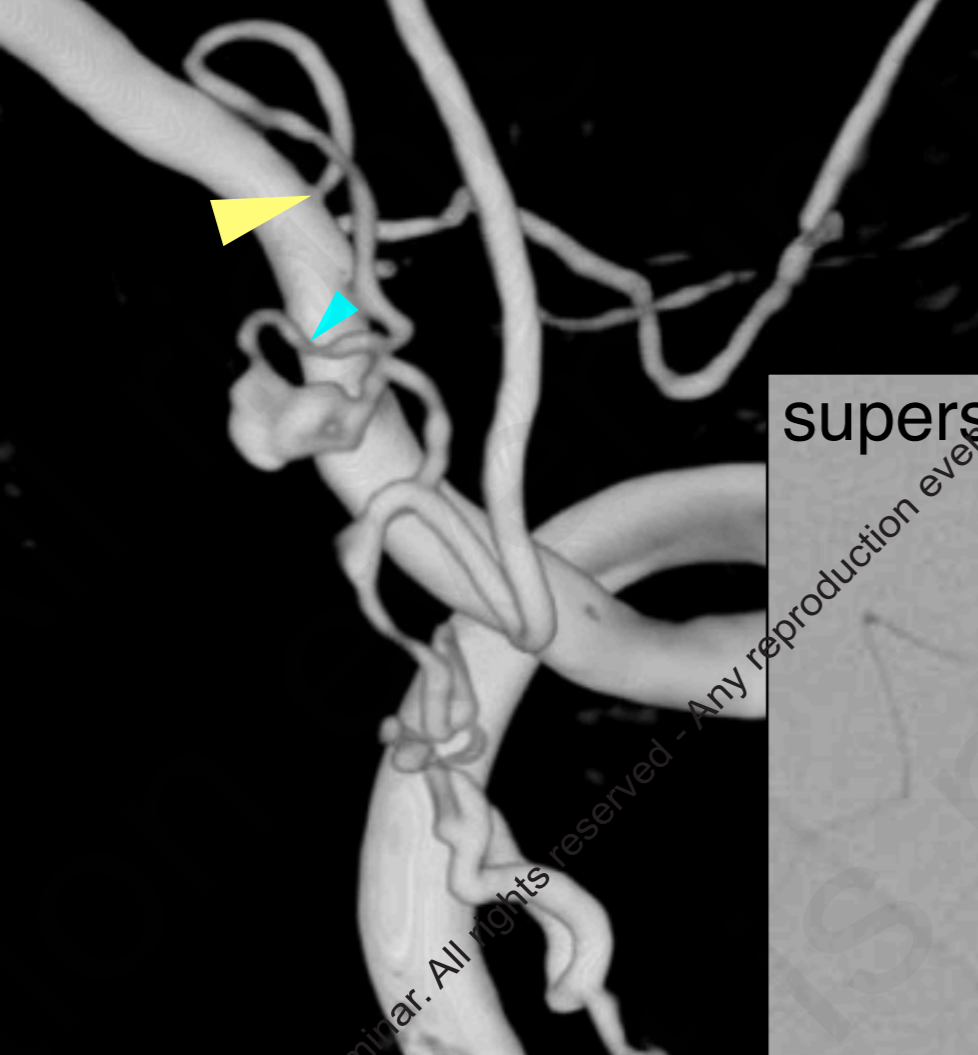
Head Side

Run Number: 5012
Volume Type: 3DRA
Run Date: 2011/11/22
Run Time: 16:56:20
Cube Size: 70.24 mm



Made in OsiriX





superselective injection



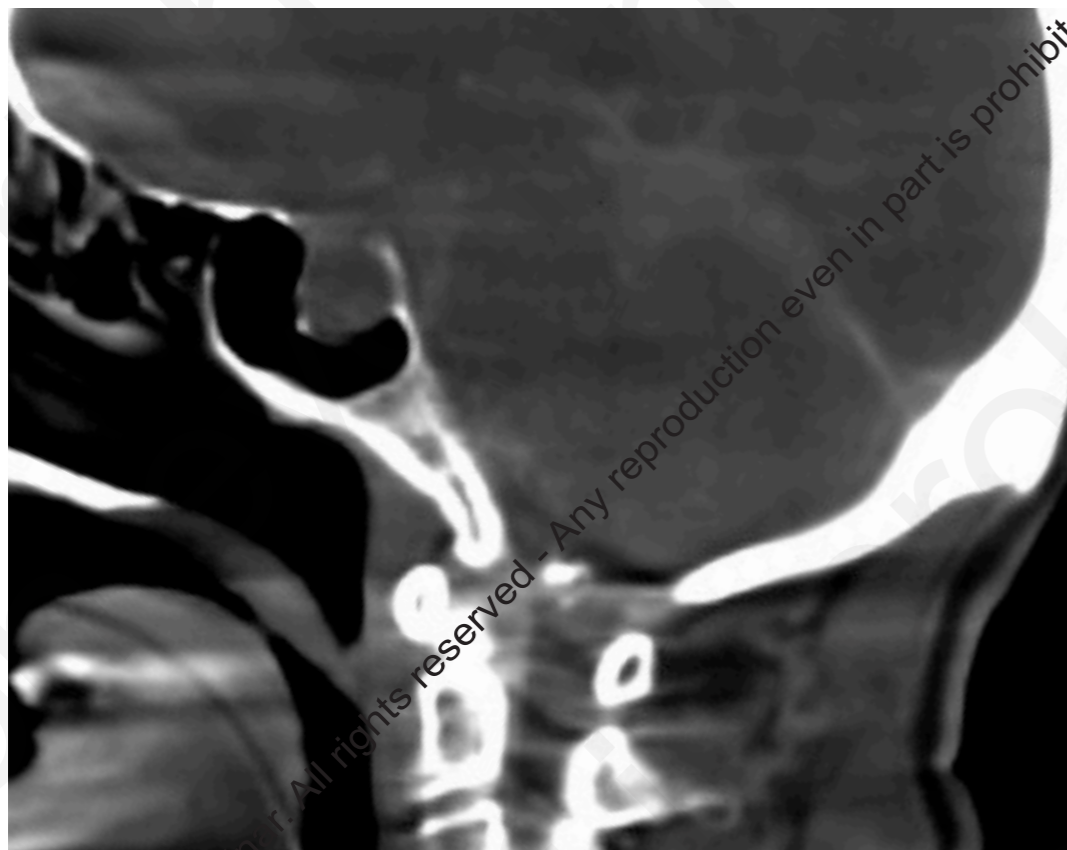
glue injection

*2D and 3D images are shown from opposite direction

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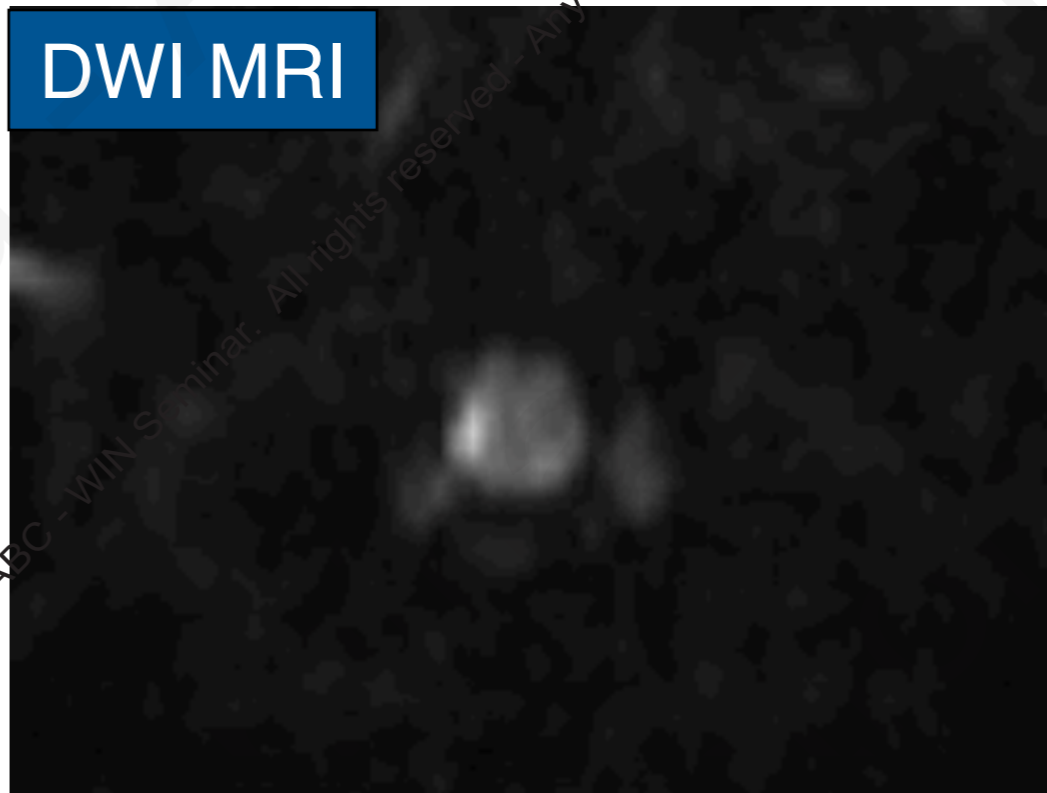
Post-embo CBCT



Post-embo DSA



DWI MRI



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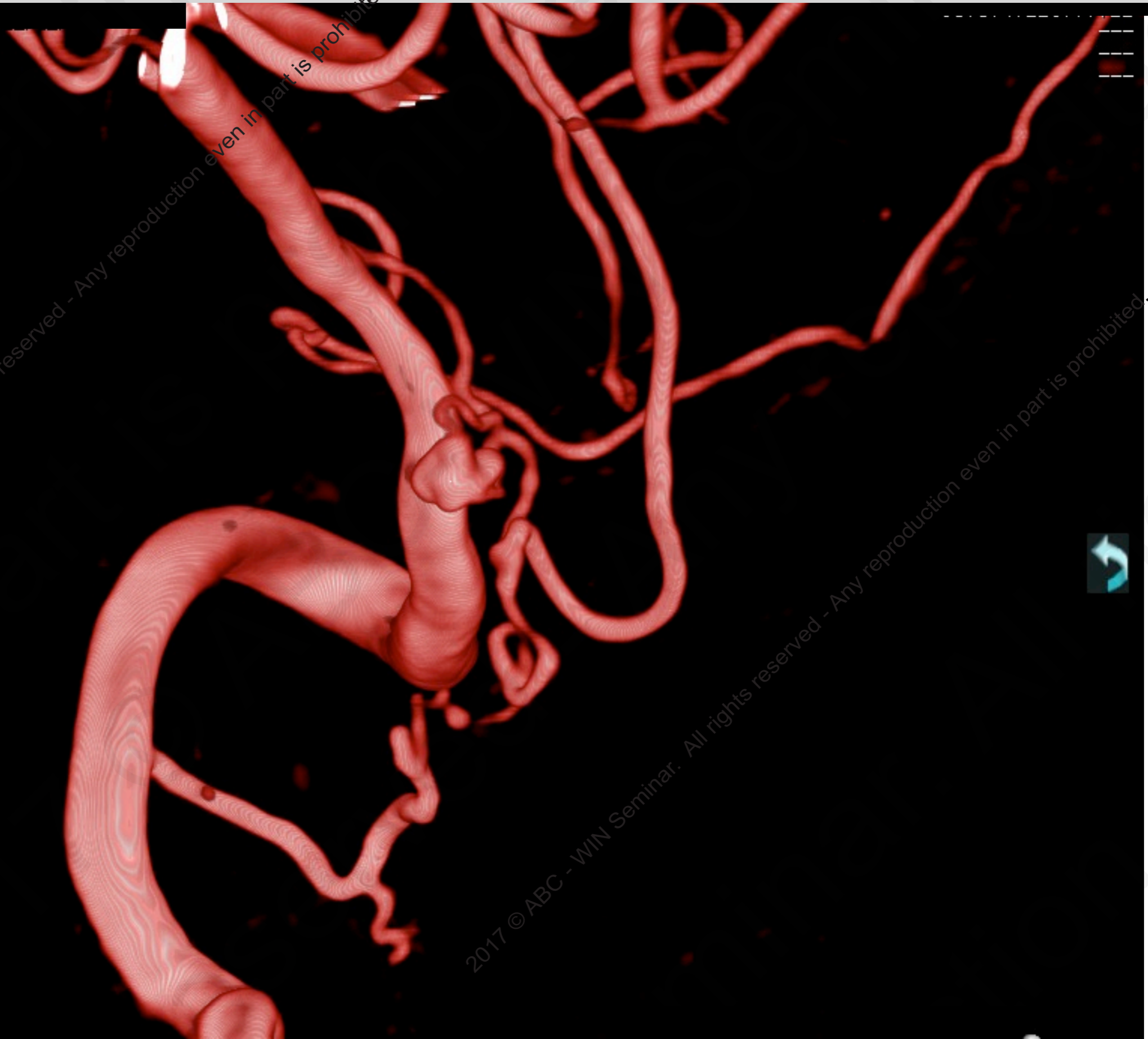
The PICA arises from the lateral spinal artery system and embolizing part of the lateral spinal artery resulted in brain stem infarction.

M

Rot: +57°

Ang: -1°

Head Side



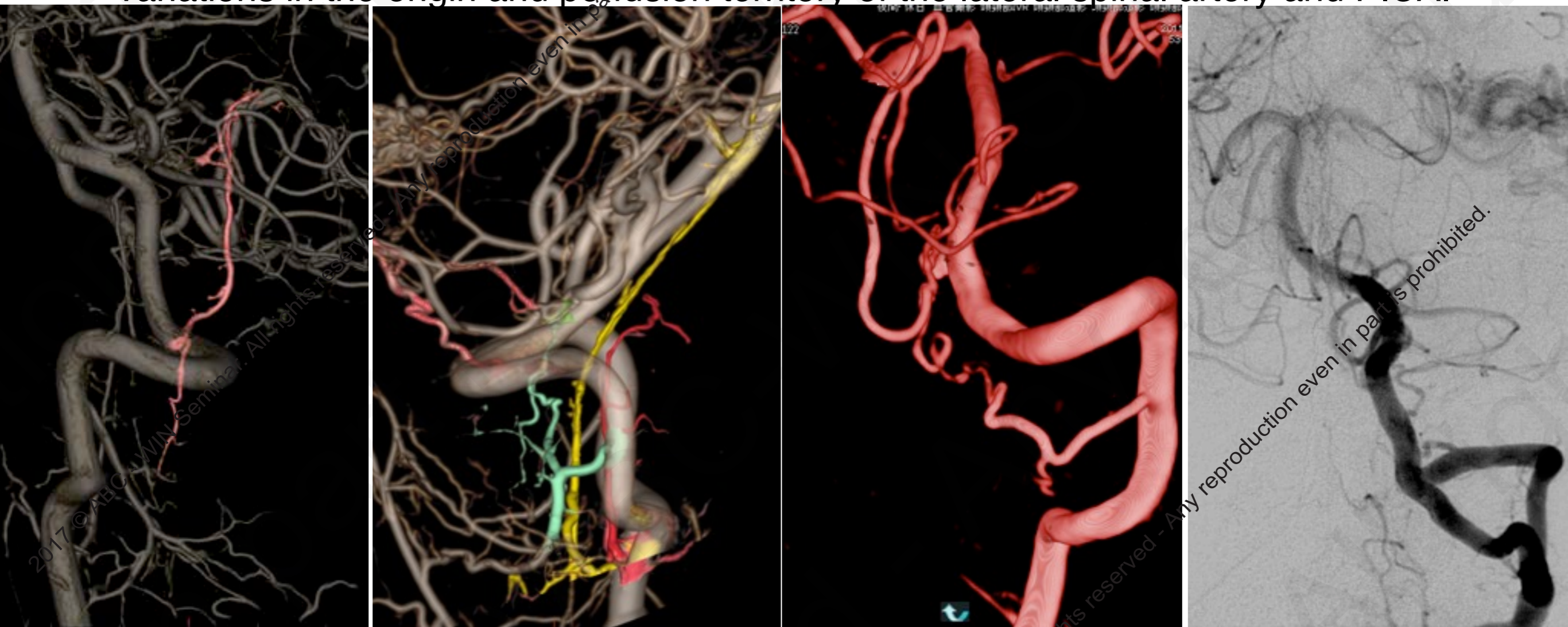
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The lateral spinal artery system...

...and the PICA

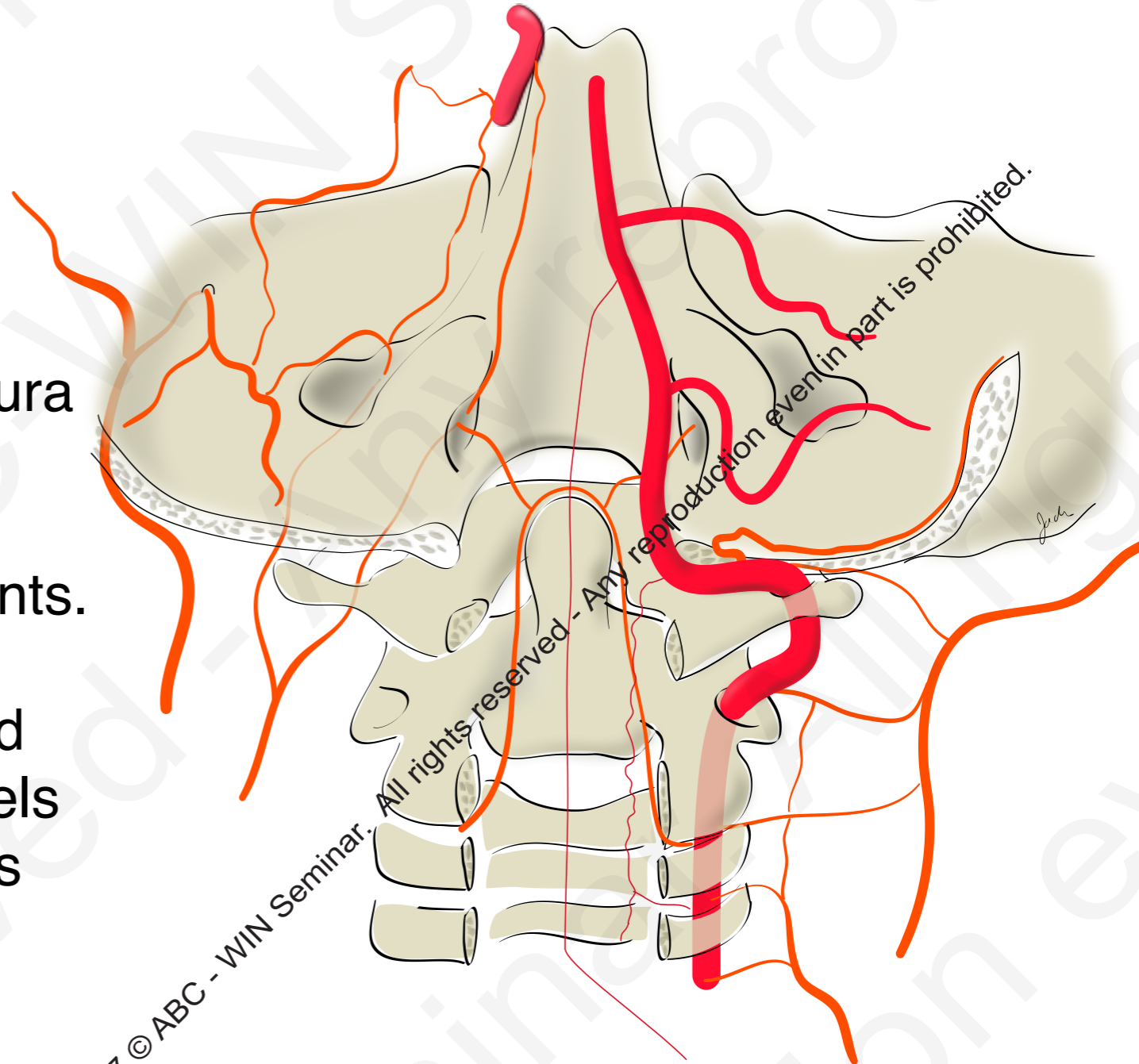
variations in the origin and perfusion territory of the lateral spinal artery and PICA.



Although a large artery in this area, the PICA is only a part of the pial supply system (but with the perforators) of the posterior fossa. It can arise from the intra/extradural VA or any other segments as a “lateral spinal artery”.

Summary of the arterial system in the CCJ area

- The arteries in the CCJ area have close relationship and various connections to one another. (dural <--> pial system)
- The VA close to the entrance to the dura has a long “transitional” part (as the C1 segment) that can give all types of artery as of any other segments.
- Considering the close relationship and the difficulty of visualizing these vessels on angiogram, one should be cautious when using liquid embolic material around this area.



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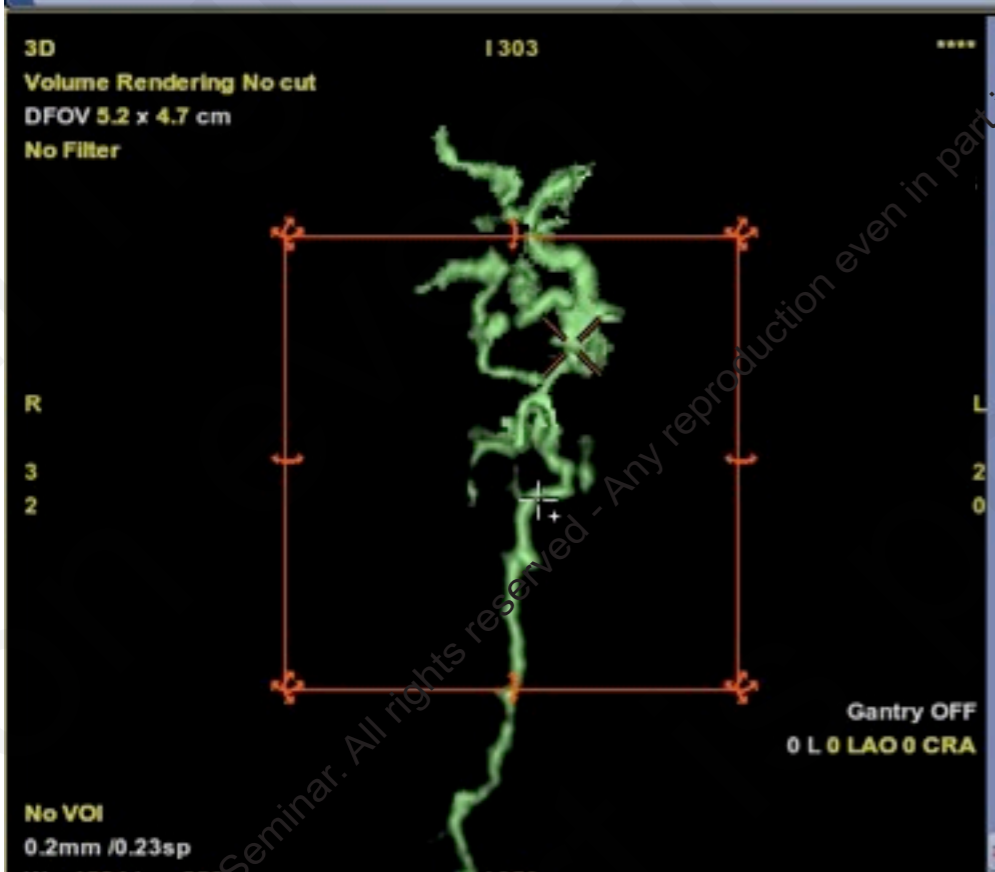
A word on how we obtain the 3D images

5-second subtracted rotational
angiography

VR images and MIP images analysis

coloring and/or extracting and/or
dilating vessel(s) of interest

*Unless mention otherwise, the region of
interest will not be directly involved in the
lesion, to show the normal anatomy and not
secondarily induced dural branch(es).*



Auto Select

Select Structure and Add or Remove:

- Small Vessels
- Any Structure
- Pick from VR

Add Remove

Press & Hold left mouse button until vessel is filled

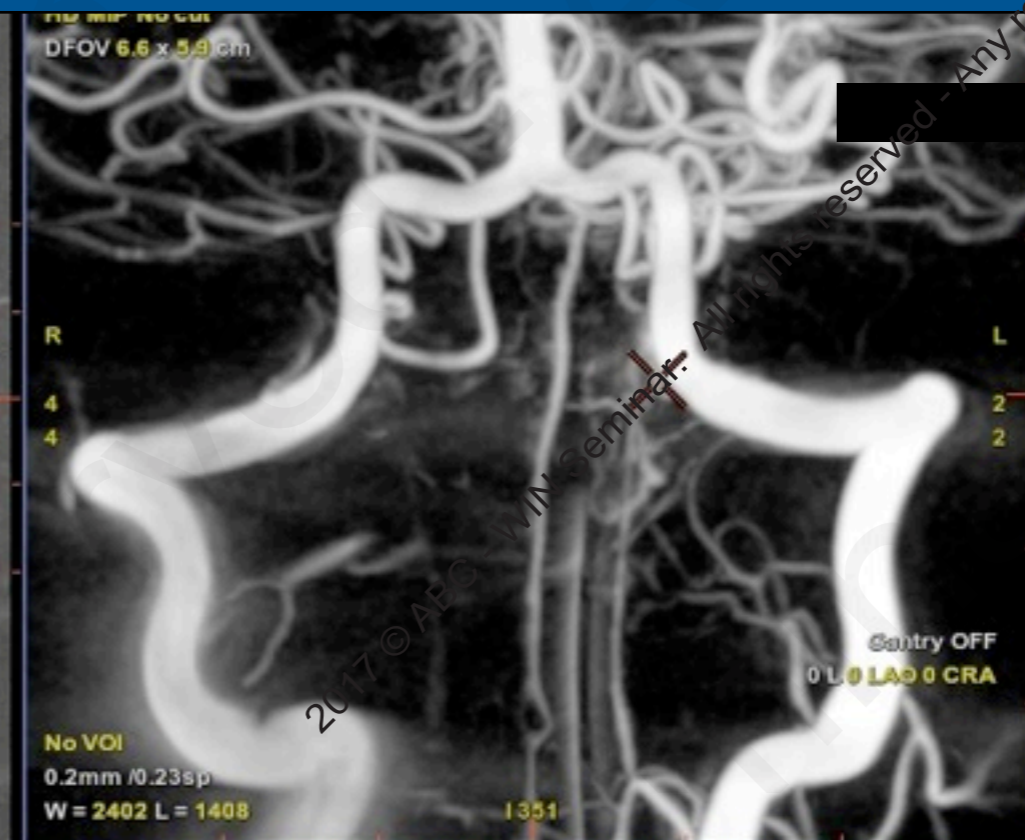
Transparent Background

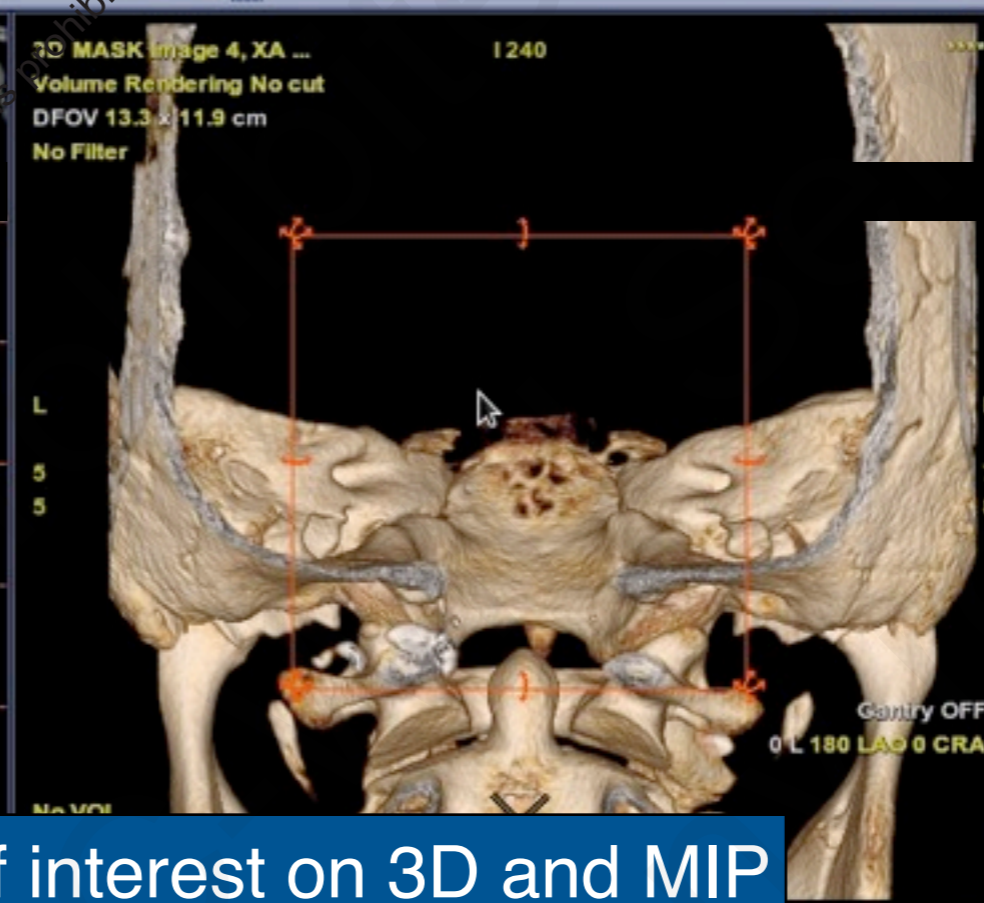
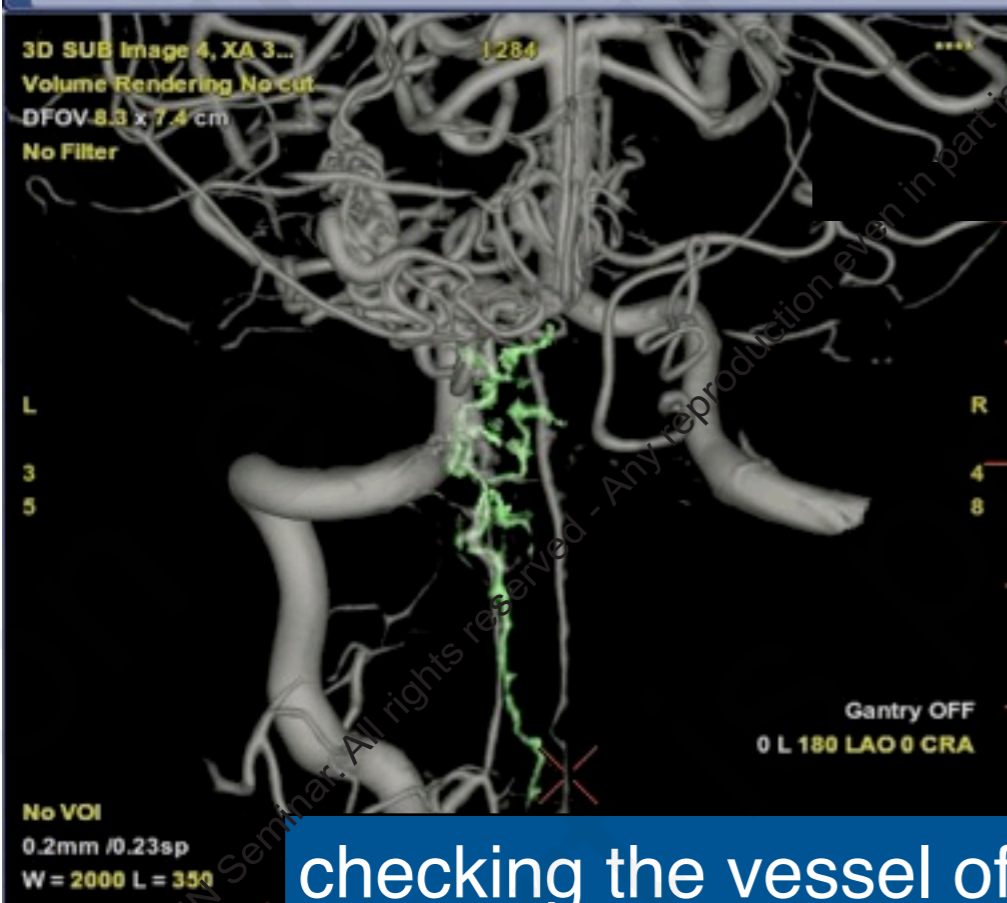
Advanced Options:

Show Removed Apply

Undo

extracting a lateral spinal artery from a rotational DSA on a workstation





Color

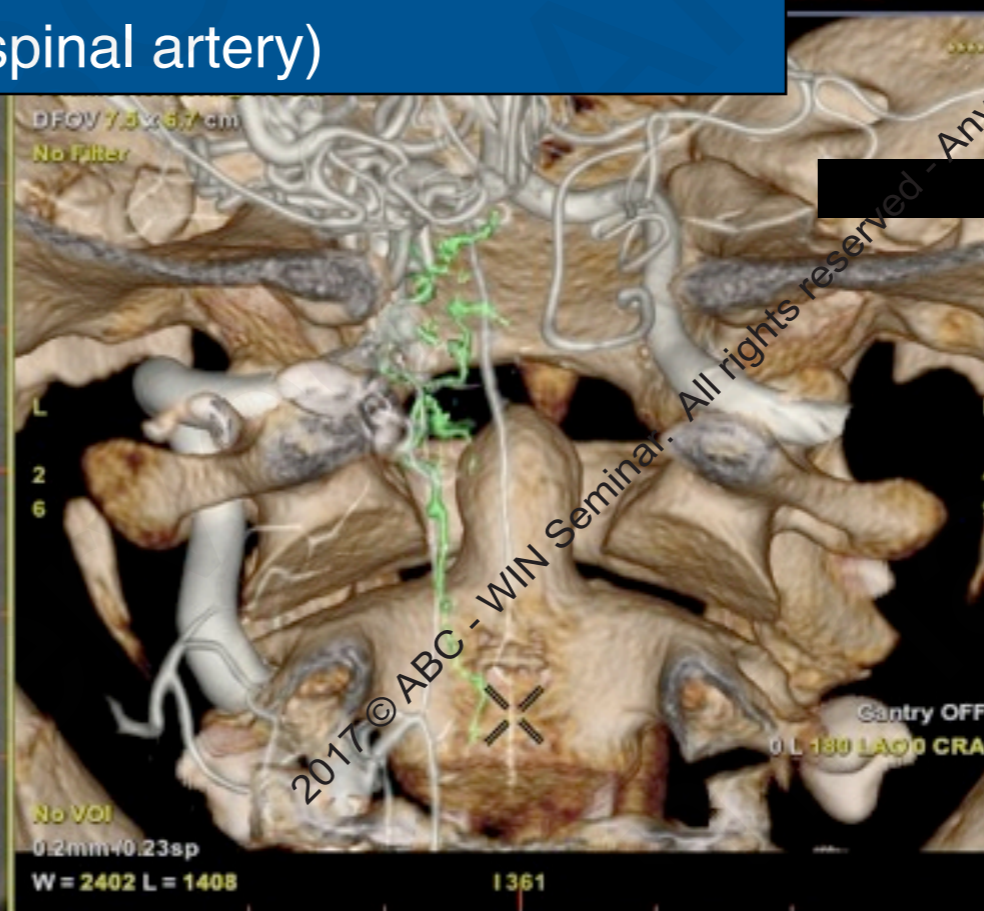
Reference Vol. Overlay Vol.

ColorMap

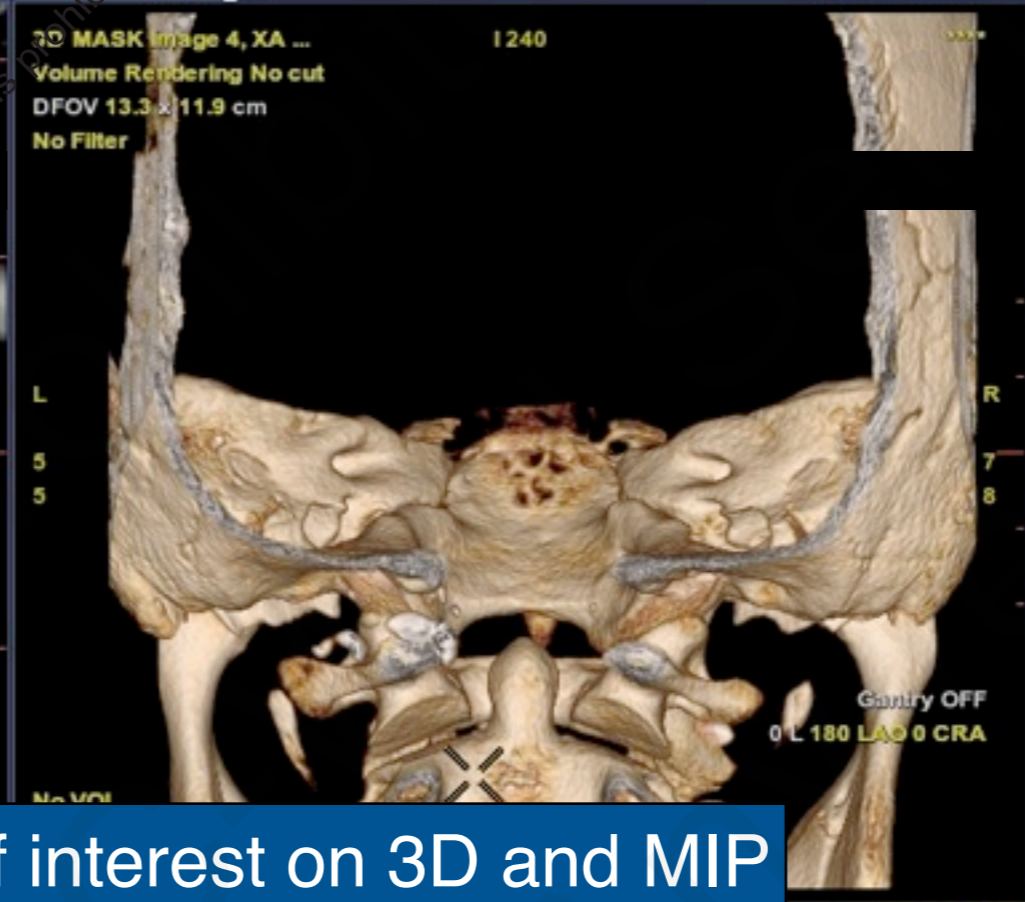
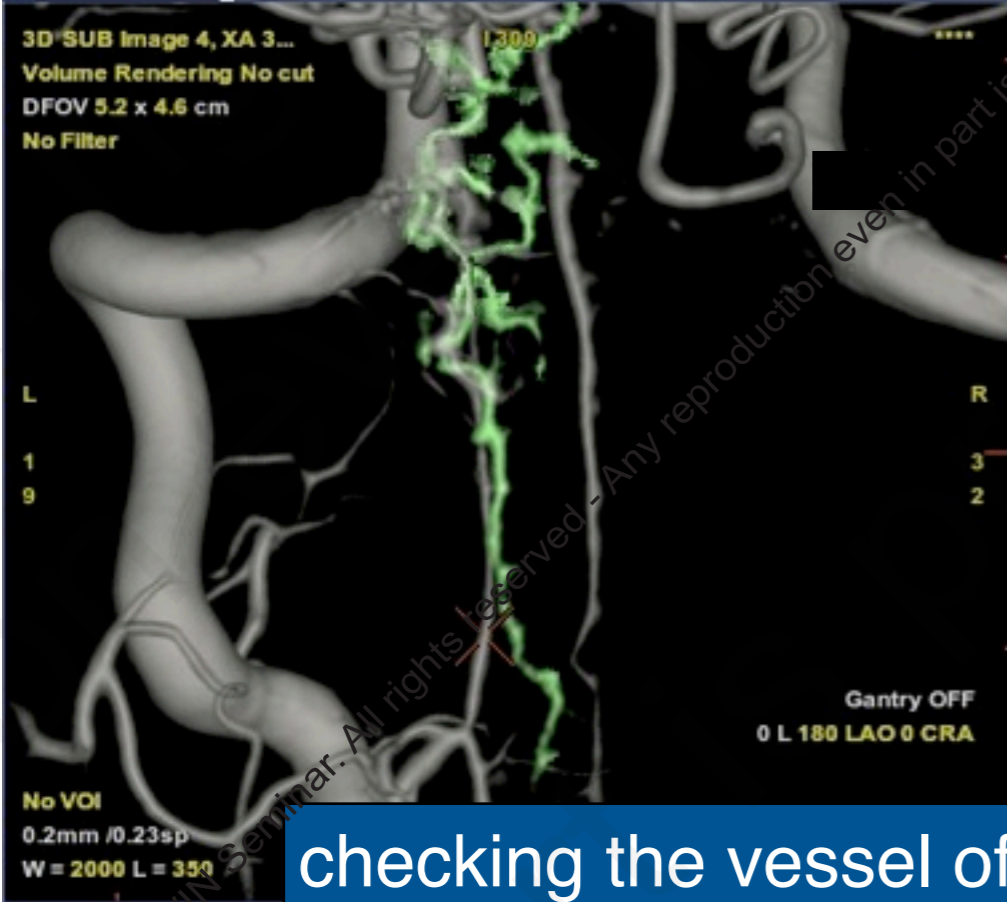
Linear Gray

Custom Color

checking the vessel of interest on 3D and MIP
(anterior spinal artery)



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Batch

Protocols: Oblique

Loop Oblique Rotate

Target Viewport: No target

Set Start Set End

Output Filmer Movie

Description Processed Image

Apply to Current Volume

Display views while saving

Hide annotations on saved images (SCP)

Do not flip images when exporting batch

Preview OK

Advanced

checking the vessel of interest on 3D and MIP (anterior meningeal artery)

