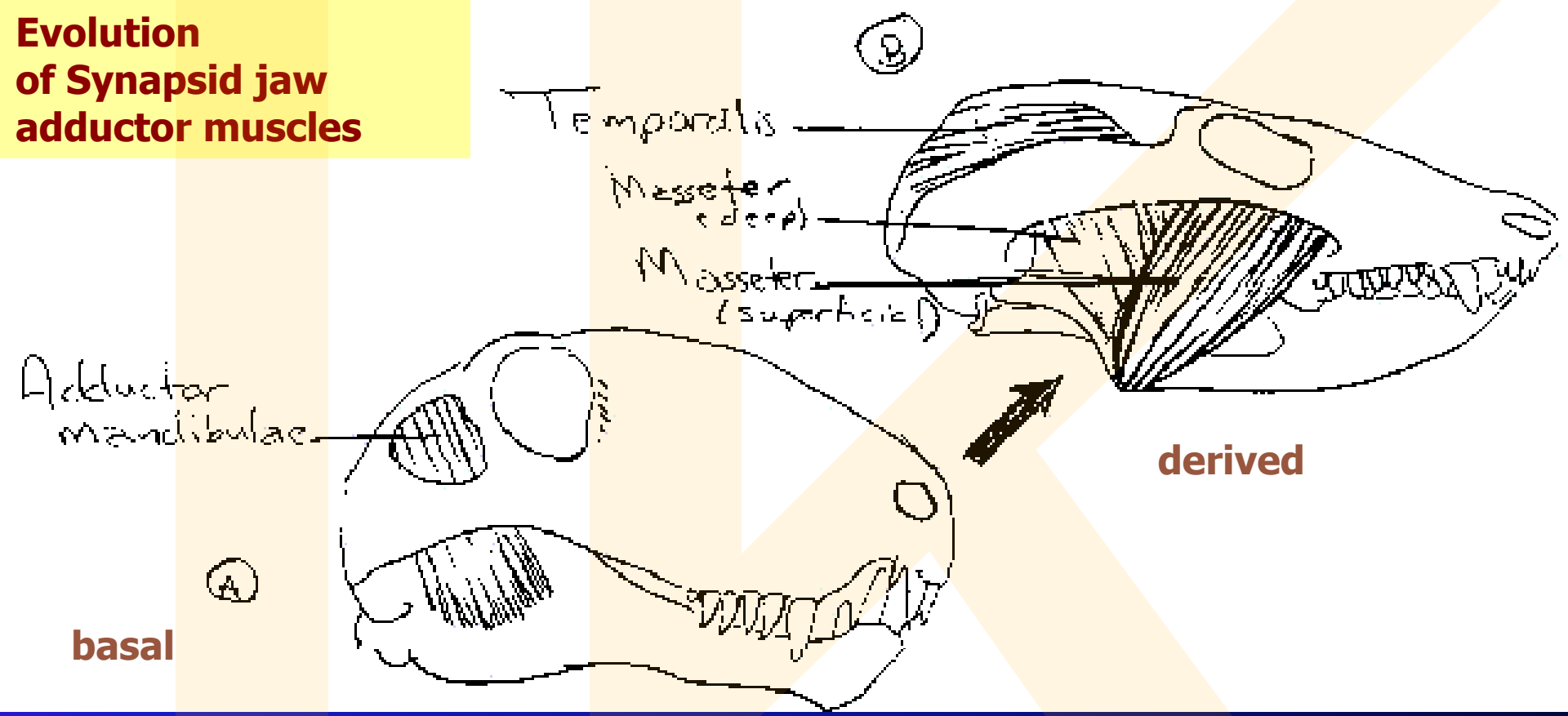
UNIVERSITAS CAROLINA PRAGENSIS

Charles University in Prague – Faculty of Medicine LF1, LF2

Masticatory muscles TMJ joint.

Ivo Klepáček

Evolution of Synapsid jaw adductor muscles



JAW MUSCLES There is differentiation of the jaw-closing musculature.

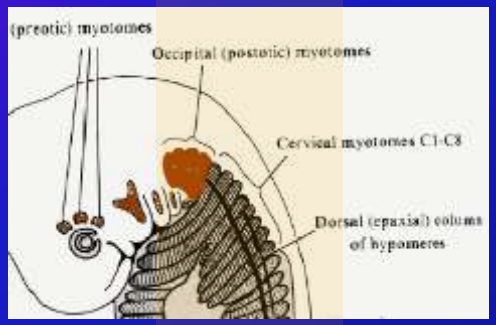
In basal synapsids, the major jaw-closing muscle is the adductor mandibulae (externus). It originates from the back of the skull and inserts on the posterior end of the lower jaw.

In derived synapsids, the adductor mandibulae divides into two major sets of jaw-closing muscles, the temporalis and masseter. The temporalis originates from the skull roof near the sagittal crest and inserts on the coronoid process. The masseter in turn divides into two parts. The deep masseter originates on the zygomatic arch and inserts on the lower jaw; the superficial masseter part arises beneath the eye, passes across the deep masseter, to insert on the angle of the dentary.

BRANCHIAL (pharyngeal) STRUCTURES

(their myogenic material probably comes from the ´occipital´ myotomes):

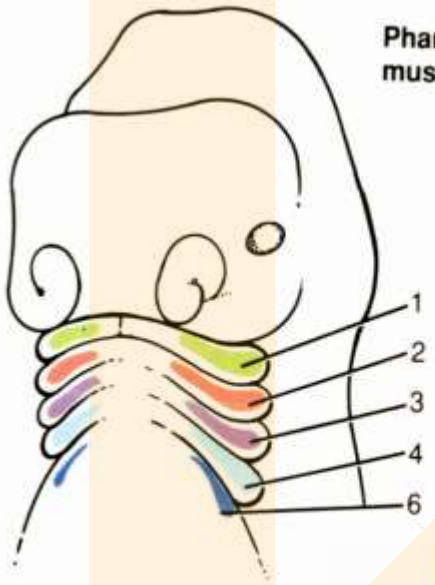
- Muscles of the pharyngeal arch I. (V. trigeminus)
- Muscles of the pharyngeal arch II. (VII. facialis)
- Muscles of the pharyngeal arch III. (IX. X. XI., glossopharyngeus, vagus, accessorius)



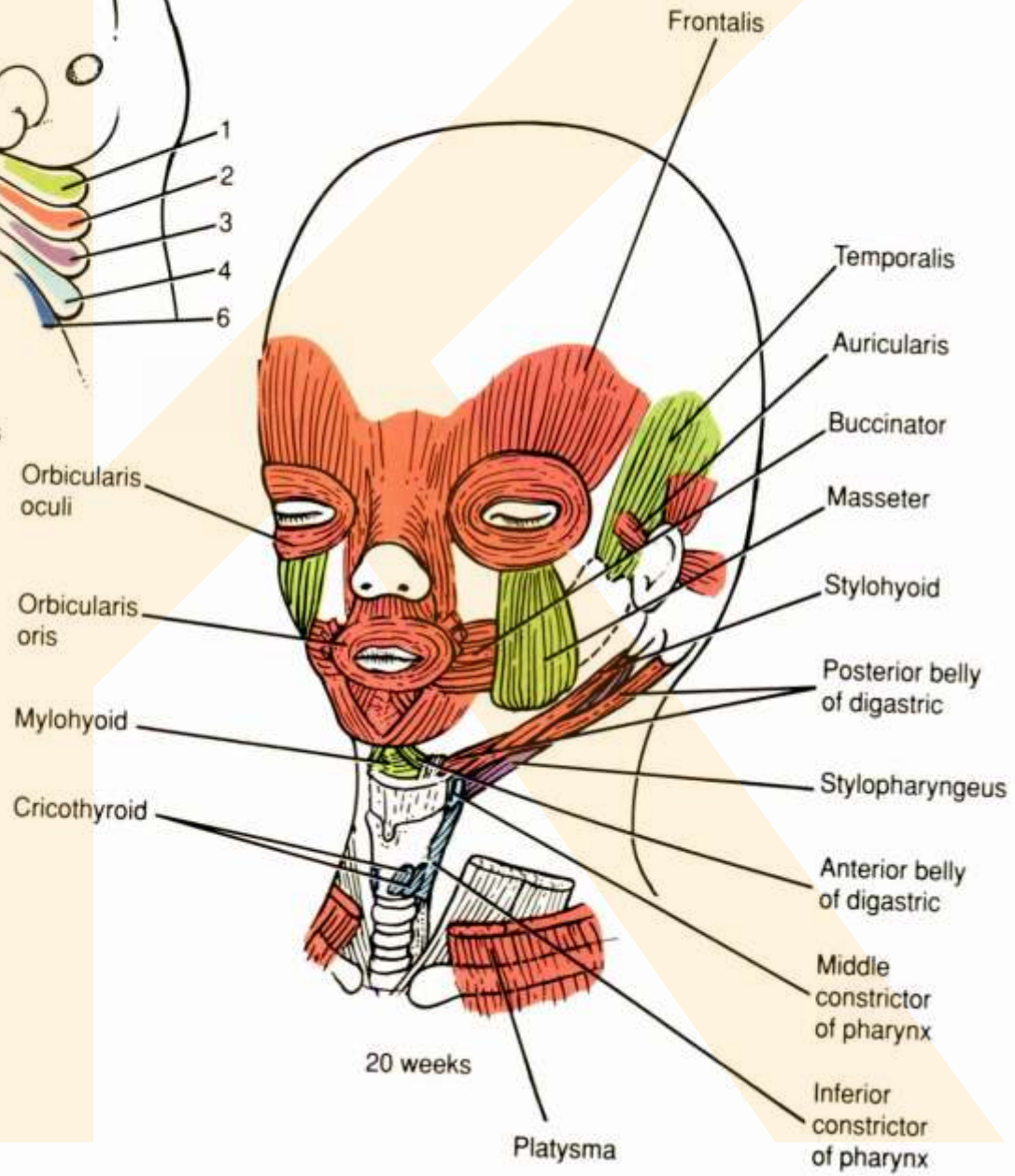
III. arch:

Cranial part: formation of the pharyngeal and laryngeal muscles

Caudal part: formation of the m. trapezius (trapezoid) and STCLM muscle (sternocleidomastoideus)



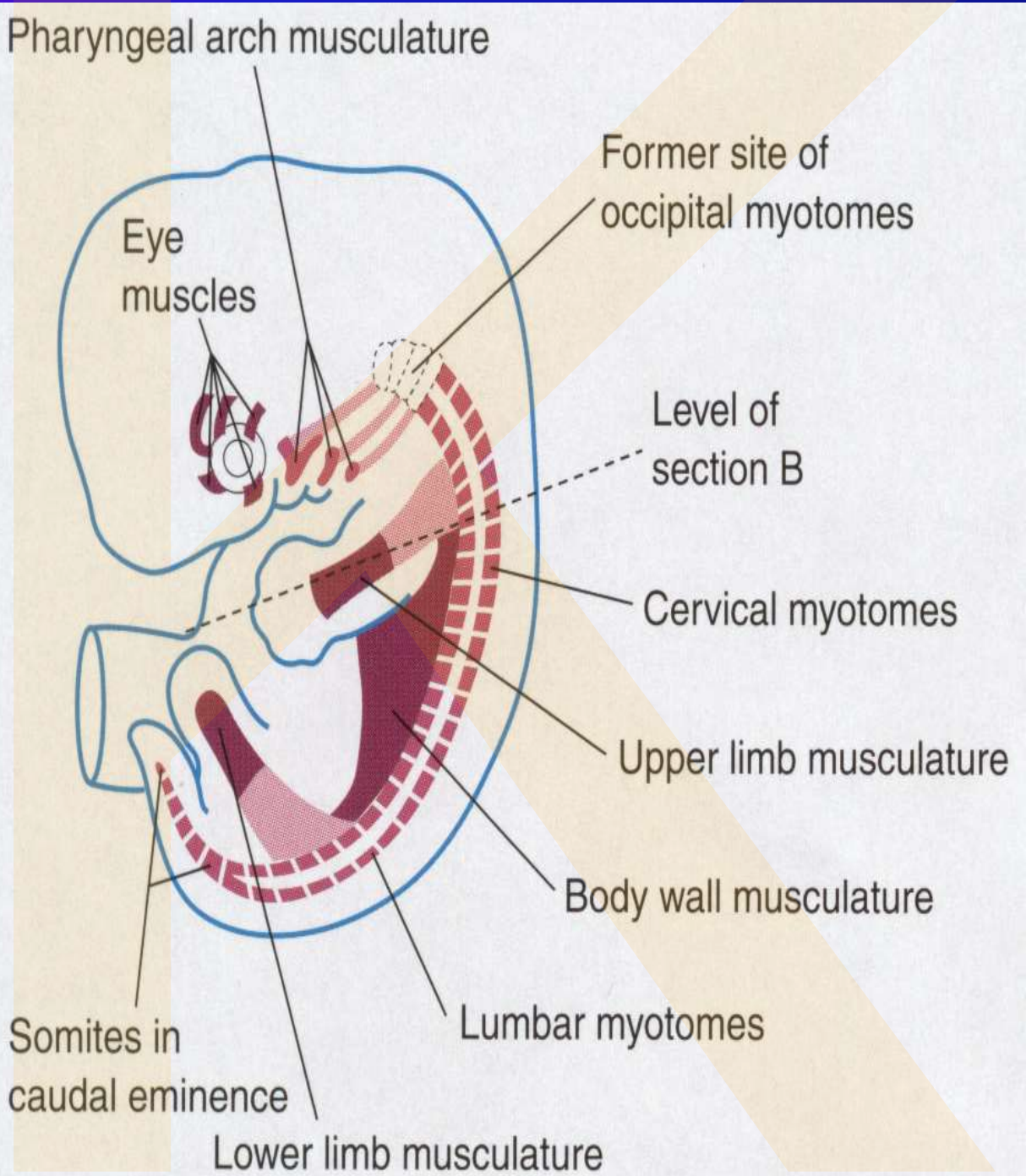
Motor areas of the following nerves: V3., VII., IX.,X.,XI.



ORGANIZING centers (paraaxial and lateral mesoderm somitomeres, somites)

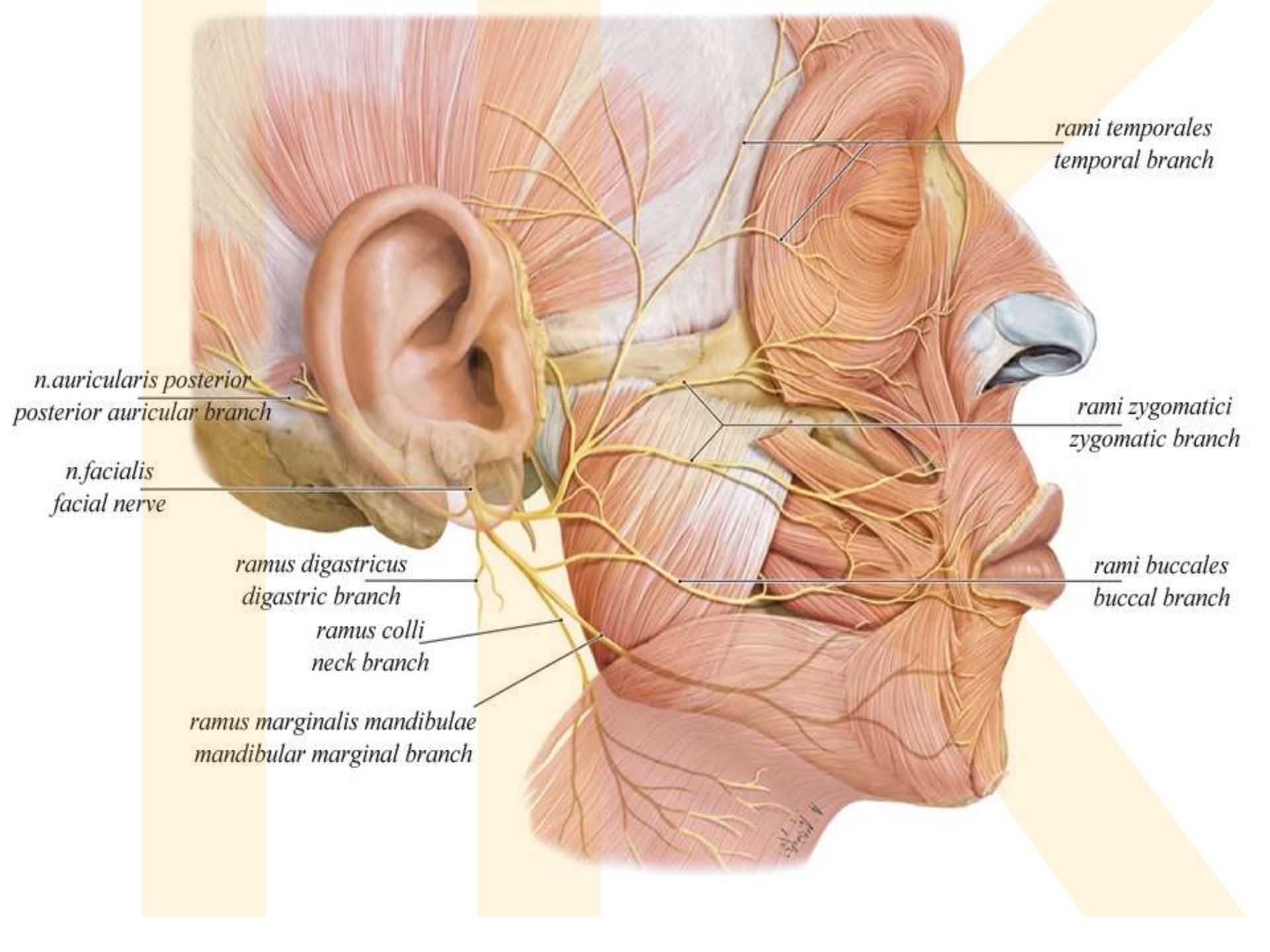
Somitomeres = head
1,2,3,5-extrinsic eyeball muscles (III.,IV.,VI.)
4- jaw elevators (V.)
6- jaw depressors (VII.)
7-stylopharyngeus

Somites = collum, thorax, abdomen, pelvis
1,2-inner pharyngeal muscles (X.)
2-5-lingua (tongue) (XII.)



Musculi masticatorii
Muscles of mastication

V3 – MANDIBULARIS
deriváty 1. žaberního oblouku


rami temporales
temporal branch
n.auricularis posterior
posterior auricular branch
rami zygomatici
zygomatic branch
n.facialis
facial nerve
ramus digastricus
digastric branch
rami buccales
buccal branch
ramus colli
neck branch
ramus marginalis mandibulae
mandibular marginal branch

aa. temporalis media (a.temp.superf.)
a. temporalis profunda ant., post. (a. maxillaris)

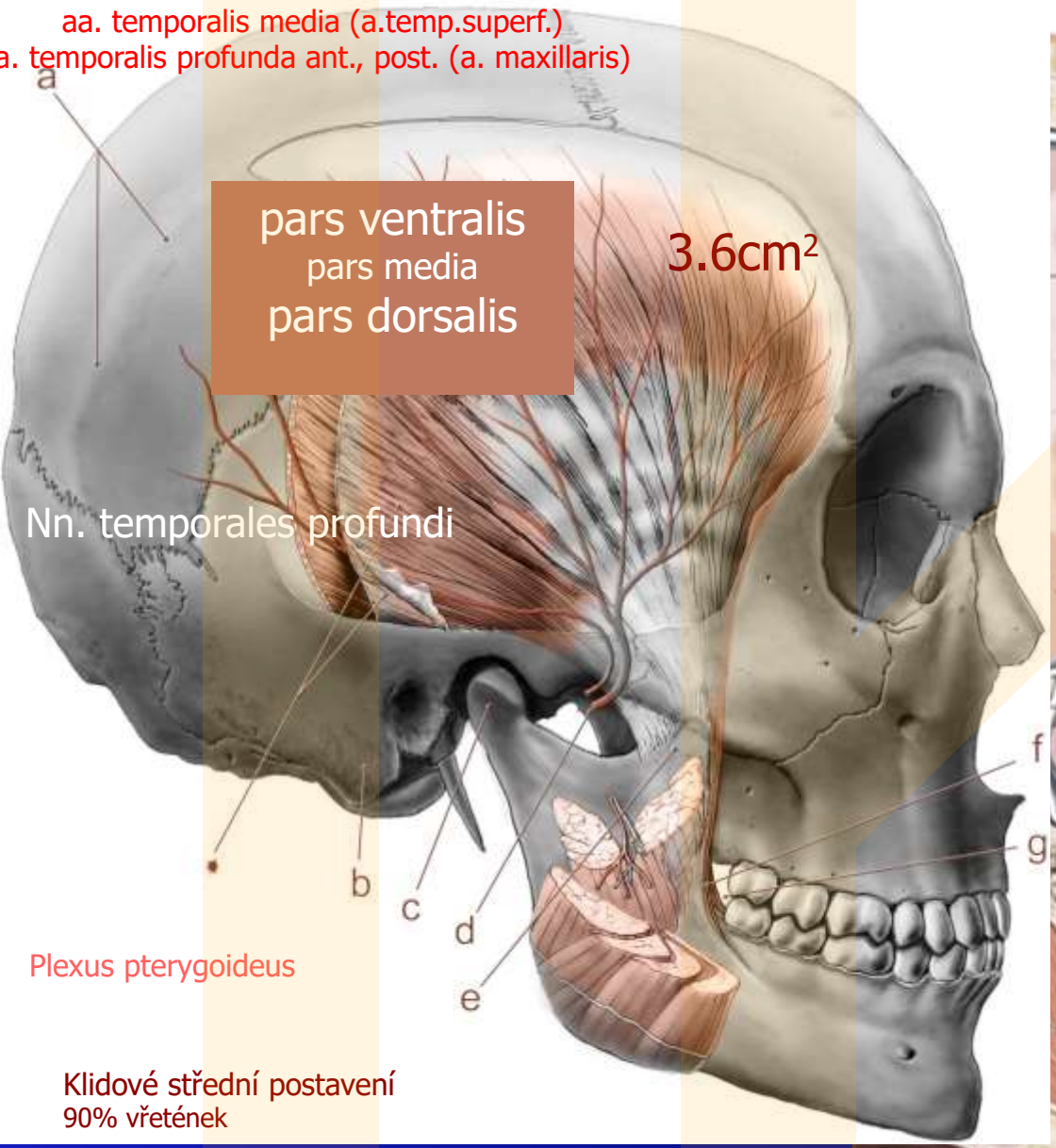
pars ventralis
pars media
pars dorsalis

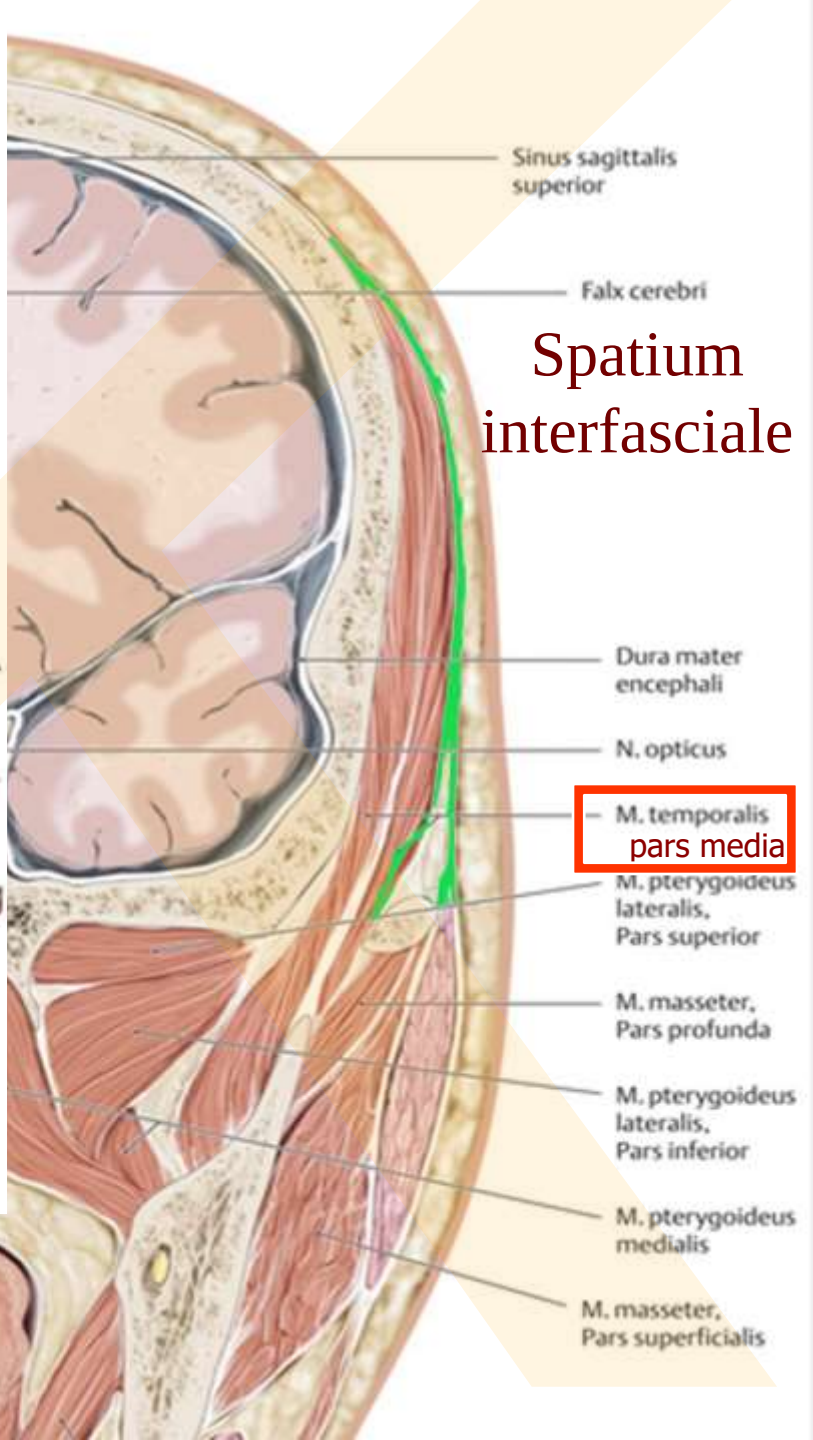
3.6cm²

Nn. temporales profundi

Plexus pterygoideus

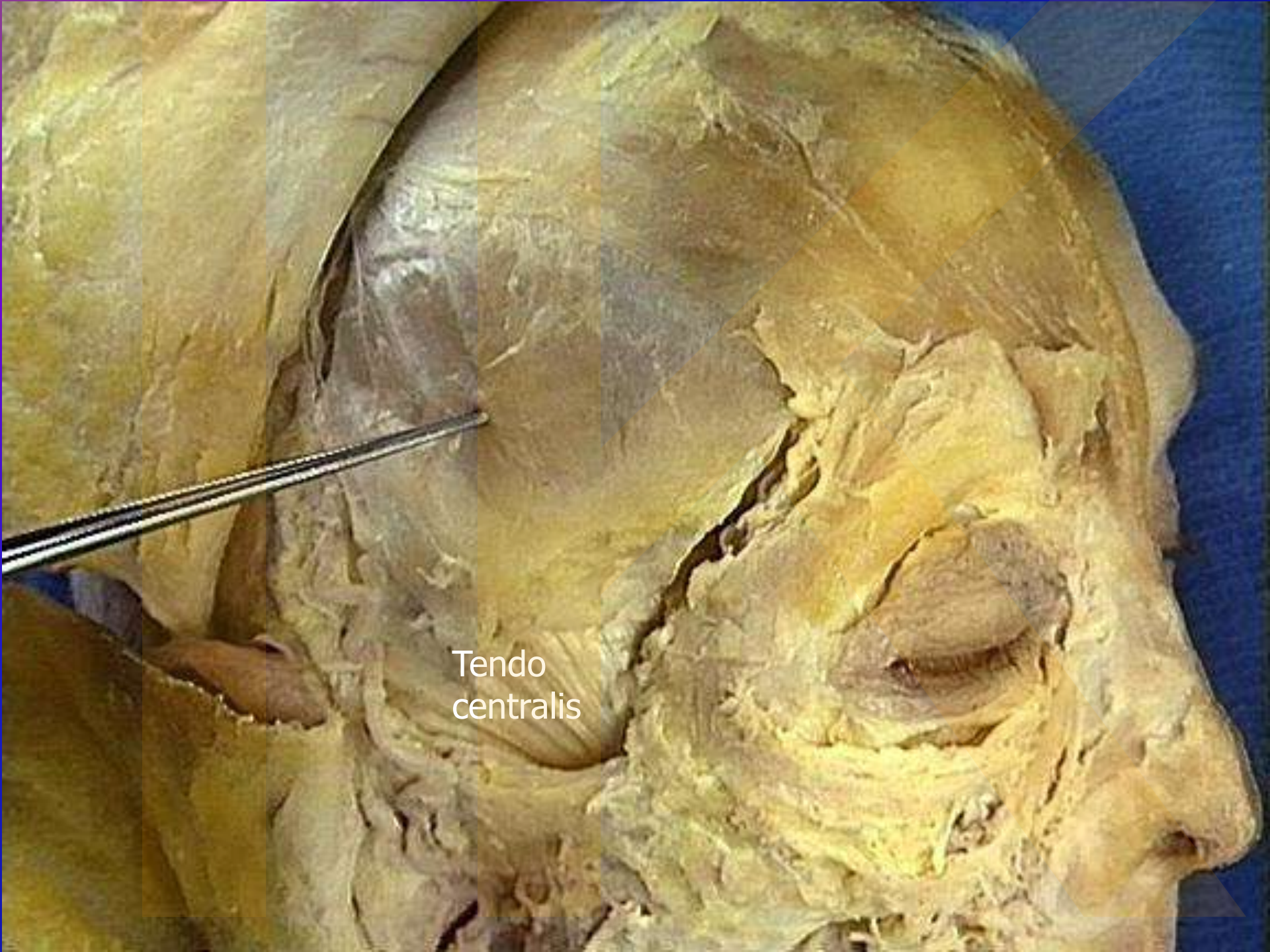
Klidové střední postavení
90% vřetének

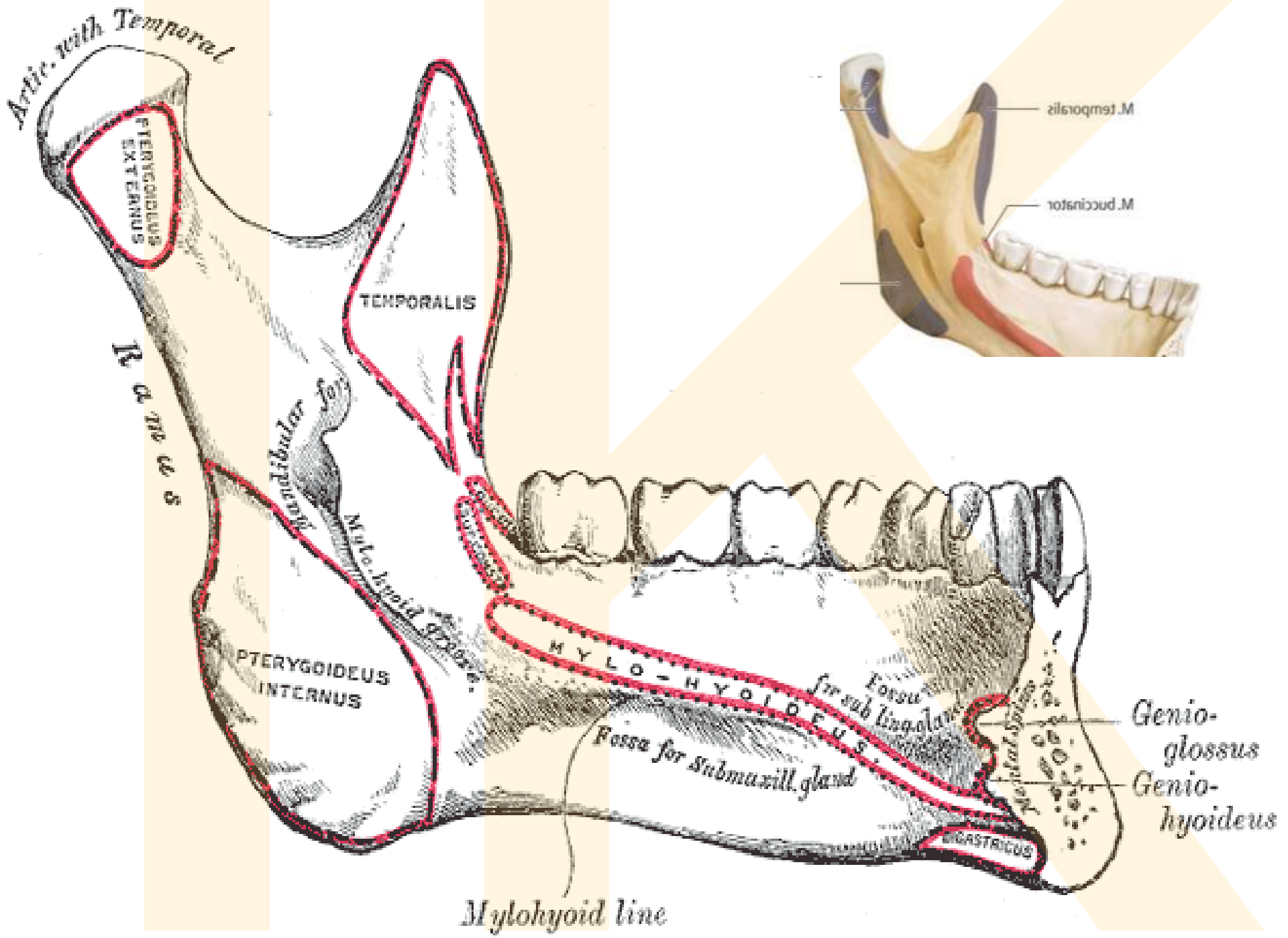




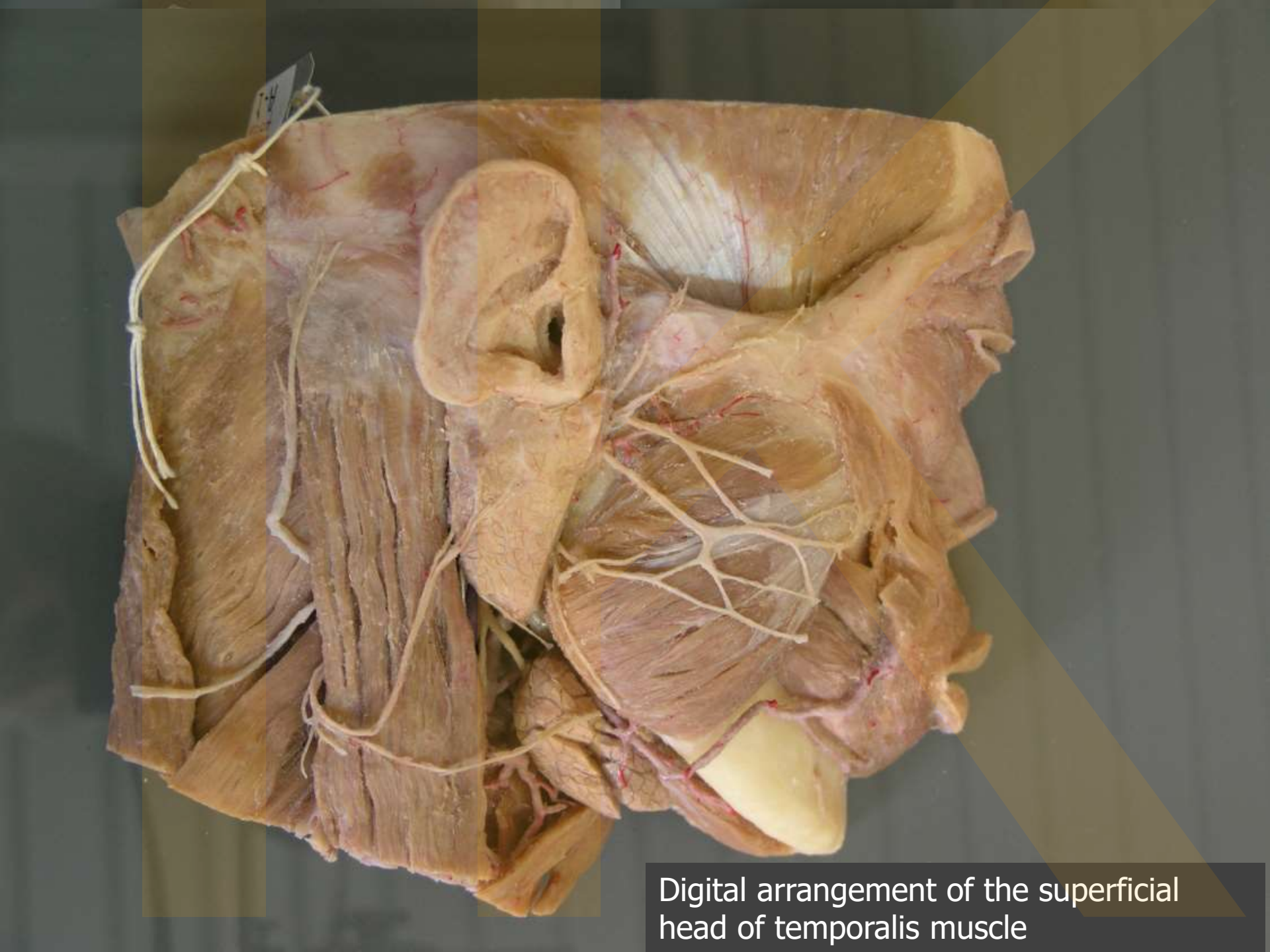
Spatium interfasciale

M. temporalis
et fascia temporalis


Tendo
centralis


Artic. with Temporal
PTERYGOIDEUS EXTERNUS
TEMPORALIS
Ramus
Mandibular for.
Mylo-hyoid groove
PTERYGOIDEUS INTERNUS
MYLO-HYOIDEUS
Fossa for sublingual gland
Fossa for submaxill. gland
Mylohyoid line
DIGASTRICUS
Genio-glossus
Genio-hyoideus
M. temporalis
M. buccinator

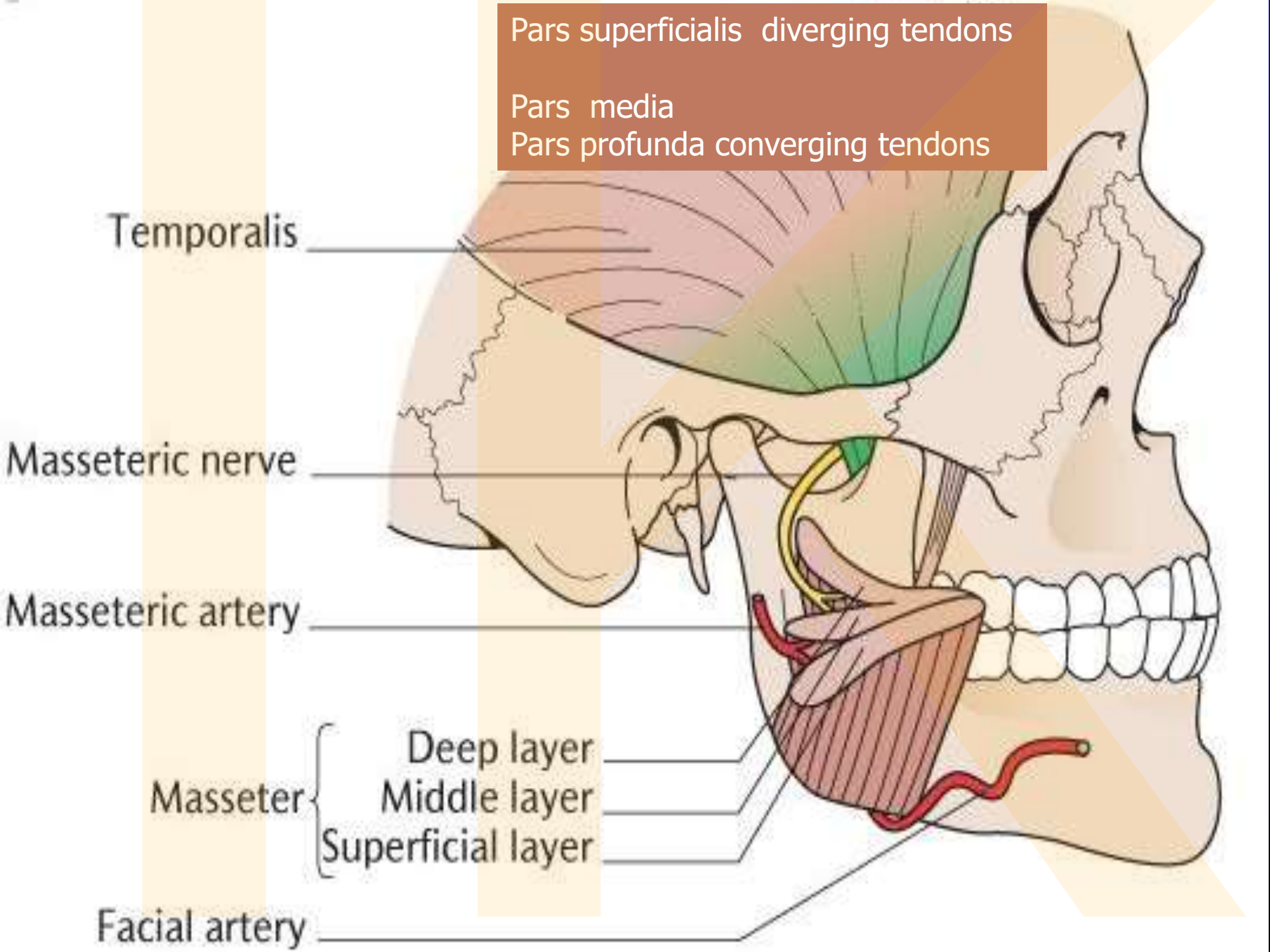
BODY



Digital arrangement of the superficial head of temporalis muscle

Pars superficialis diverging tendons

Pars media
Pars profunda converging tendons

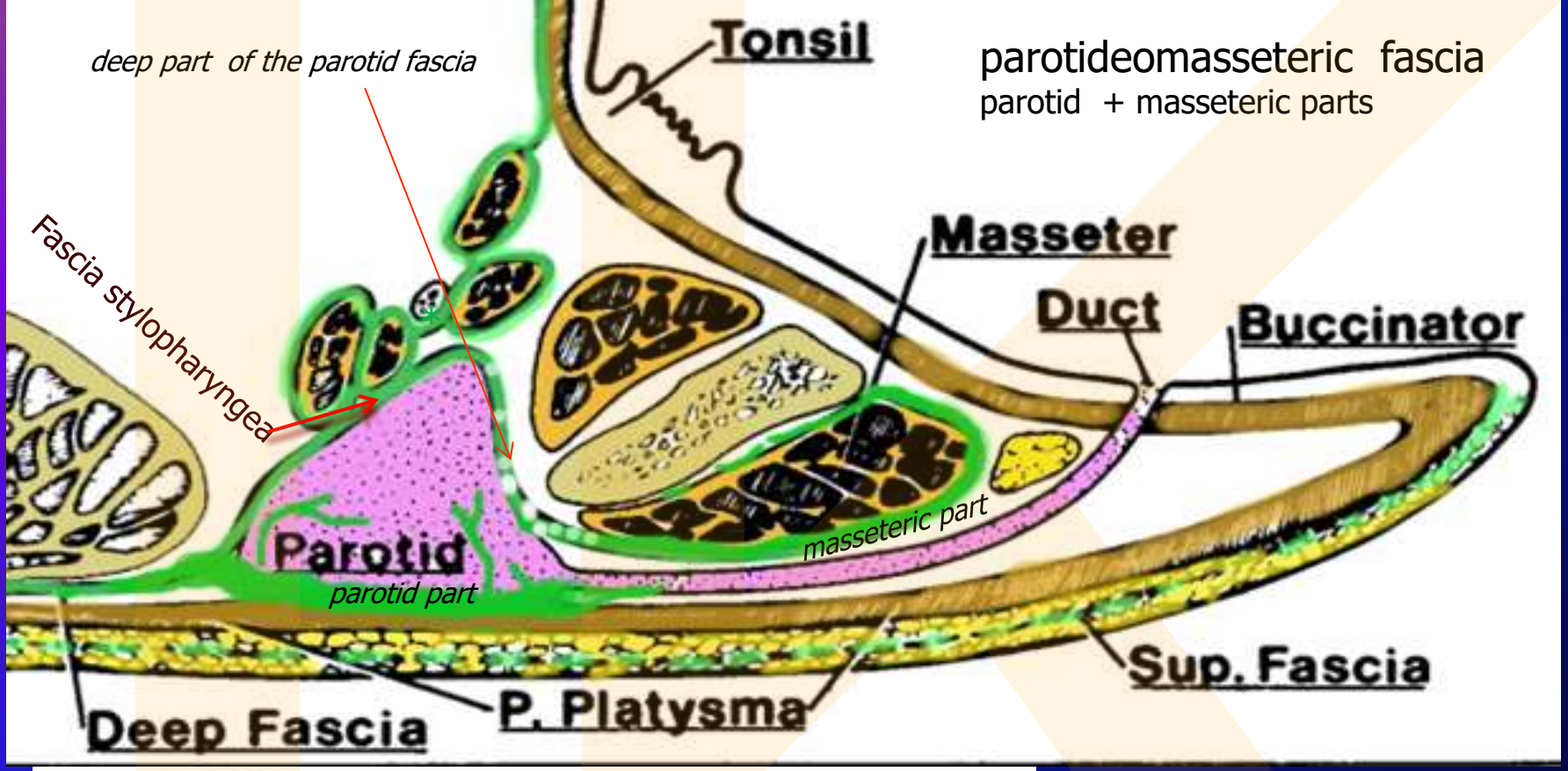


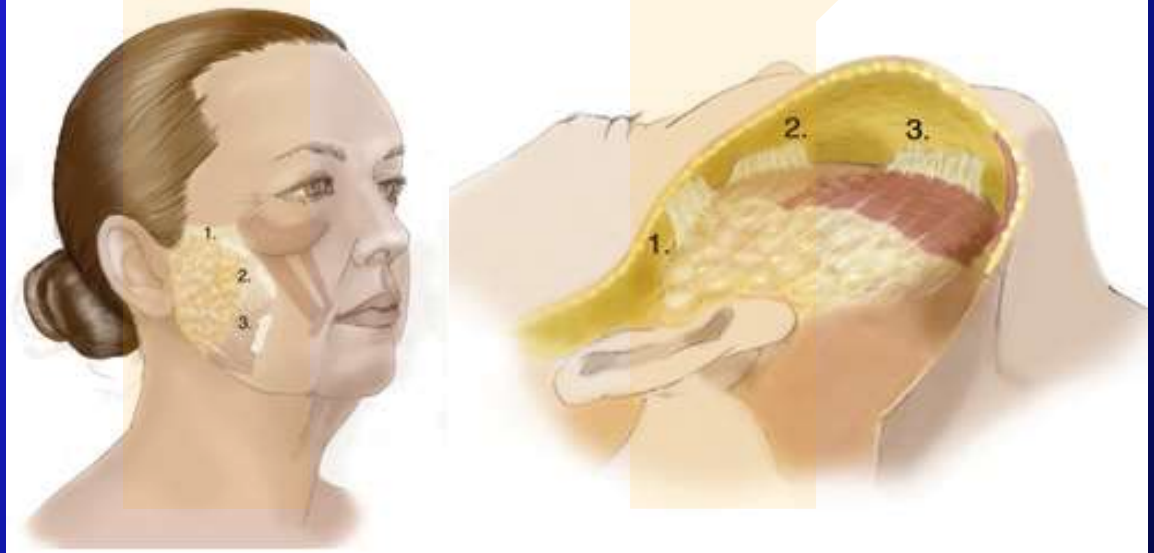
Fascie ve vztahu ke komplexu žláza sval:

1 - m. temporalis
2 - m. masseter (pars prof.)
3 - m. masseter (pars superfic.)
4 - ductus parotideus
5 - n. auriculotemporalis

6 - a. carotis ext. et a. transversa faciei
7 - n. VII. et a. retroauricularis
8 - r. colli (n. VII.)
9 - plexus parotideus
- resection line

Parotidea (1.parotideomasseterica, 2.lamina profunda fasciae parotidae, 3.tractus angularis (navazuje na lig. stylomandibulare))



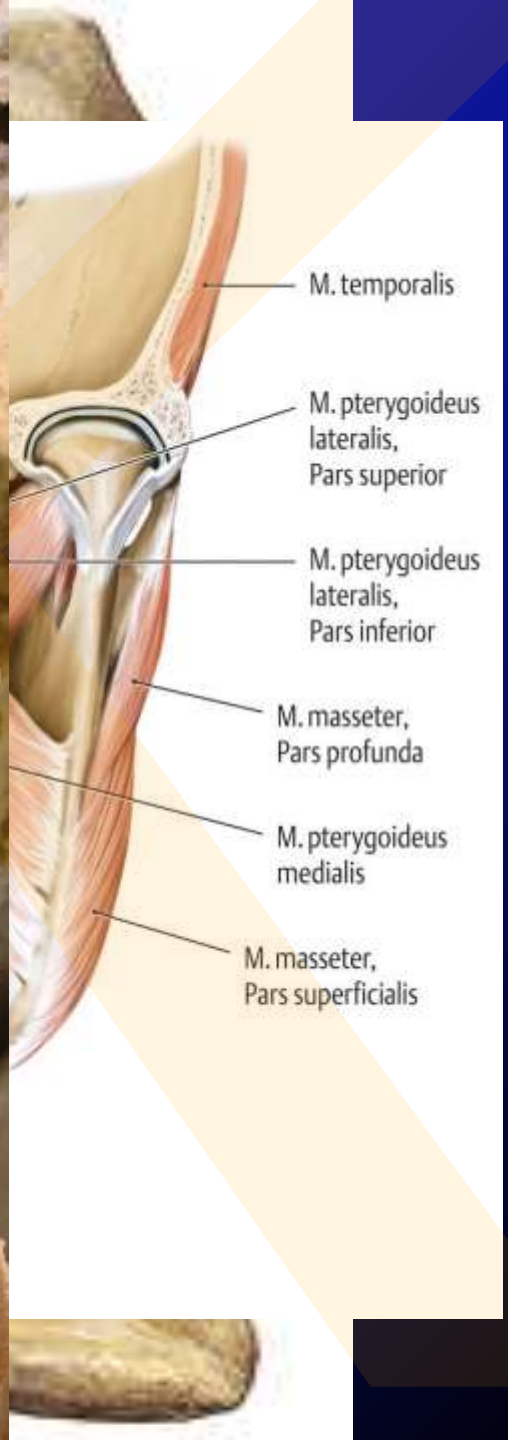


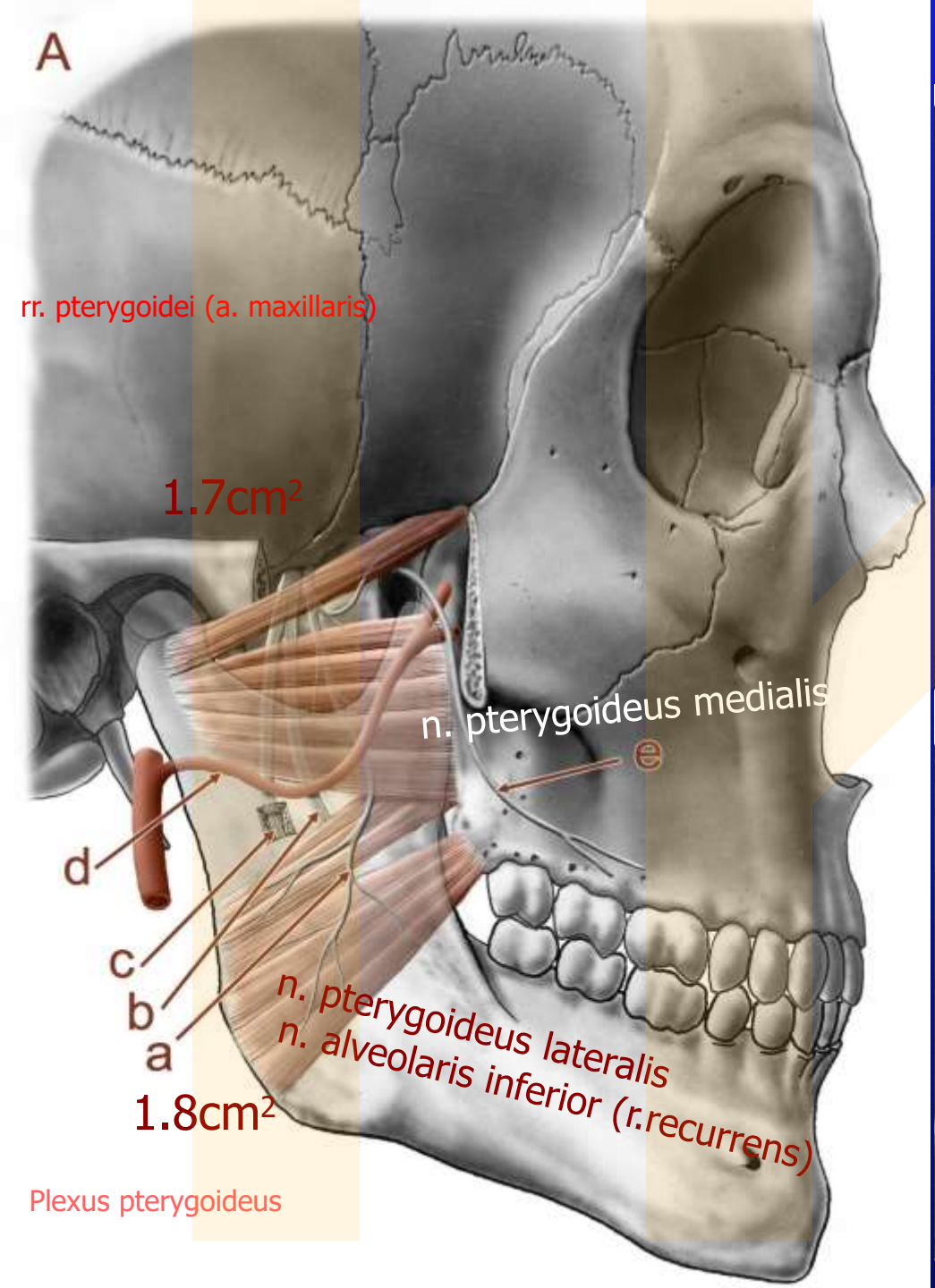
Jost , G, Levet, V.: Parotid fascia and Face lifting: A critical Evaluation of the SMAS concept. Plastic and Reconstructive Surg, 74:42-51, 1983 - *modified*

- Mm

Discus arti

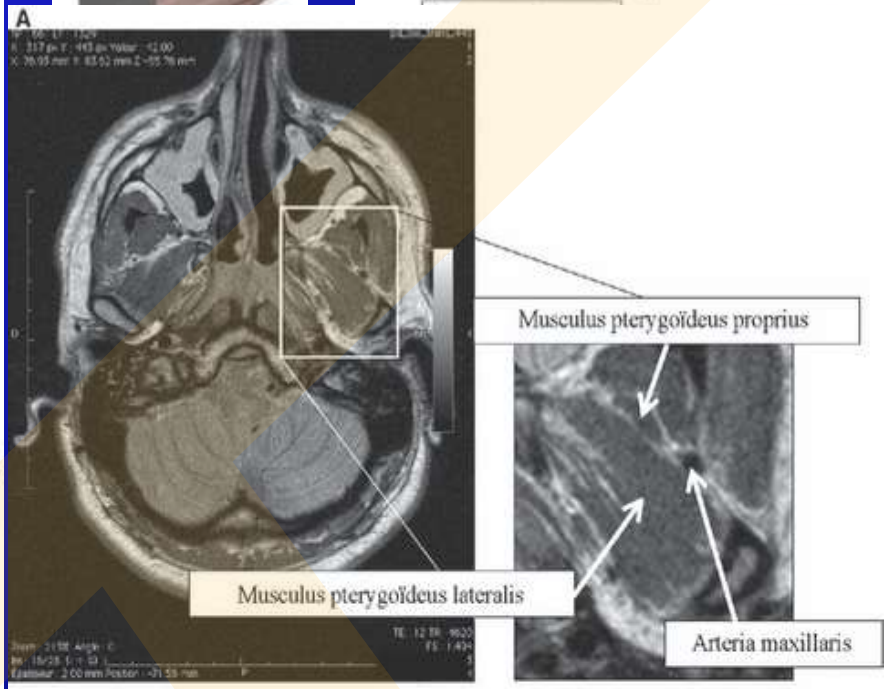
Caput mandi
Facies arti

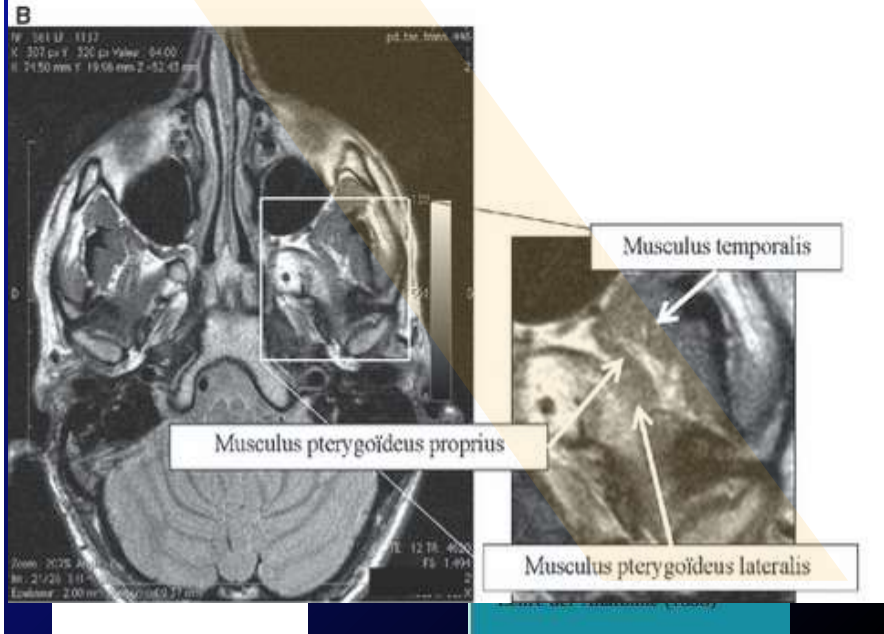


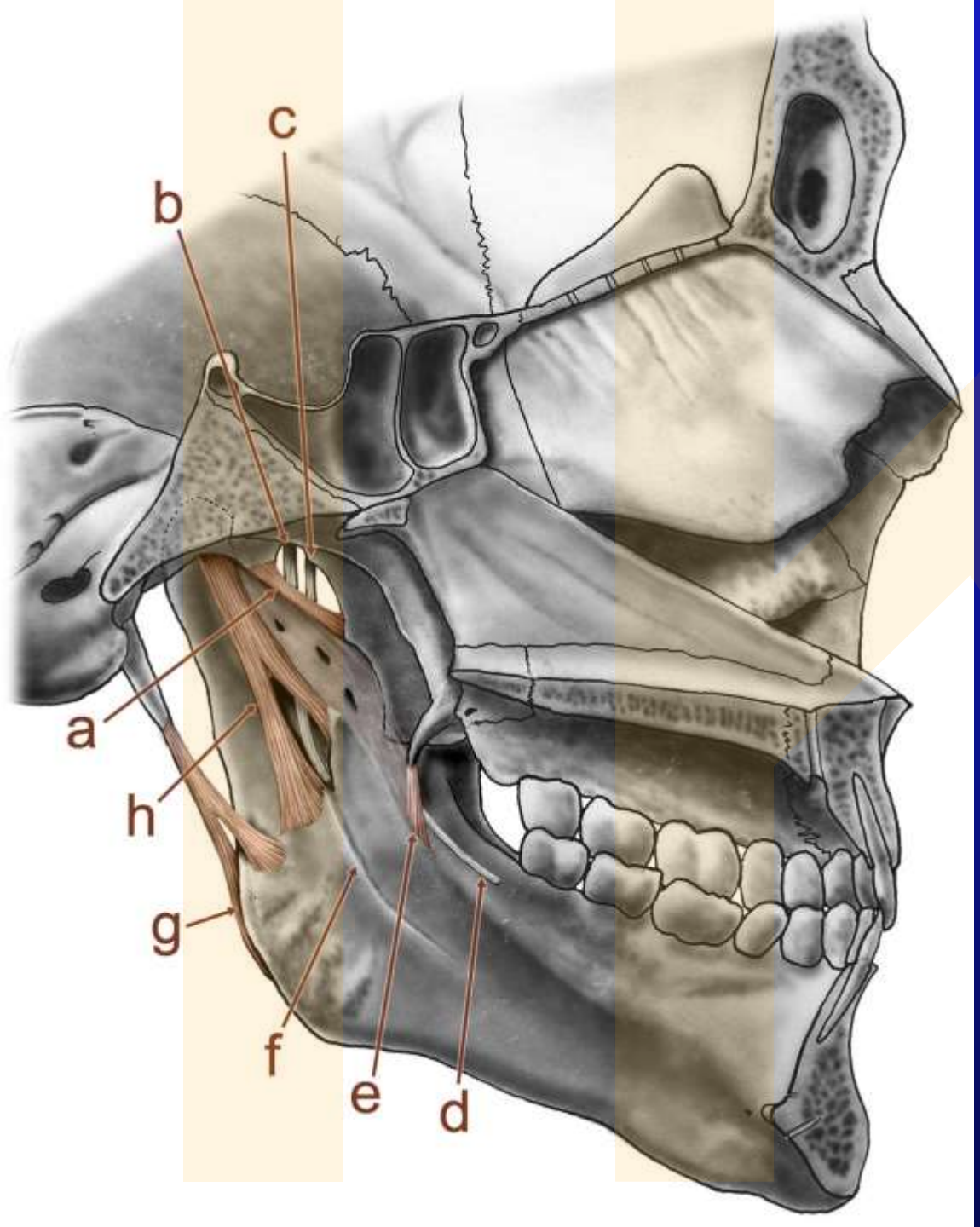


pterygomandibularis

pterygoideus proprius







a – lig. pterygospinosum

b – n. alveolaris inferior

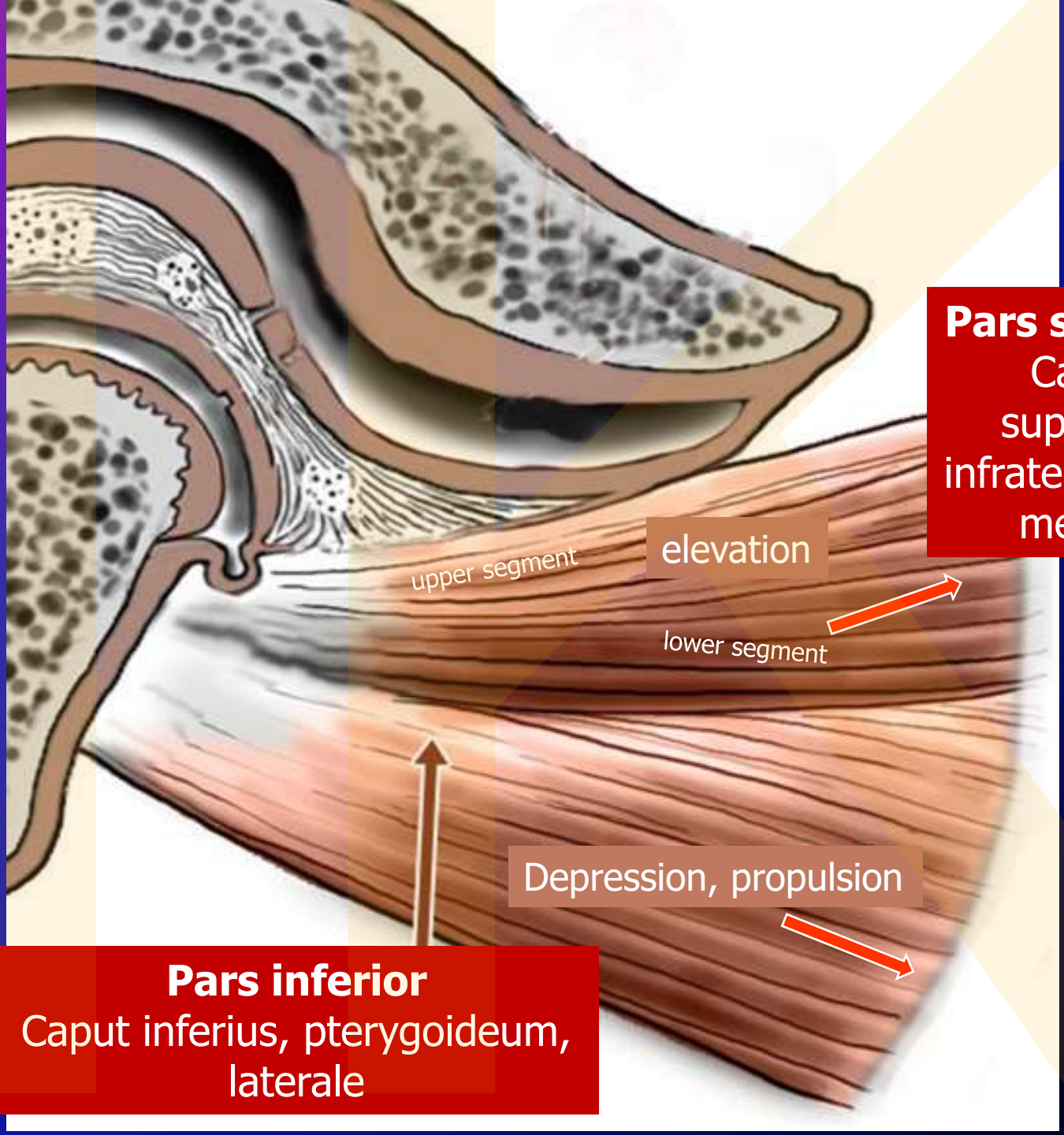
c, d – n. lingualis

e – lig. pterygomandibulare (raphe buccopharyngea)

f – sulcus mylohyoideus

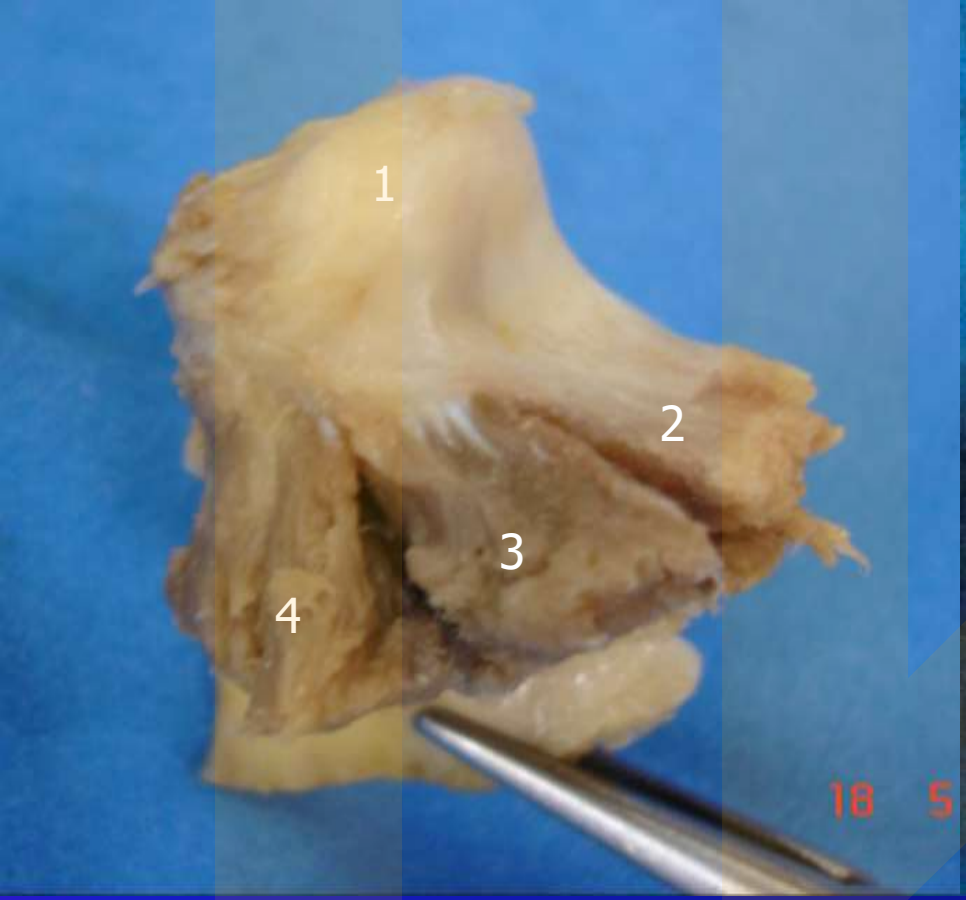
g – angulus mandibulae et lig. stylomandibulare

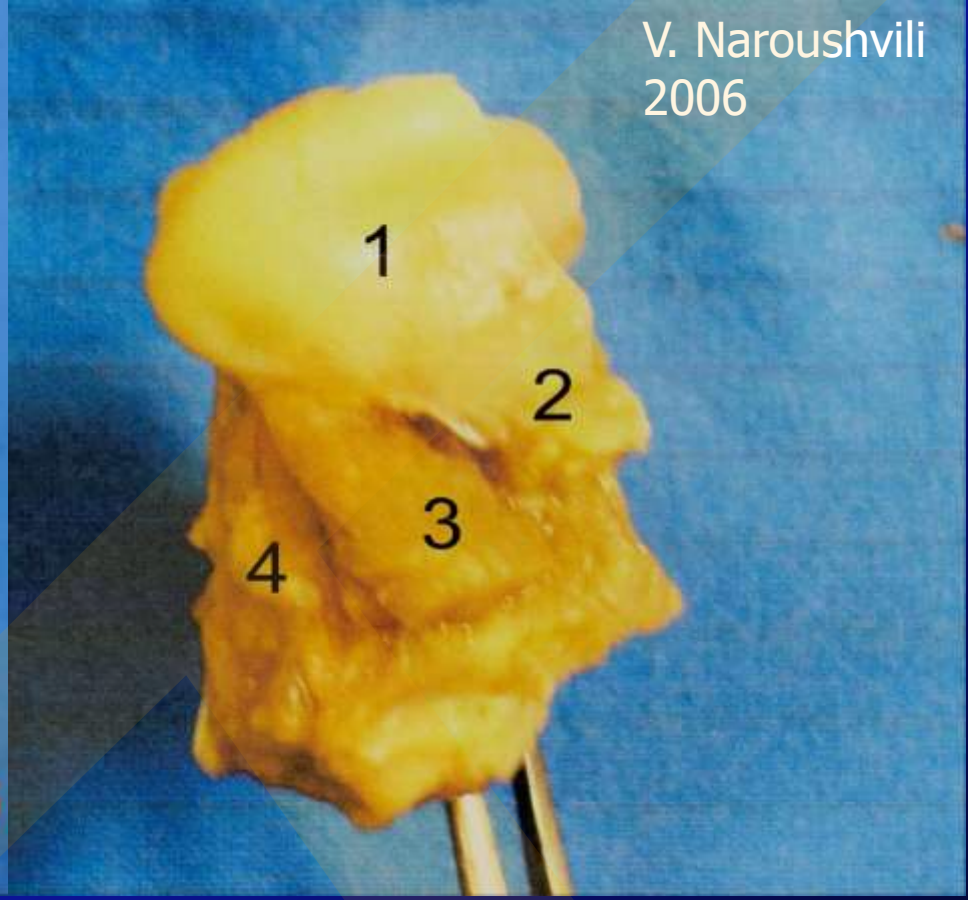
h – lig. sphenomandibulare



Pars superior
Caput superius, infratemporale, mediale

Pars inferior
Caput inferius, pterygoideum, laterale





Discus articularis (dissected)
1-Discus articularis,
2-insertion of the mm. masseter and temporalis,
3-insertion of the m. pteryg.lat (superior head),
4-insertion of the m. pteryg.lat (inferior head)

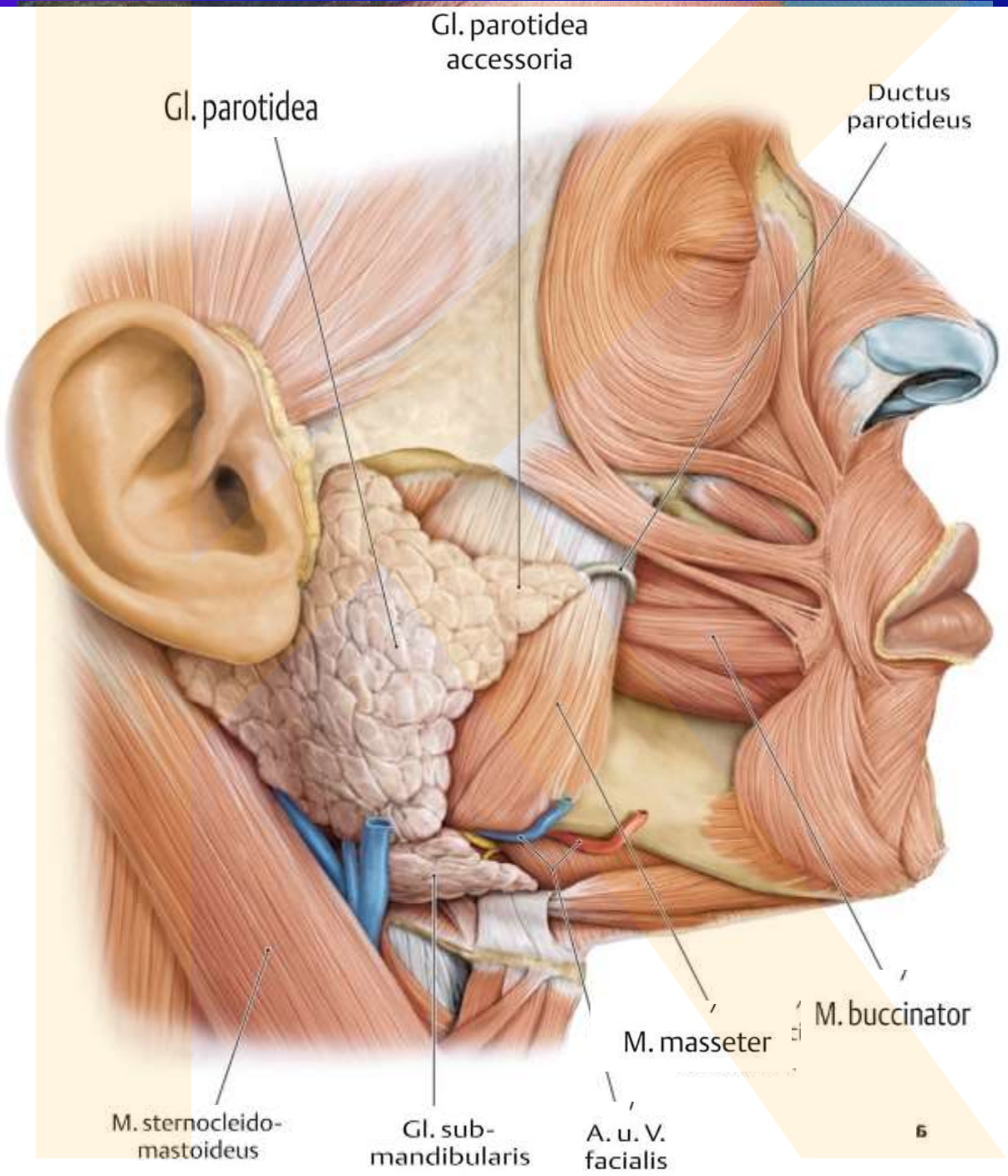
Superior head, inferior head, and ´third´head of the lateral pterygoid are shown (dissected)
1-Discus articularis,
2-M.pteryg.lat (superior head),
3-M.pteryg.lat (inferior head),
4- third head of the m. pteryg. lat (attached inferior head)

Elevace Elevation	masseter m. temporalis m. pterygoideus medialis m. pterygoideus lateralis	156 kg
Deprese Depression	venter anterior m. digastrici m. mylohyoideus m. geniohyoideus m. pterygoideus lateralis	
Retrakce Retraction	m. digastricus (biventer) pars superficialis (superficial part) masseteris pars posterior (dorsal part) m. temporalis	15-20 kg
Lateropulse Laterotraction (lateropulsion)	m. pterygoideus lateralis protilehlé strany lateral pterygoid on opposite head side	55 kg
Protrakce Protraction	m. pterygoideus lateralis pars profunda (deep part) masseteris m. pterygoideus medialis	55 -60 kg

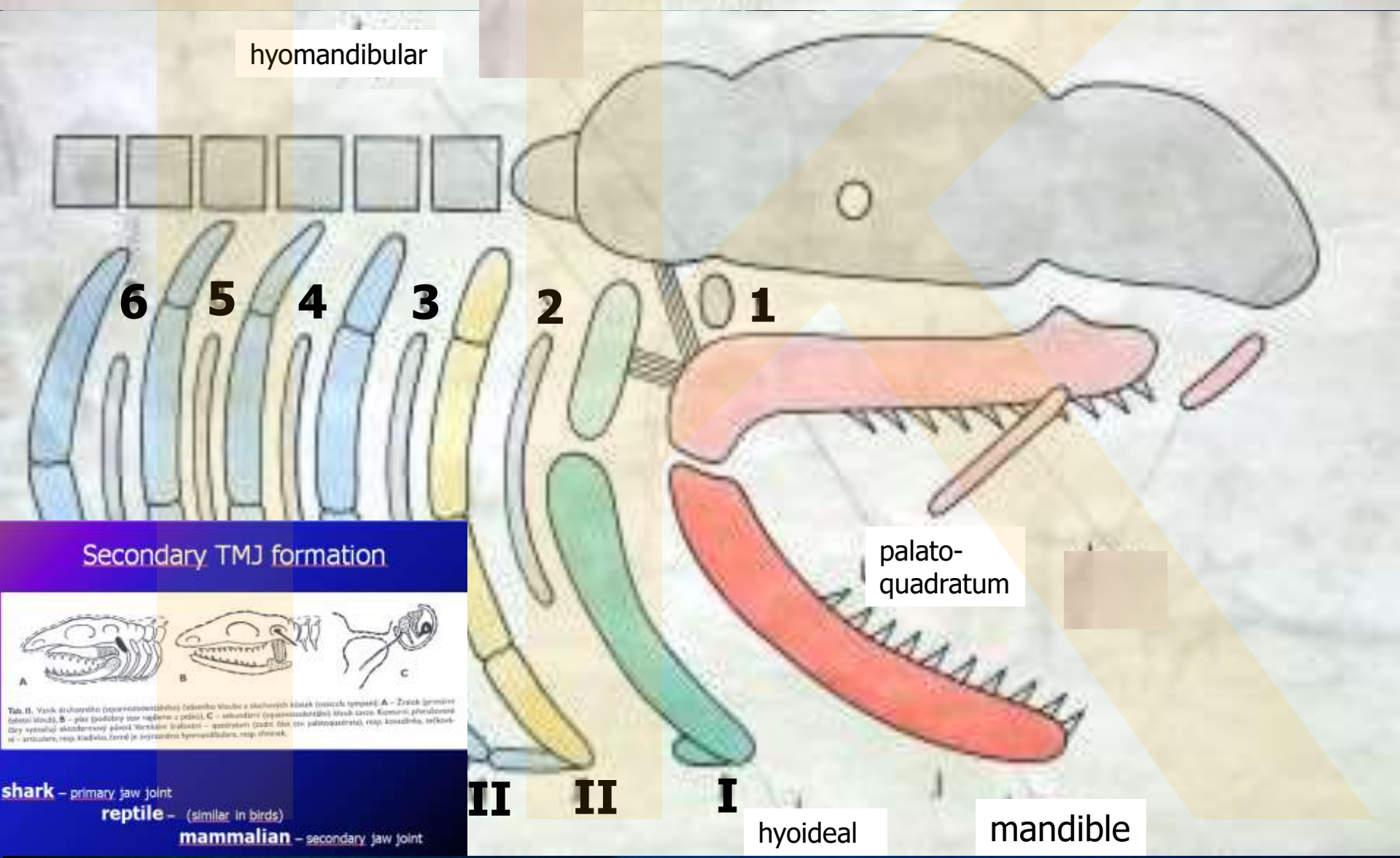
Upraveno podle Machoň, Hirjak a kol. 2014

Articulatio temporomandibularis, craniomandibularis

(Temporomandibular joint
TM joint
Temporocranial joint
Craniomandibular joint)



Arrangement and head proportion in respect to development



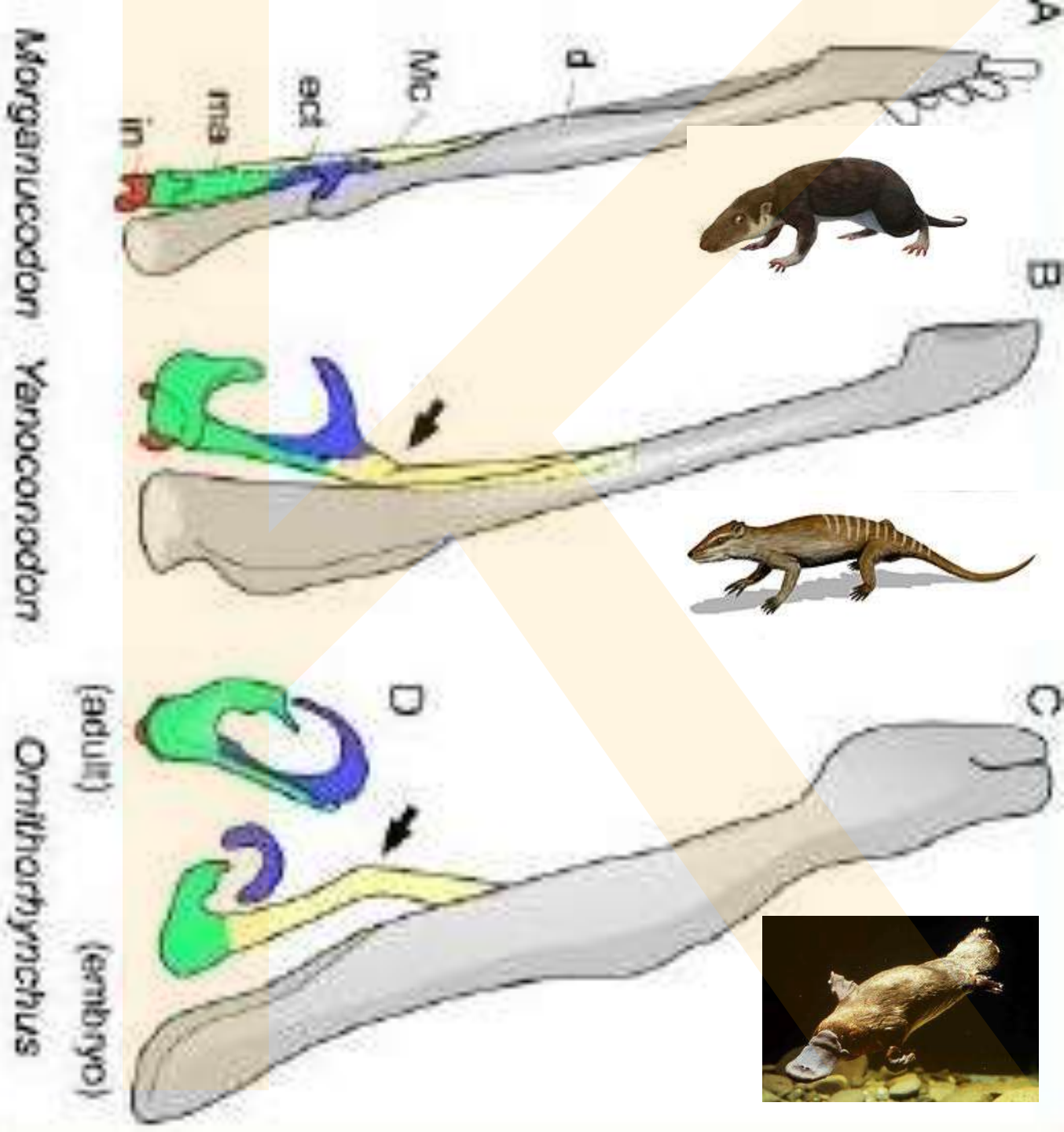
Secondary TMJ formation

shark – primary jaw joint

reptile – (similar in birds)

mammalian – secondary jaw joint

Figure 3. Evolution of the lower jaw skeleton in ancestral mammals (based on Luo et al., 2007). (A) Ventral view of the lower jaw of the most "primitive" mammal, *Morganucodon*. The ectotympanic and malleus are completely in contact with the dentary. By contrast, in *Yanoconodon* (B), the ectotympanic and malleus are connected anteriorly to the dentary via an ossified Meckel's cartilage, but these are mediolaterally separated from the posterior part of the dentary, facilitated by curvature of the cartilage (arrow). A similar condition is seen in an extant monotreme embryo, *Ornithorhynchus* (C). The middle ear bones of an adult *Ornithorhynchus* (D) demonstrate significant similarity to those of *Yanoconodon*. *Yanoconodon* seems to retain the embryonic pattern of *Ornithorhynchus* because of an earlier ossification of Meckel's cartilage, but otherwise its ectotympanic, malleus, and incus are almost identical to those of the adult *Ornithorhynchus*.

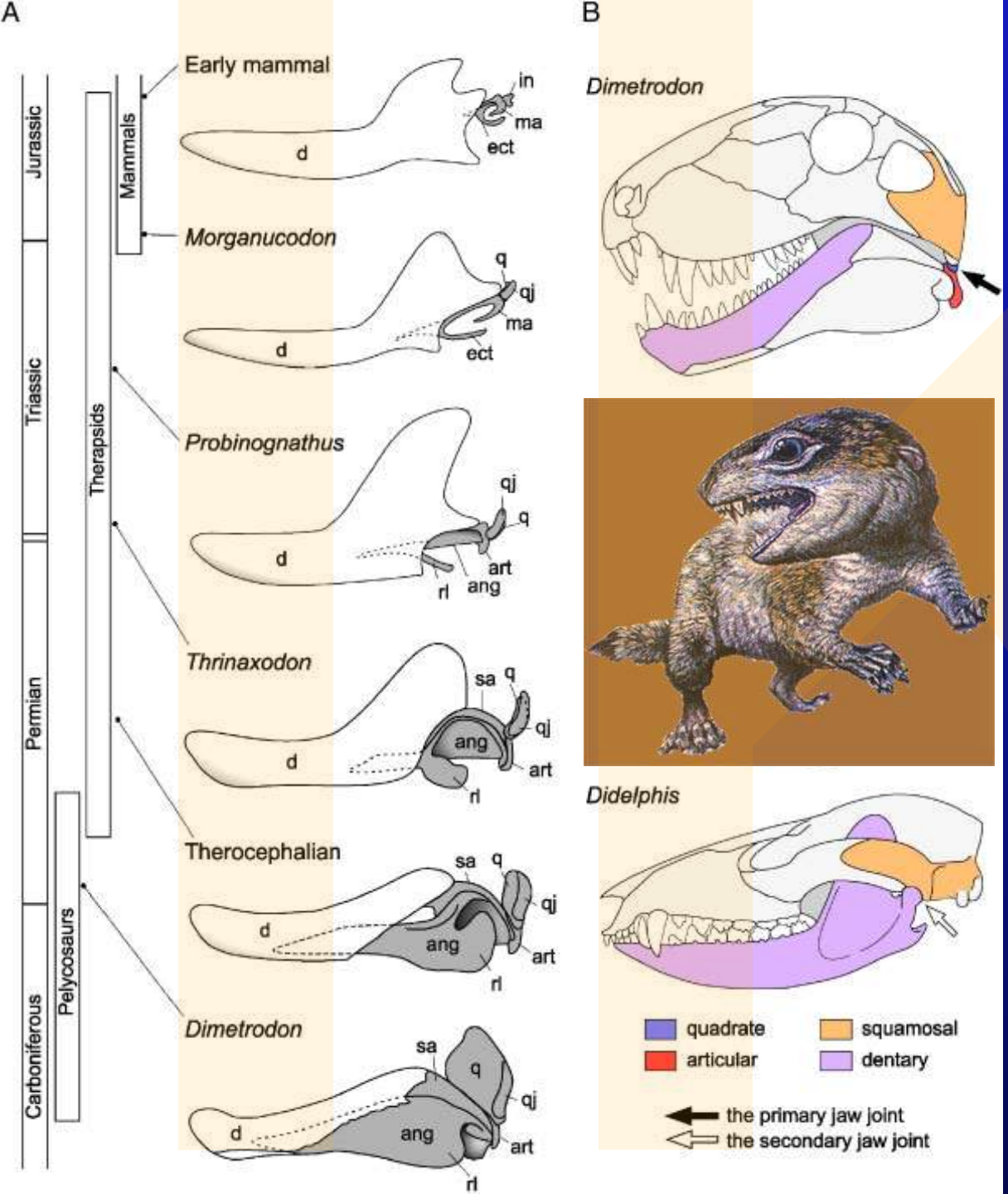


Mammal of the trias period

Jurassic mammal

Platypus (water mole)

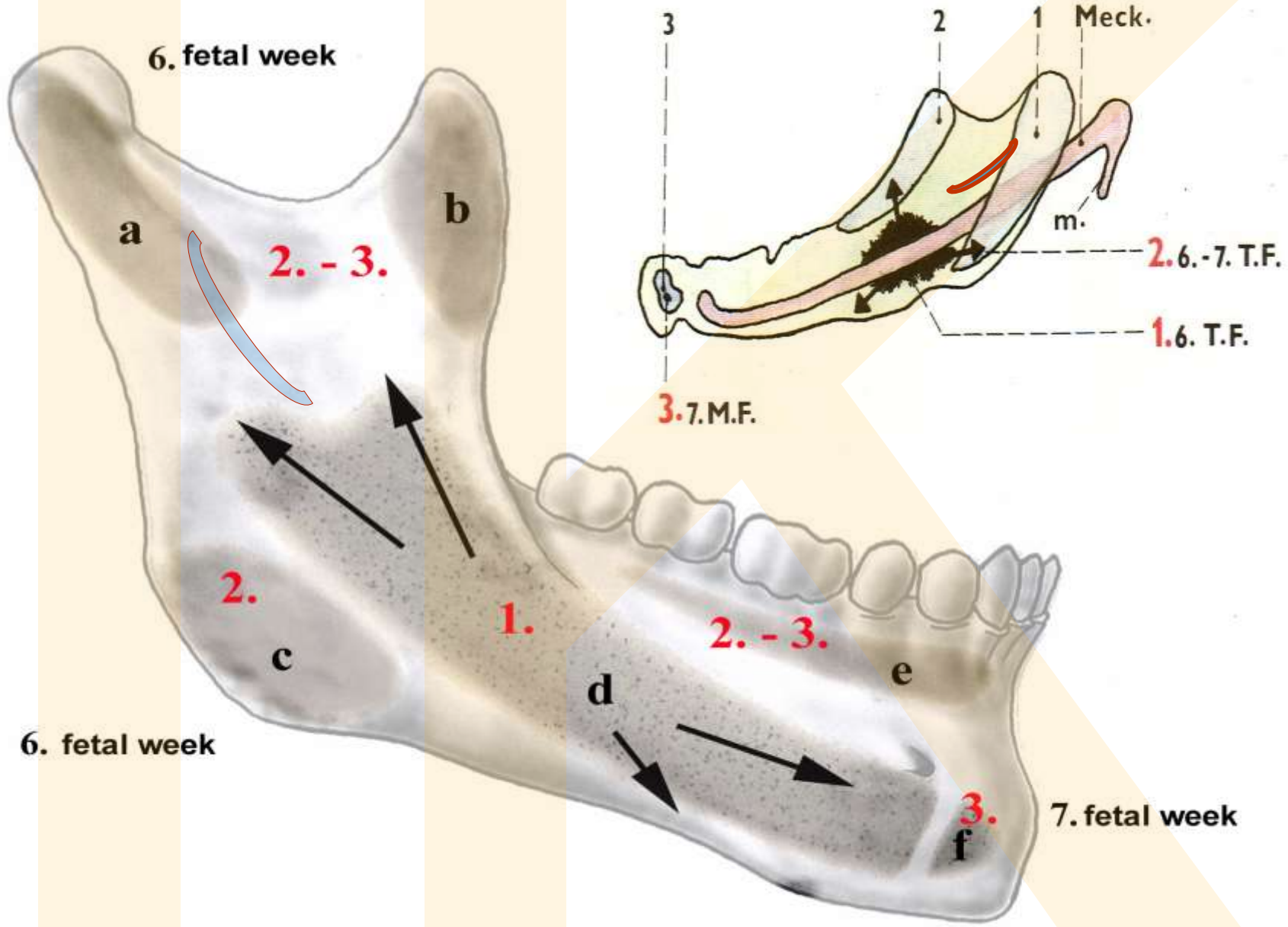
Paleontological evidence for mammalian middle ear and TMJ evolution.



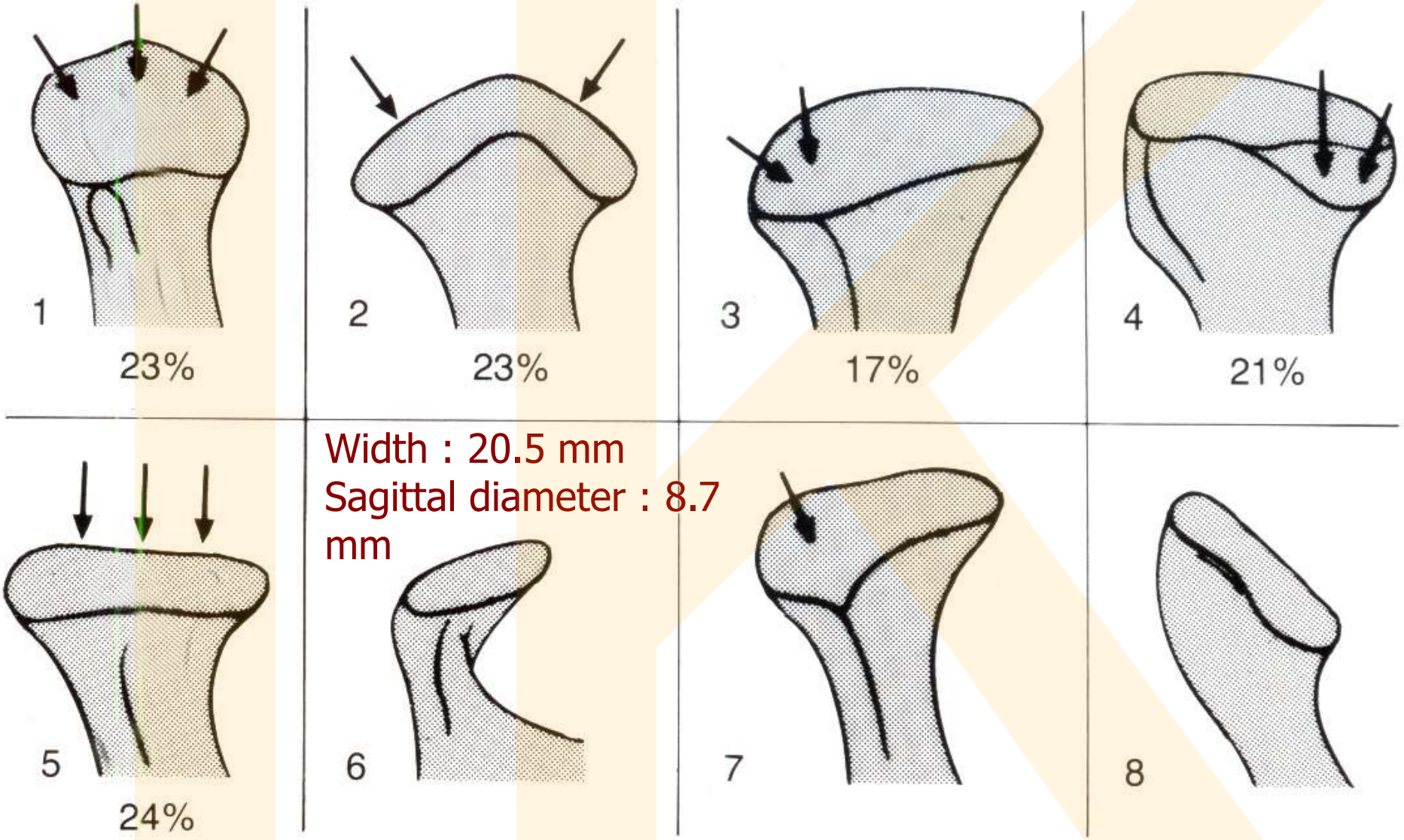
(A) Diagrams of lateral views of jaw skeletal elements showing modifications leading to the mammalian condition (after Allin, ’75). The geological record and occurrence of each animal are indicated on the left. For clarity of comparison, no teeth are shown. Note that a set of postdentary elements (articular, surangular, and angular) and the upper jaw elements (quadrate and quadratojugal), indicated by gray, became separated from the dentary and reduced in size during the transition from pelycosaurs to mammals. The sequence of changes represent only structural grades.

(B) Changes in jaw articulation during mammalian evolution. In a pelycosaur, Dimetrodon (top), the quadrate and articular formed a functional jaw joint (black arrow). In an ‘‘advanced’’ cynodont, Diarthrognathus (middle), an additional jaw joint was observed between the squamosal and dentary (white arrow). In an extant marsupial, Didelphis (bottom), the functional jaw joint has been taken over only by the squamosal and dentary.

Takechi M, Kuratani S. 2010. History of studies on mammalian middle
ear evolution: a comparative morphological and developmental biology perspective. J. Exp. Zool. (Mol. Dev. Evol.) 314B:[page range].

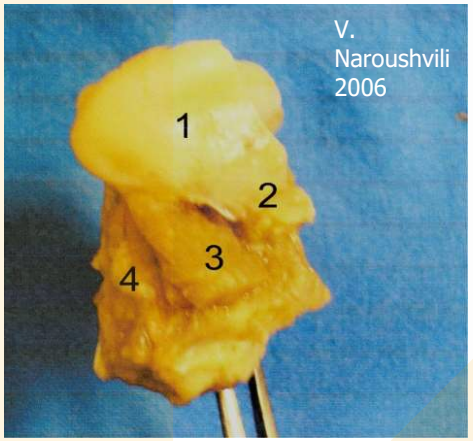


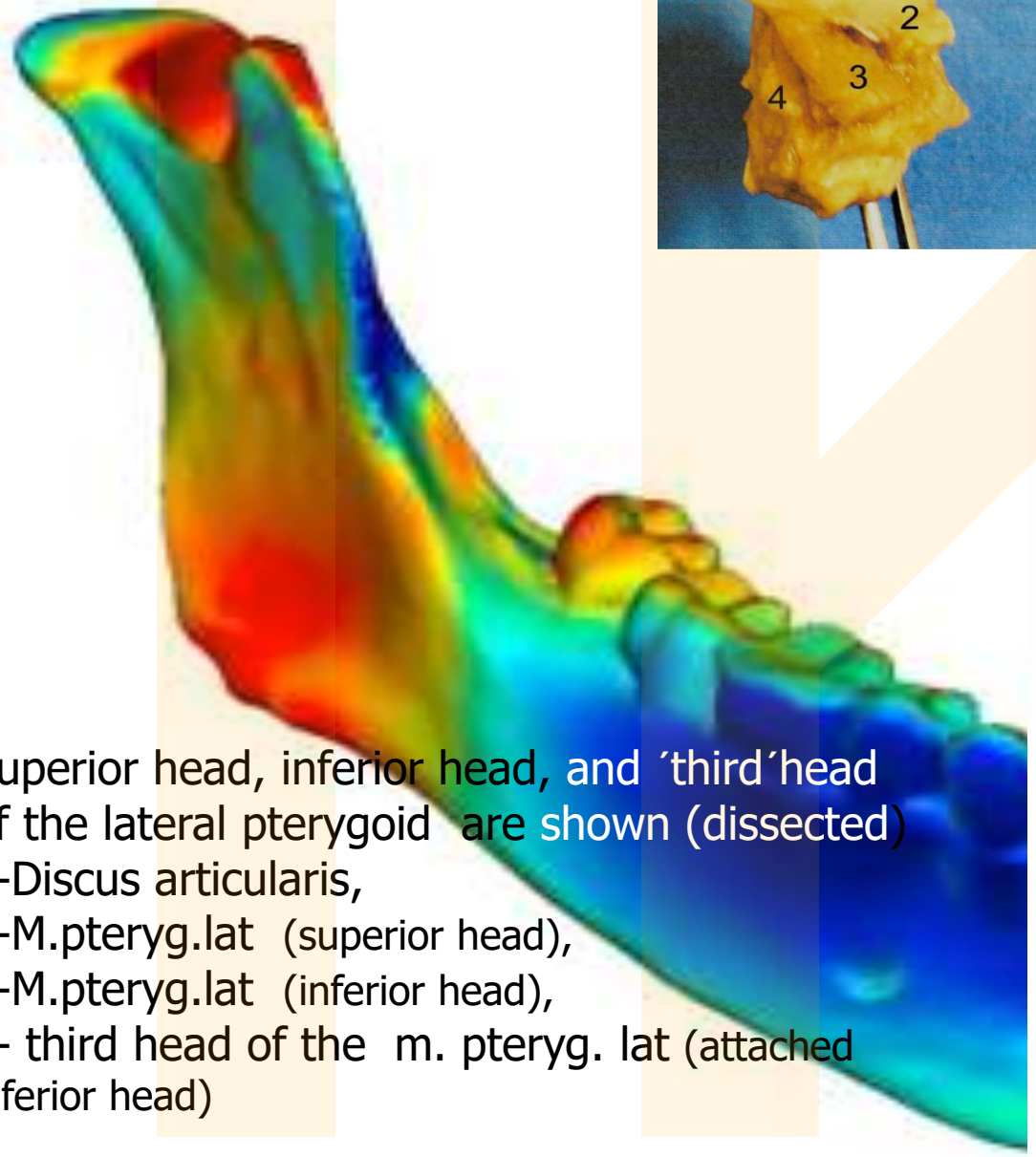
Cartilaginous column – derivative from the Meckel´s cartilage ?



Width : 20.5 mm
Sagittal diameter : 8.7 mm

Various morphologic types of mandibular condyle and their prevalence, based on specimens from fully dentulous individuals 20–53 years of age (Mongini 1975)





Superior head, inferior head, and ´third´head of the lateral pterygoid are shown (dissected)
1-Discus articularis,
2-M.pteryg.lat (superior head),
3-M.pteryg.lat (inferior head),
4- third head of the m. pteryg. lat (attached inferior head)


150-160°

Basis cranii externa – oblique view where os tympanicum is shown

Condylus occipitalis

Processus styloideus

Foramen jugulare

For. stylomastoideum

Processus mastoideus

Fissura tympanomastoidea

Fis.petrotympanica

Fis.petrosquamosa

Fis.tympanosquamosa

Porus acusticus ext.

•Tuberc. pharyngicum

•Foramen lacerum

•Spina sphenoidalis

•Foramen spinosum

•Foramen ovale

Fossa mandibularis

•Tuberculum articulare

Arcus zygomaticus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DICOM Storage
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Virtual Ceph
Adjust Levels
Measure Length
Measure Angle
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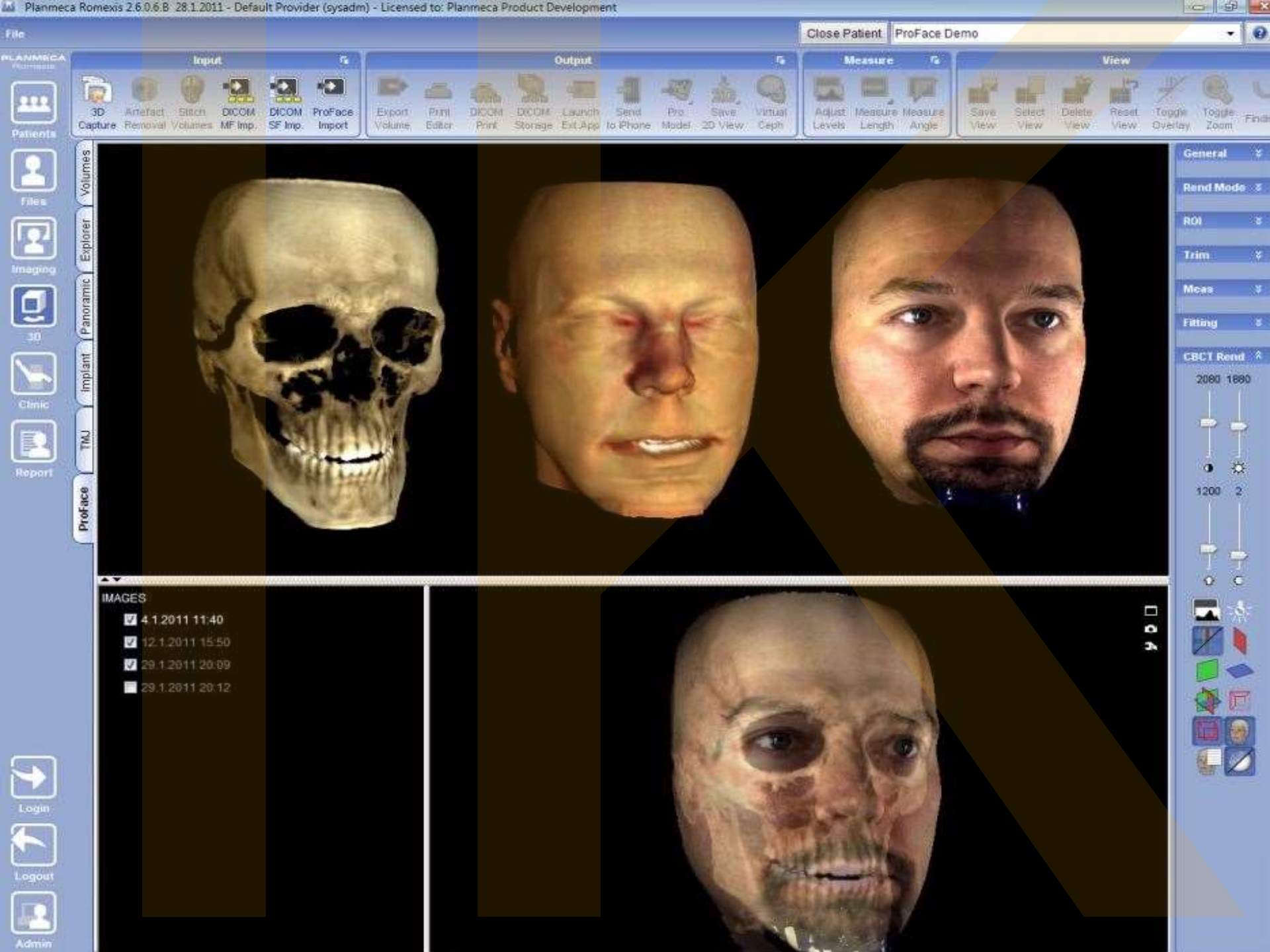
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DICOM Print
DICOM Storage
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Pro Model
Save 2D View
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Adjust Levels
Measure Length
Measure Angle
Save View
Select View
Delete View
Reset View
Toggle Overlay
Toggle Zoom
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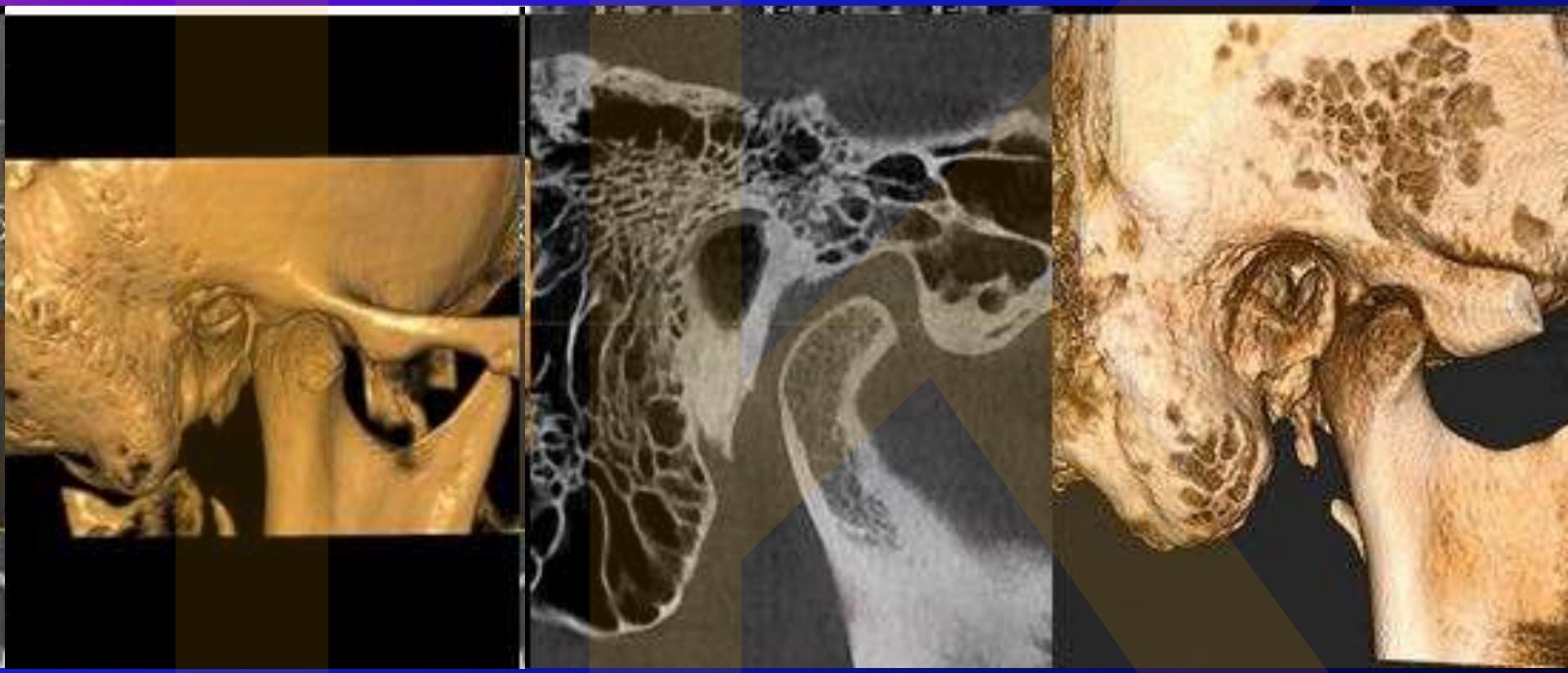
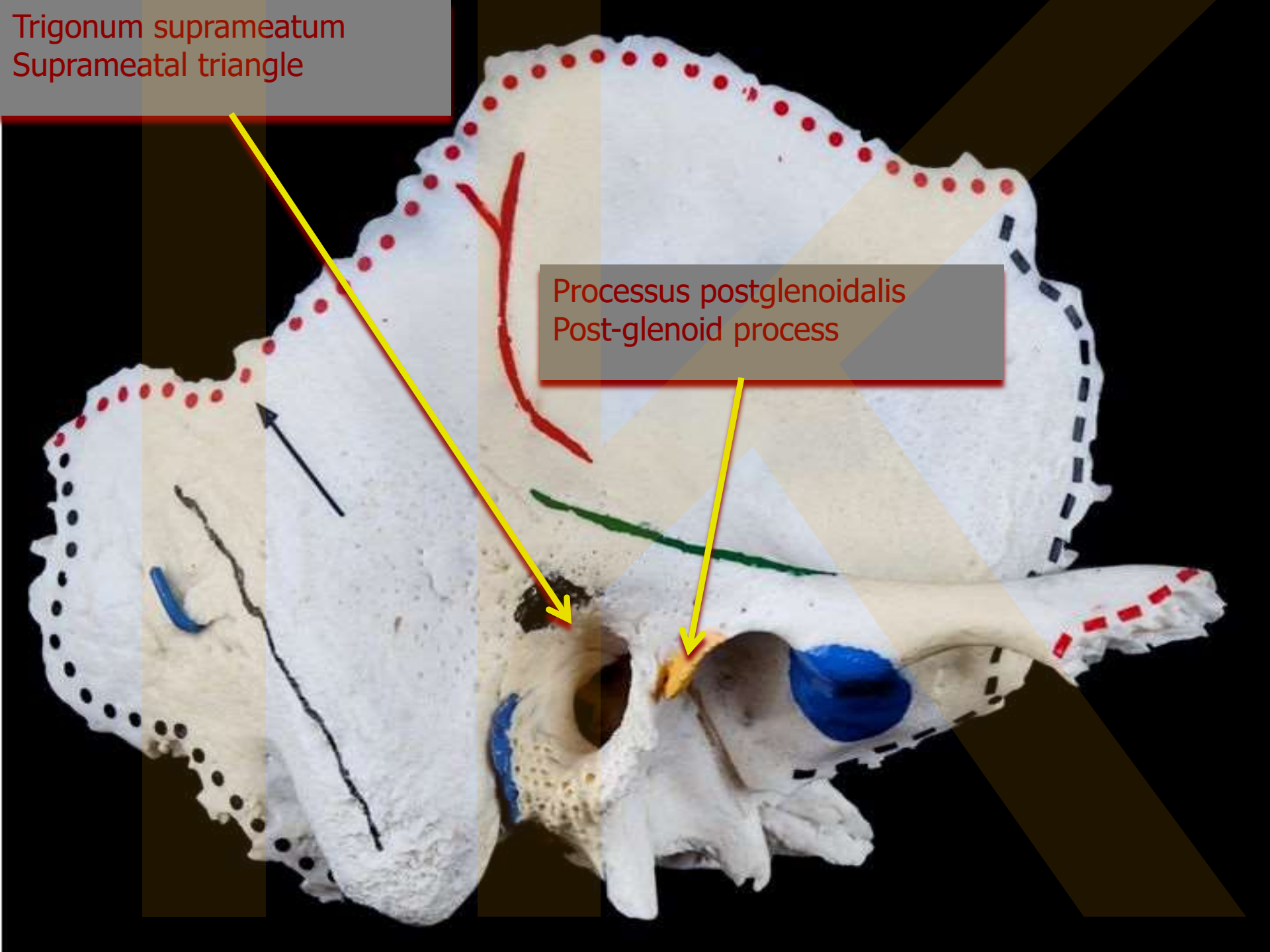
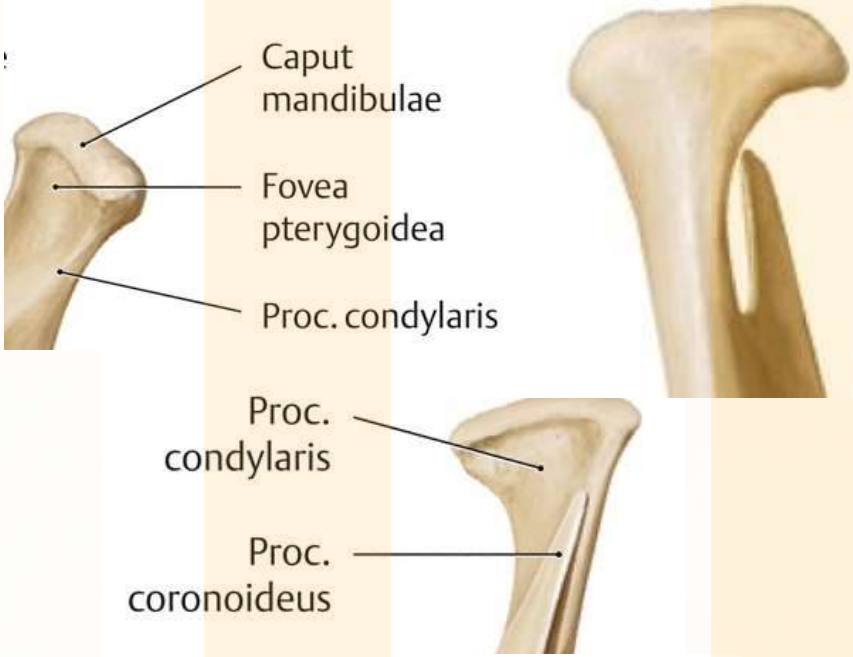
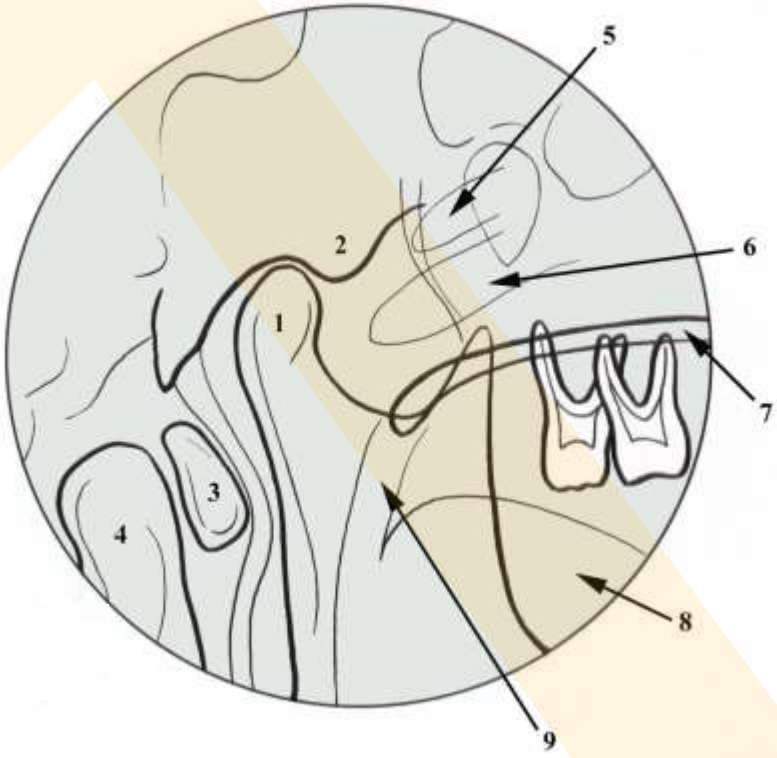



Trigonum suprameatum
Suprameatal triangle
Processus postglenoidalis
Post-glenoid process

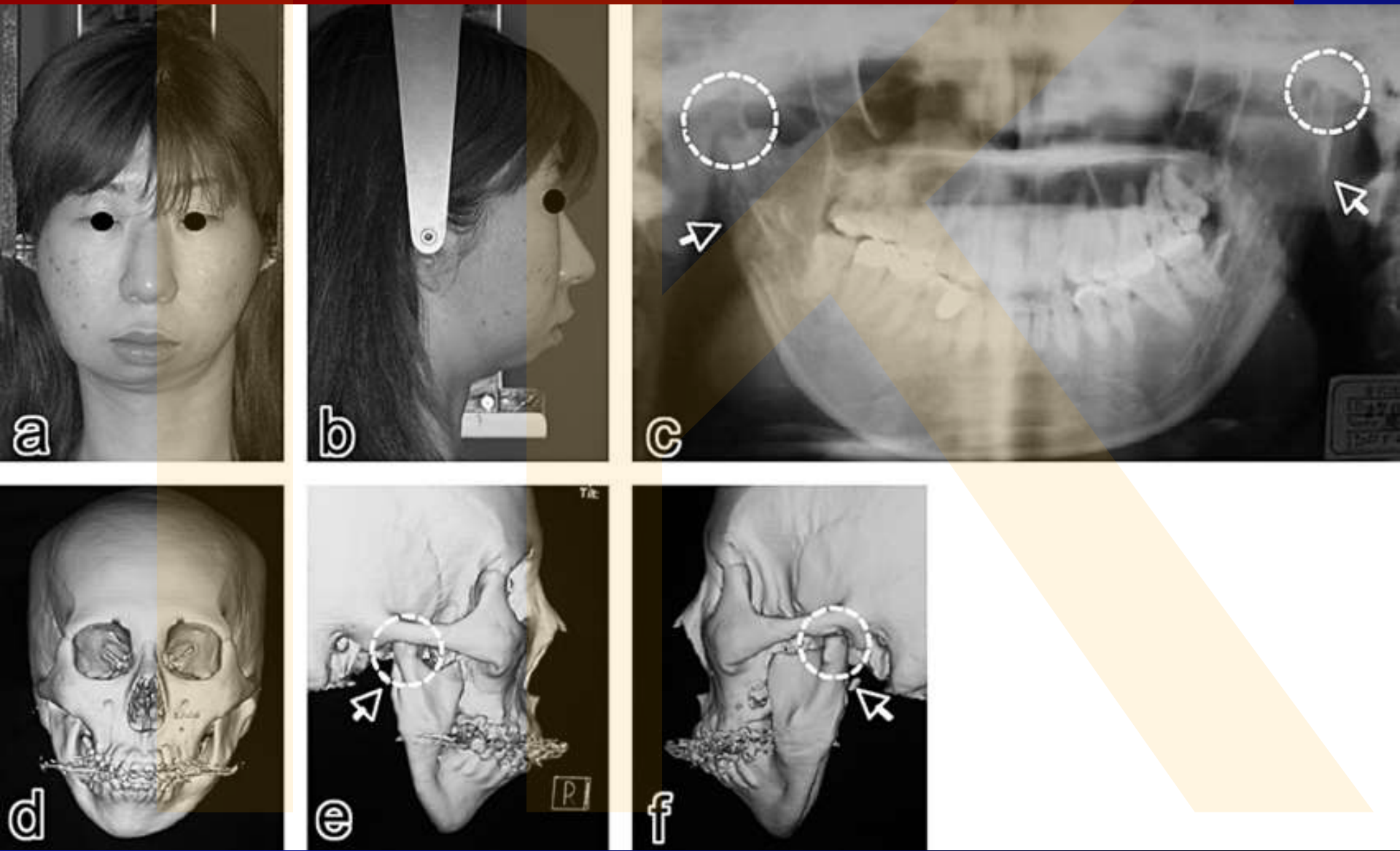


15-20 x 8-10mm

Fig. 2.122 Tomographic examination of the temporomandibular articulation. The two images (a and b) are about 0.5 cm apart.



Bilaterální hypoplasie kondylu dolní čelisti
Bilateral hypoplasia of the mandibular condyle



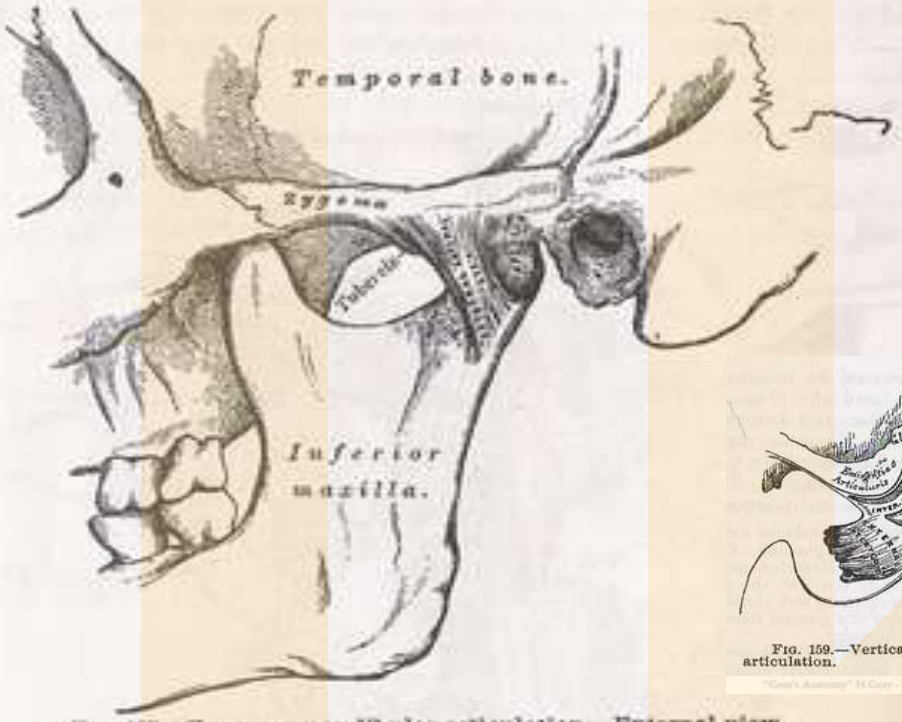


Fig. 157.—Temporo-mandibular articulation. External view.

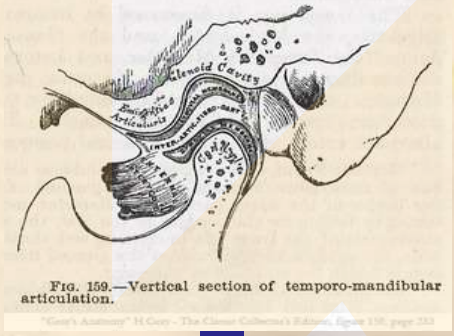


Fig. 159.—Vertical section of temporo-mandibular articulation.

Fig. 158.—Temporo-mandibular articulation. Internal view.

Gray´s anatomy, The classic collector´s edition

Articular Capsule is a sac that encloses TMJ.

Borders: Superior: Capsule is positioned underneath inferior side of Articular Eminence.
Inferior: Capsule wraps around condyle's neck (Collum Mandibulae)

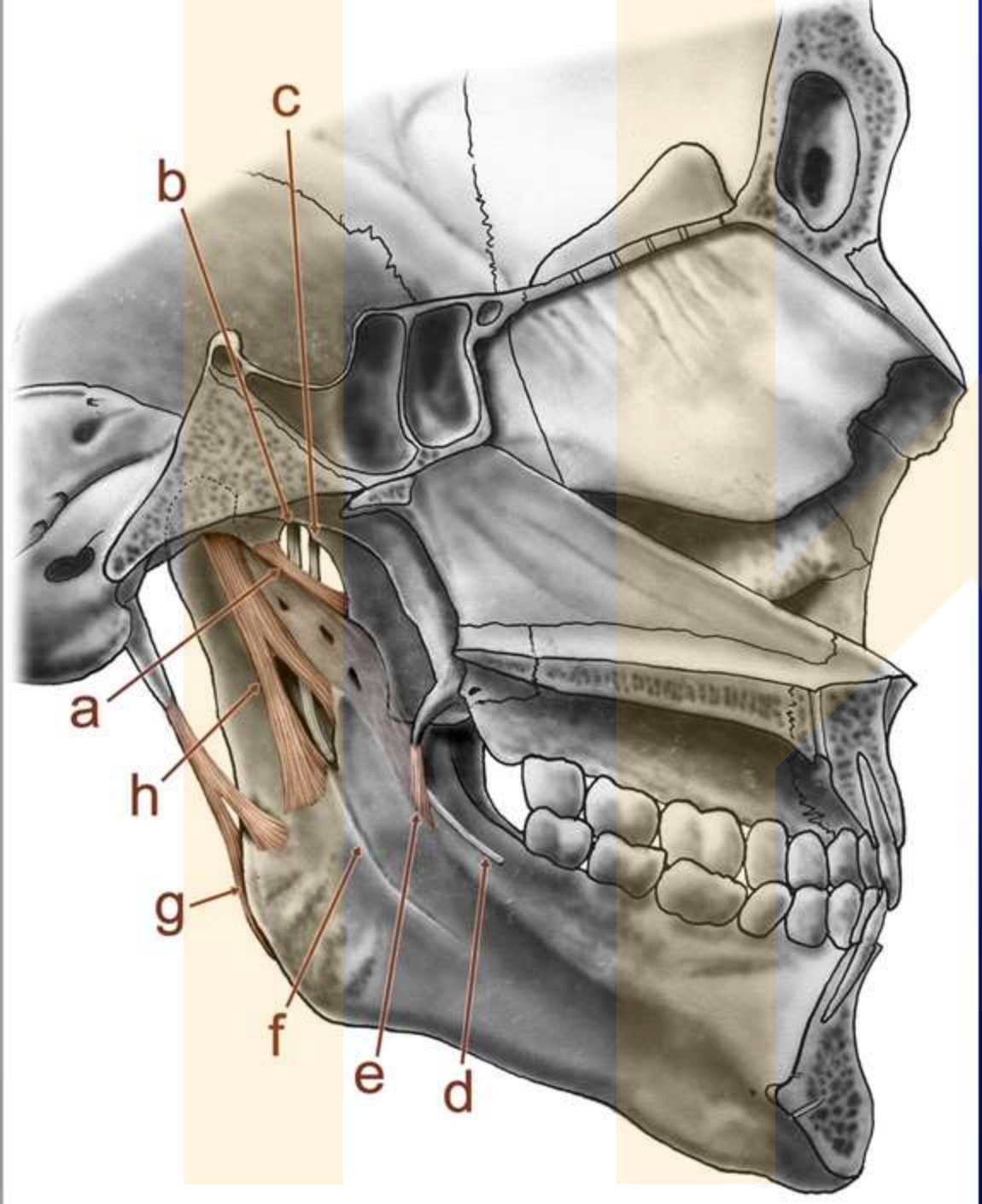
A fibro-cartilageus disc divides synovial cavity of TMJ into:

1. ***Superior synovial cavity***
2. ***Inferior synovial cavity***

Both cavities are filled with synovial fluid, secreted by inner side of articular capsule (clear, viscous fluid).

Attachments of articular disc:

1. Anterior:	a. Anterio-Superior:	indirectly to articular eminence through capsule
	b. Anterio-inferior:	to condyl's neck
2. Posterior:	a. Posterio-superior:	to post-glenoid process more salient in young *spina supra meatum ?*
	b. Posterio-inferior:	to condyl's neck



a – lig. pterygospinosum

b – n. alveolaris inferior

c, d – n. lingualis

e – lig. pterygomandibulare (raphe buccopharyngea)

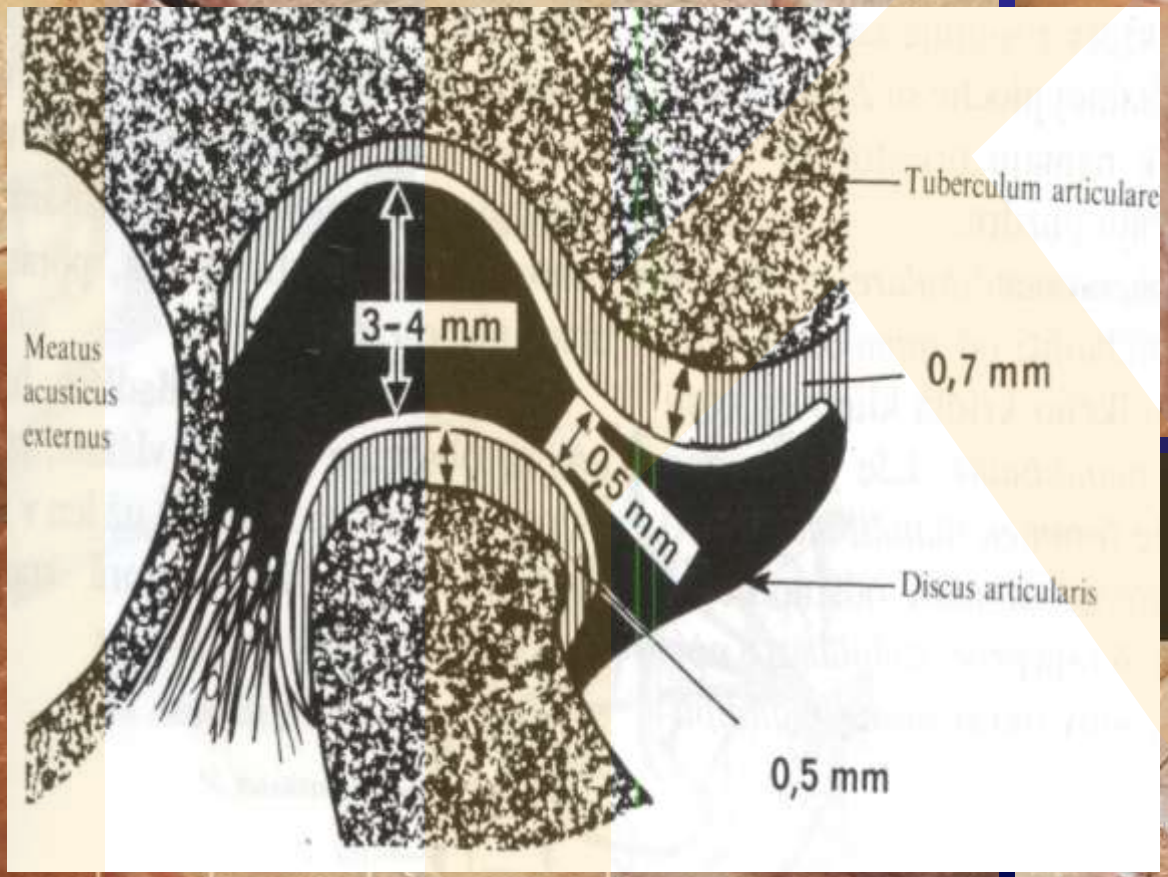
f – sulcus mylohyoideus

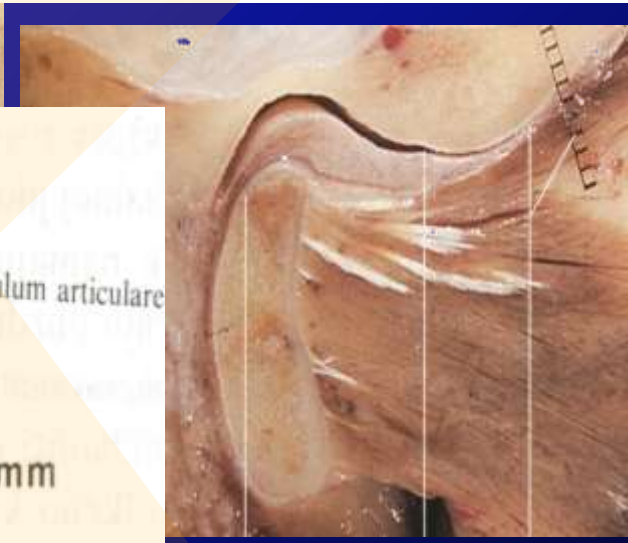
g – angulus mandibulae et lig. stylomandibulare

h – lig. sphenomandibulare

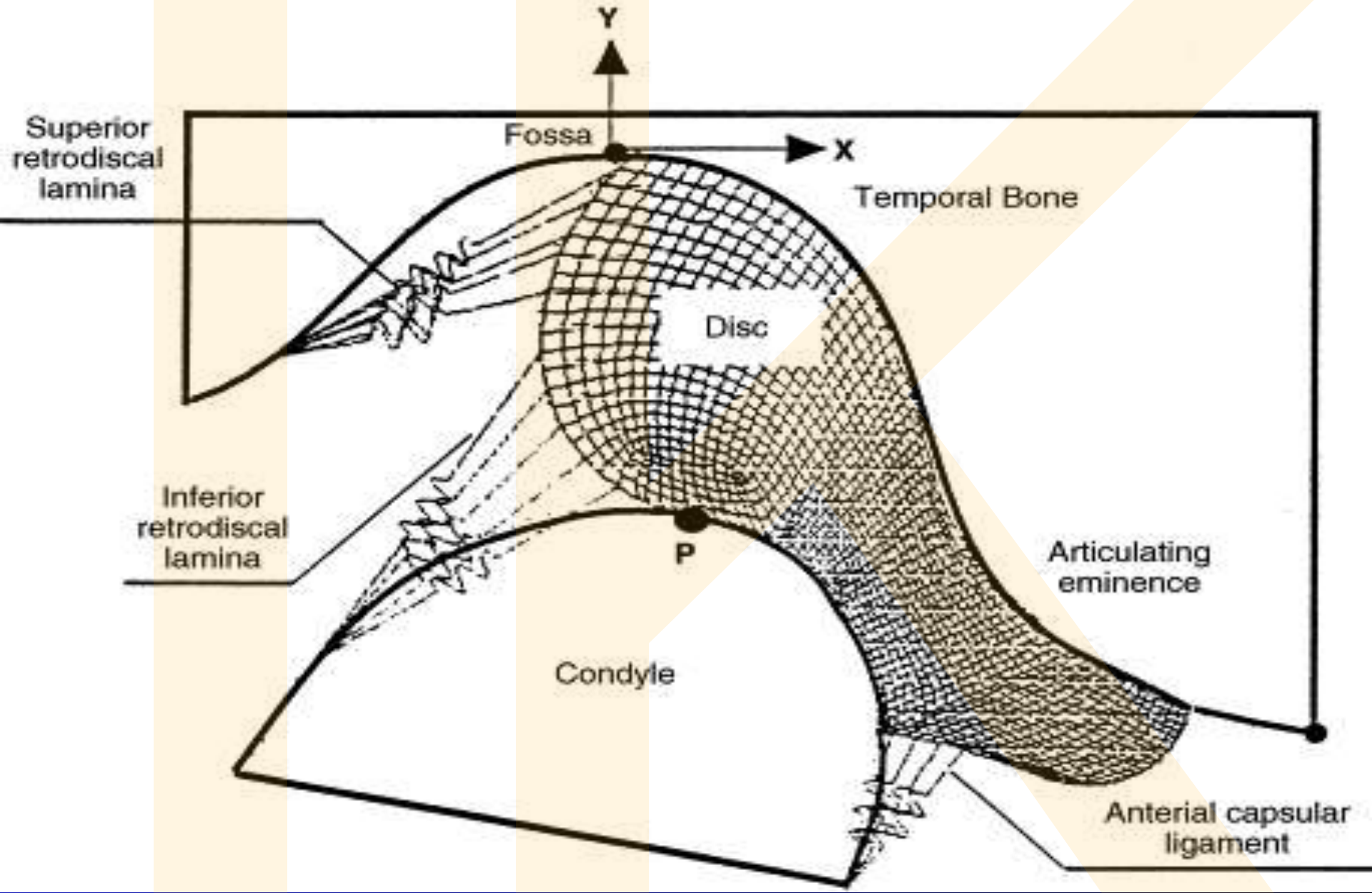
Upper space cavitas discosquamosa – 581 mm^2
Lower space cavitas discocondylaris – 396 mm^2

Medial view of the TMJ with the joint spaces opened
1 Articular eminence and upper joint space
2 Anterior end of lower joint space
3 Lateral pterygoid muscle
4 Articular disc
5 Posterior end of upper joint space
6 Tympanic membrane and posterior end of lower joint space

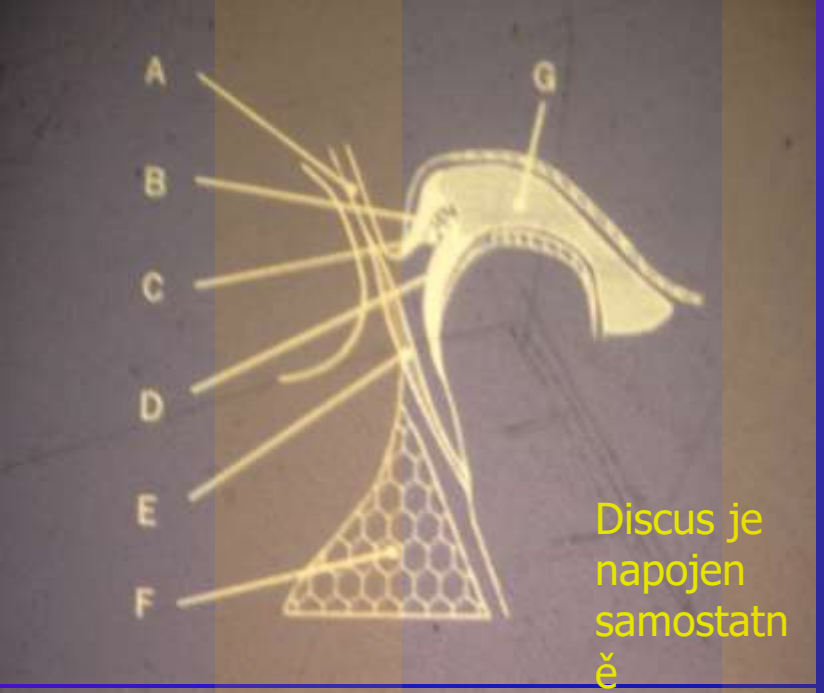




6 5 4 3 2 1



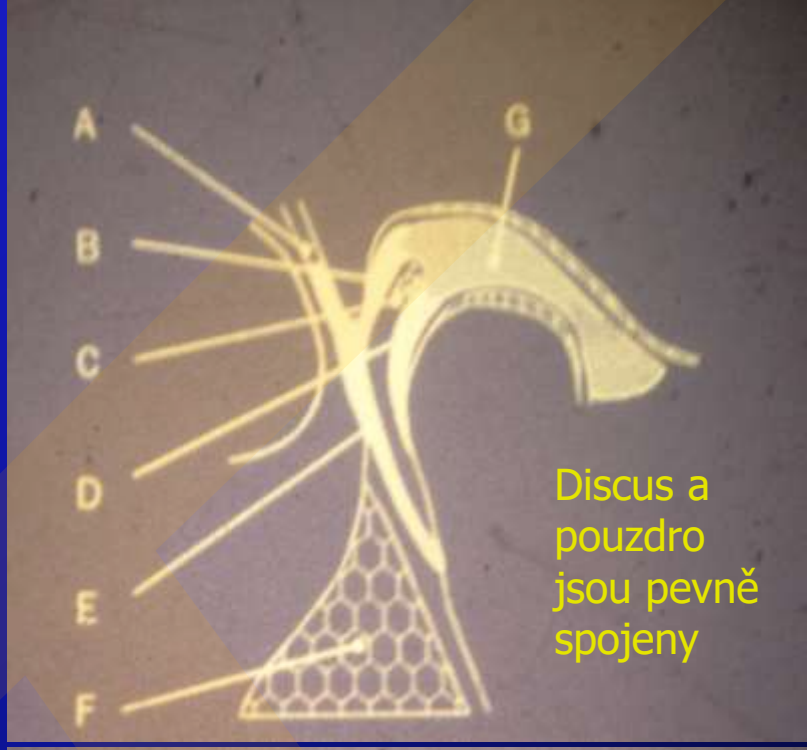
•J. Chen, U. Akyuz, L. Xu, R.M.V. Pidaparti : **Stress analysis of the human temporomandibular joint**
•**Medical Engineering & Physics 20/8/:** 565-572, October 1998



Discus je napojen samostatně

Dreger H (1994) Untersuchungen zur posterioren Anheftung Des Diskus artikularis im menschlichen Kiefergelenk. Med Diss Kiel

Vasili Naroushvili: Wechselwirkungen zwischen Okklusionsarten und Anheftungsarten des Musculus pterygoideus lateralis bei der Entstehung von Diskus Dislokation des Kiefergelenkes Hamburg 2006

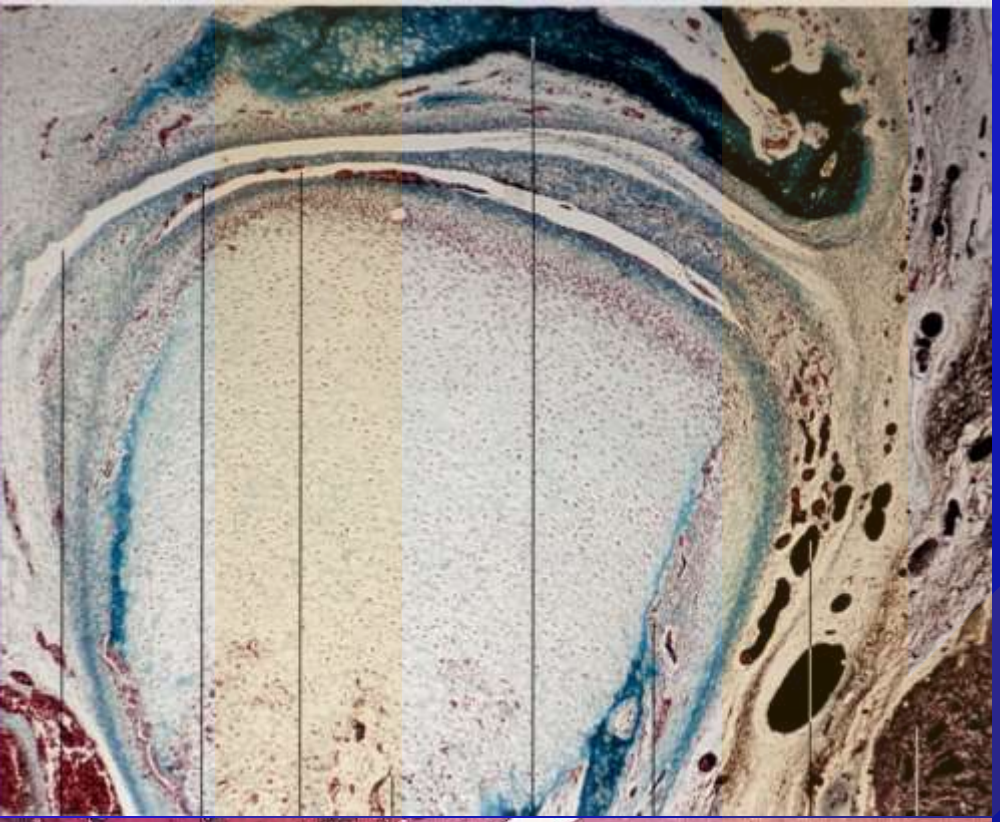


Discus a pouzdro jsou pevně spojeny

Discus napojen přes pouzdro

A) Fissura tympanosquamosa
B) Stratum superius
C) genu vasculosum
D) Stratum inferius
E) Capsule
F) Glandula parotis
G) Discus articularis

Discus napojen na fascia parotis, a podkožní struktury; pouzdro je slabé

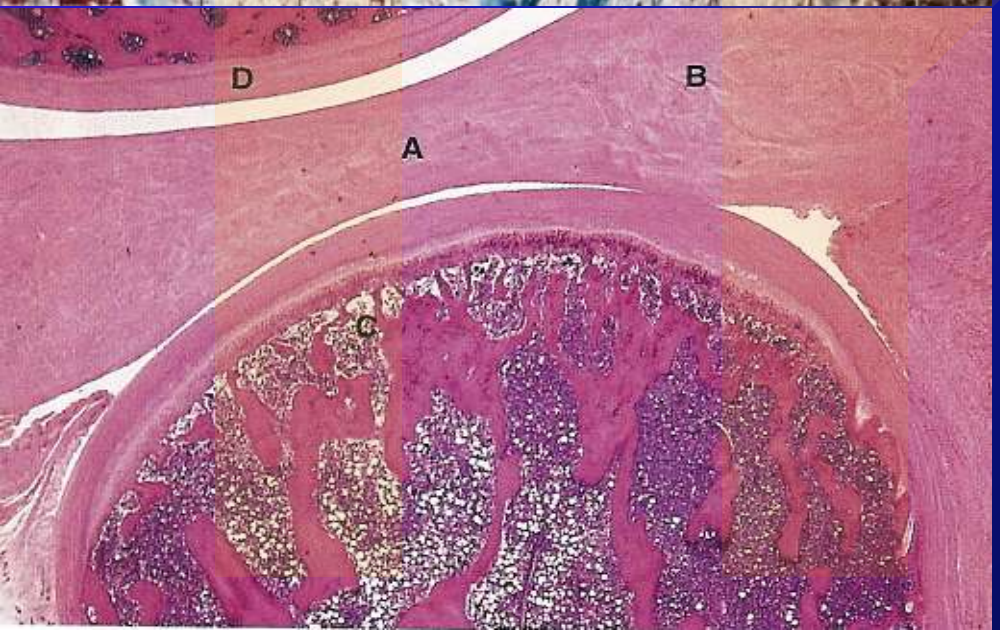


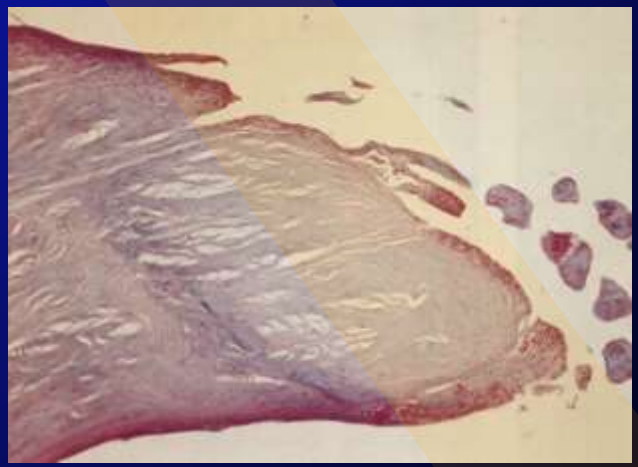
Transverse section through the TMJ of a 14-cm-long fetus
1 Upper joint space (discosquamal compartment)
2 Articular disc
3 Lower joint space (discomandibular compartment)

kloubní povrch kondylu tvoří čtyři vrstvy:

- Superficial layer: superficial articular layer = connective tissue character
- Very cellular layer:
- Proliferating layer:
- Hypertrophic layer:

discus articularis je v období vzniku bohatě vaskularizován

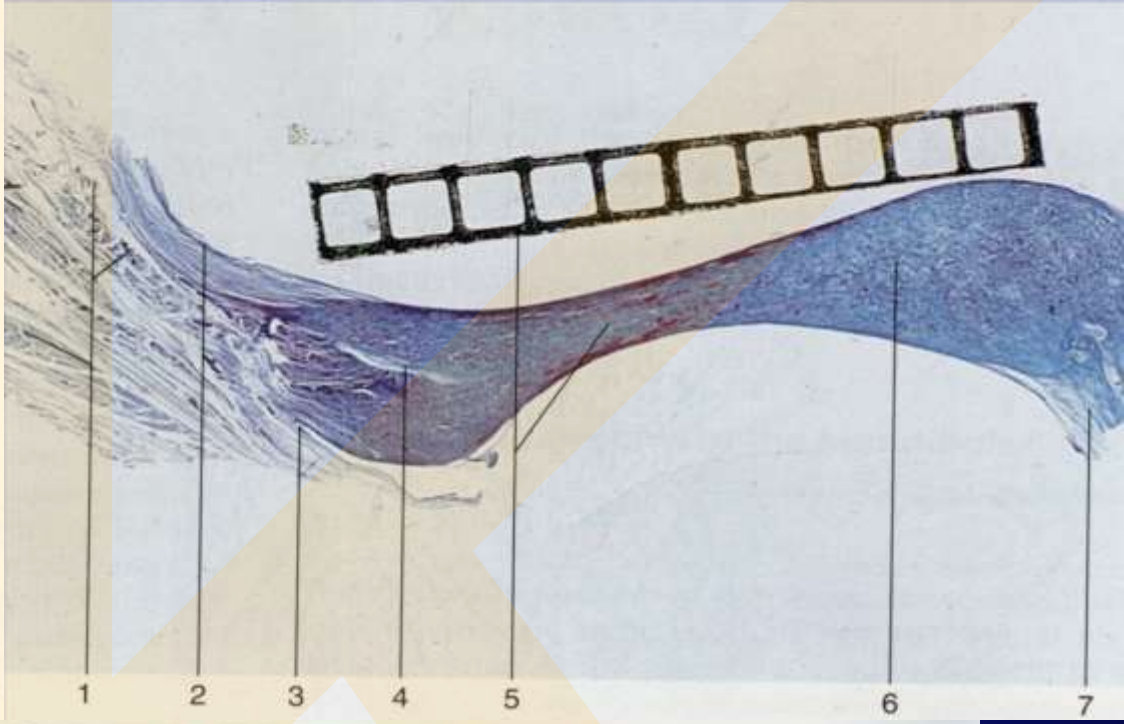




Lztráta vaskularizace podmiňuje degenerativní změny v disku

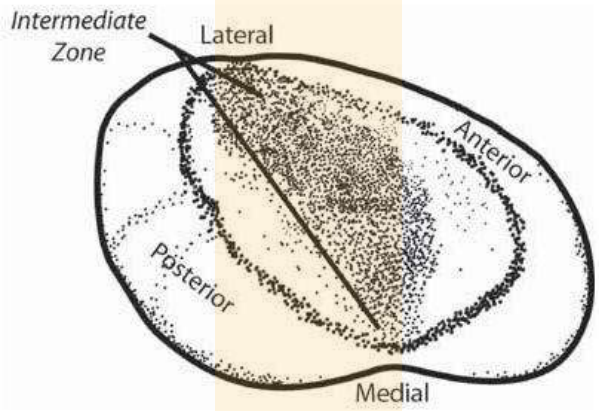
Articular disc, central zone in longitudinal section (54-year-old man)

1 Lateral pterygoid muscle
2 Capsule of upper joint space
3 Anterior reflection of lower joint space
4 Anterior end of articular disc
5 Millimeter scale and thin zone of disc
6 Posterior portion of articular disc
7 Loose retrodiscal tissue



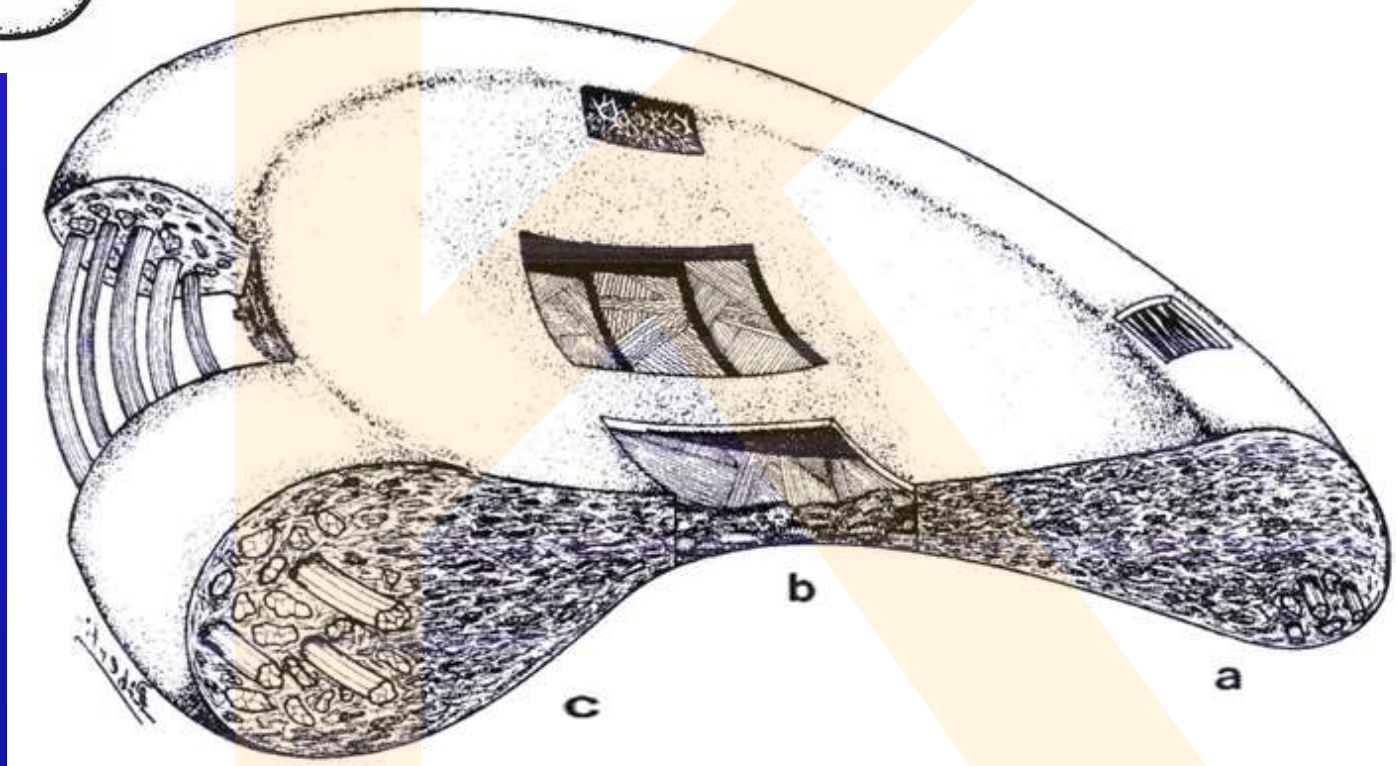
Isolated chondroid cells

Elastic fibers (black) in the anterior segment of the articular disc



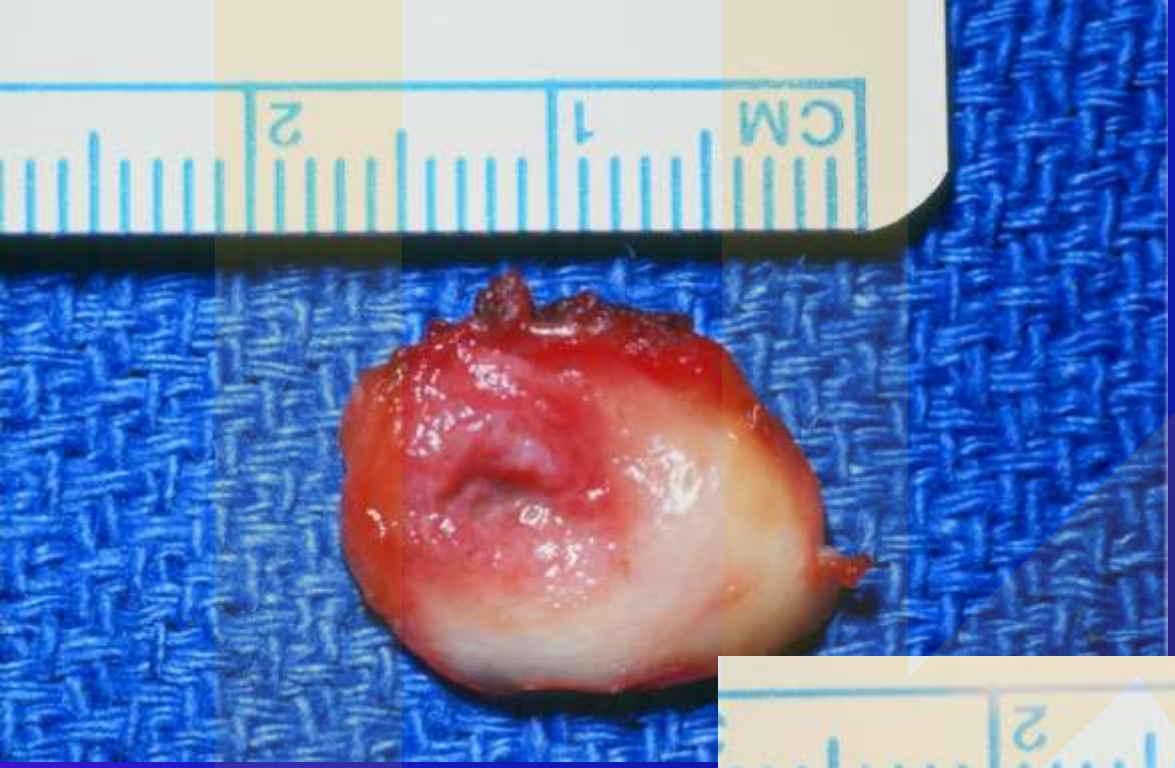
Examined discs:

16-39 weeks of intrauterine life
Up to 4 months of age
30-39 years
60-69 years



Temporomandibular disc of a human adult (a = anterior portion; b = middle portion; c = posterior portion).

Minarelli, AM, DelSanto, M, Liberti, EA: The structure of the human temporomandibular joint disc: A scanning electron microscopy study. J Orof Pain 11:95-98, 1997

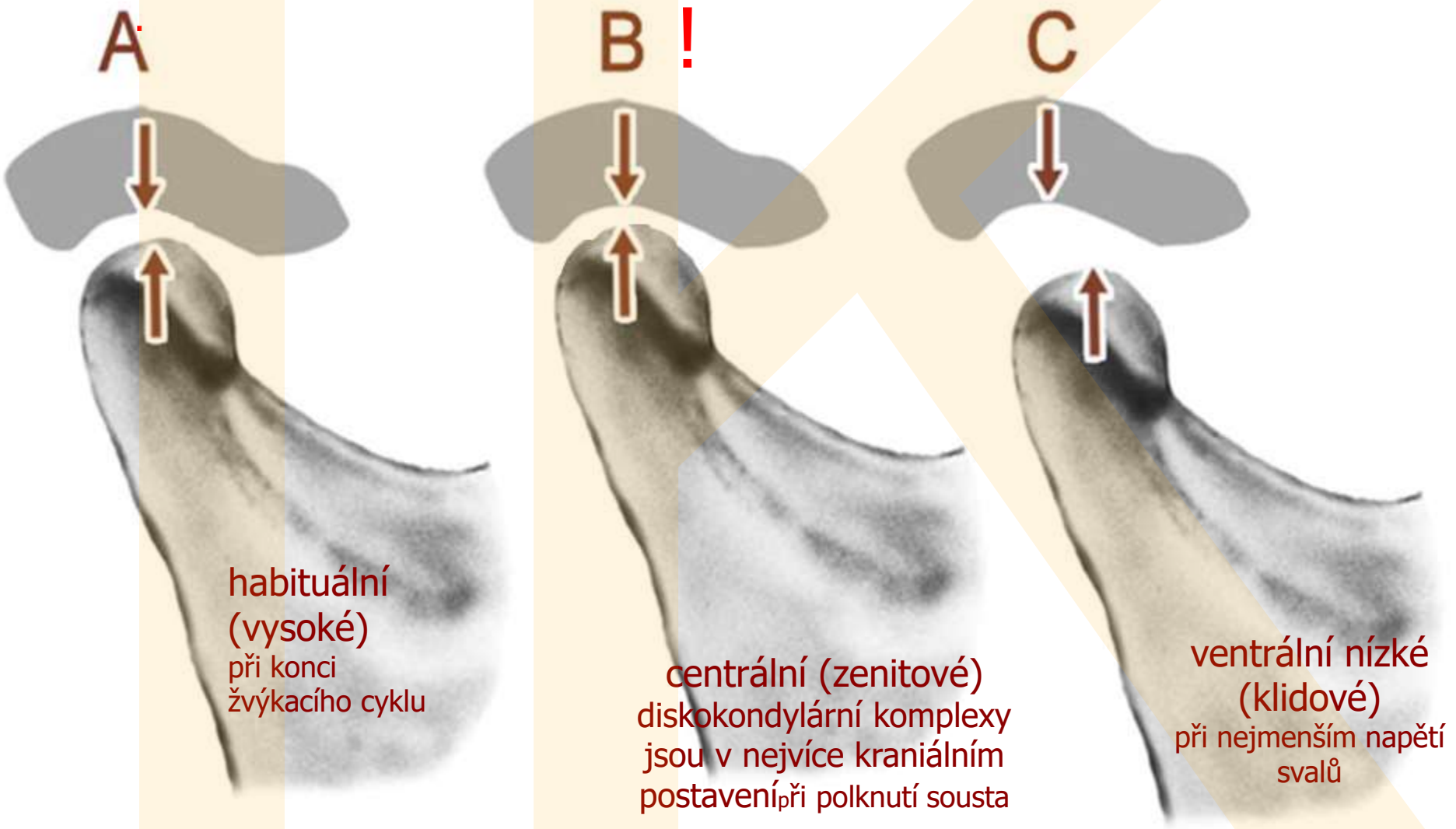


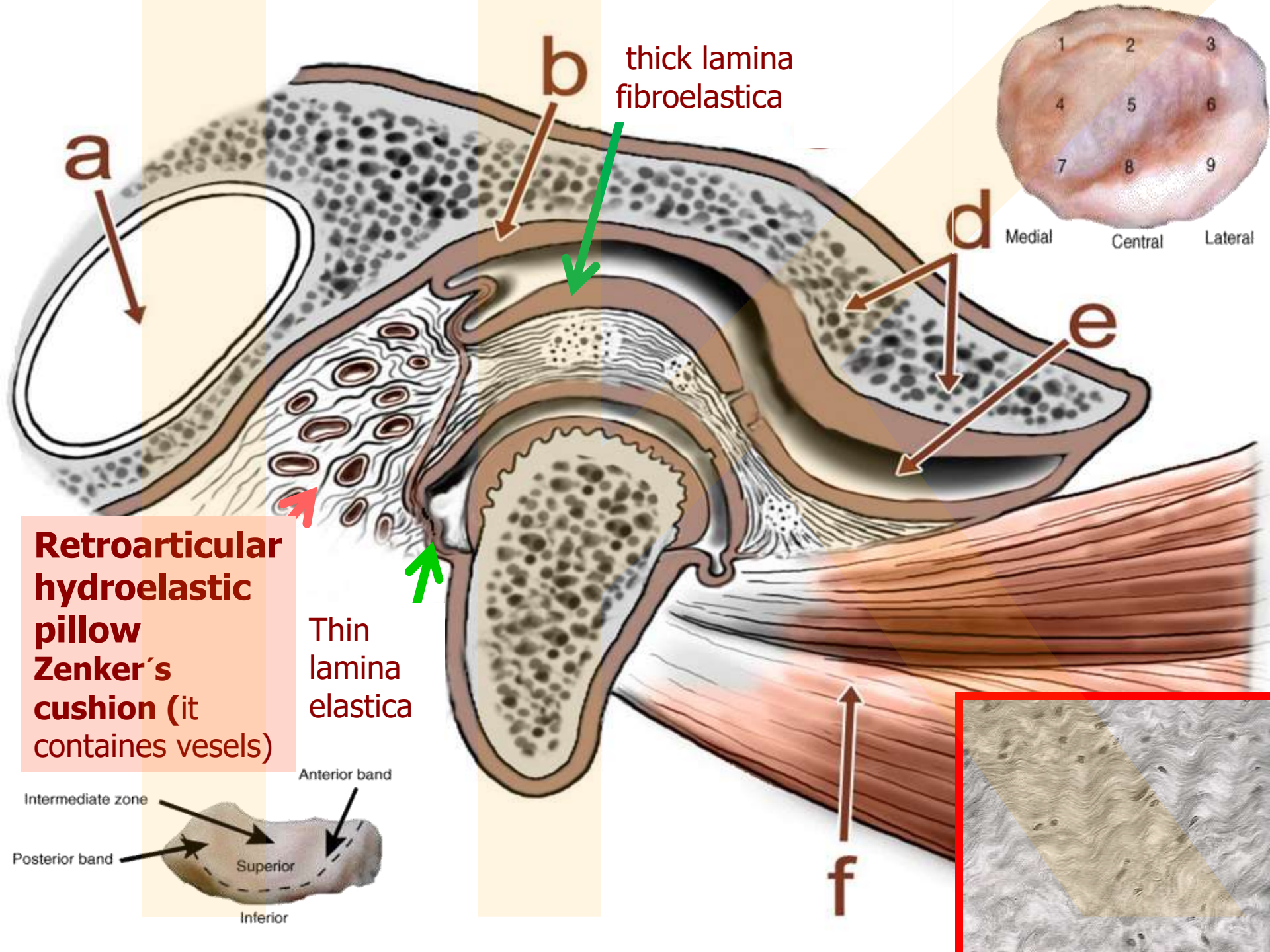
Superior view

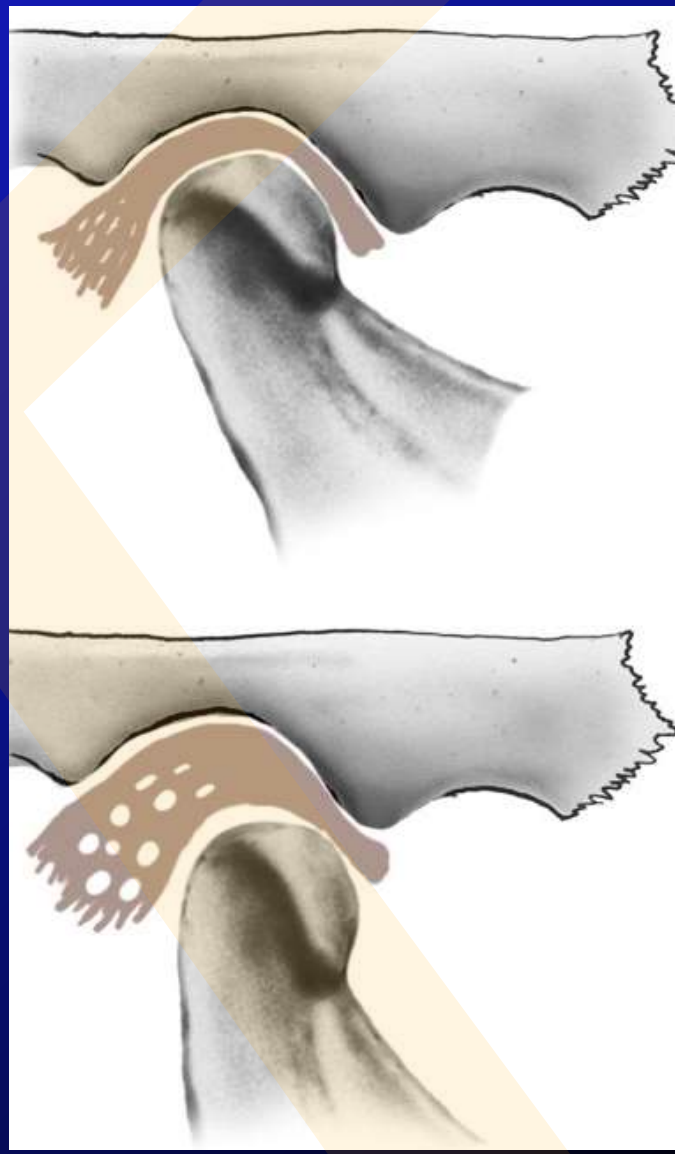
Inferior view

Inflammatory and degenerative changes

Možná postavení kondylů v kloubní jamce během žvýkacího cyklu



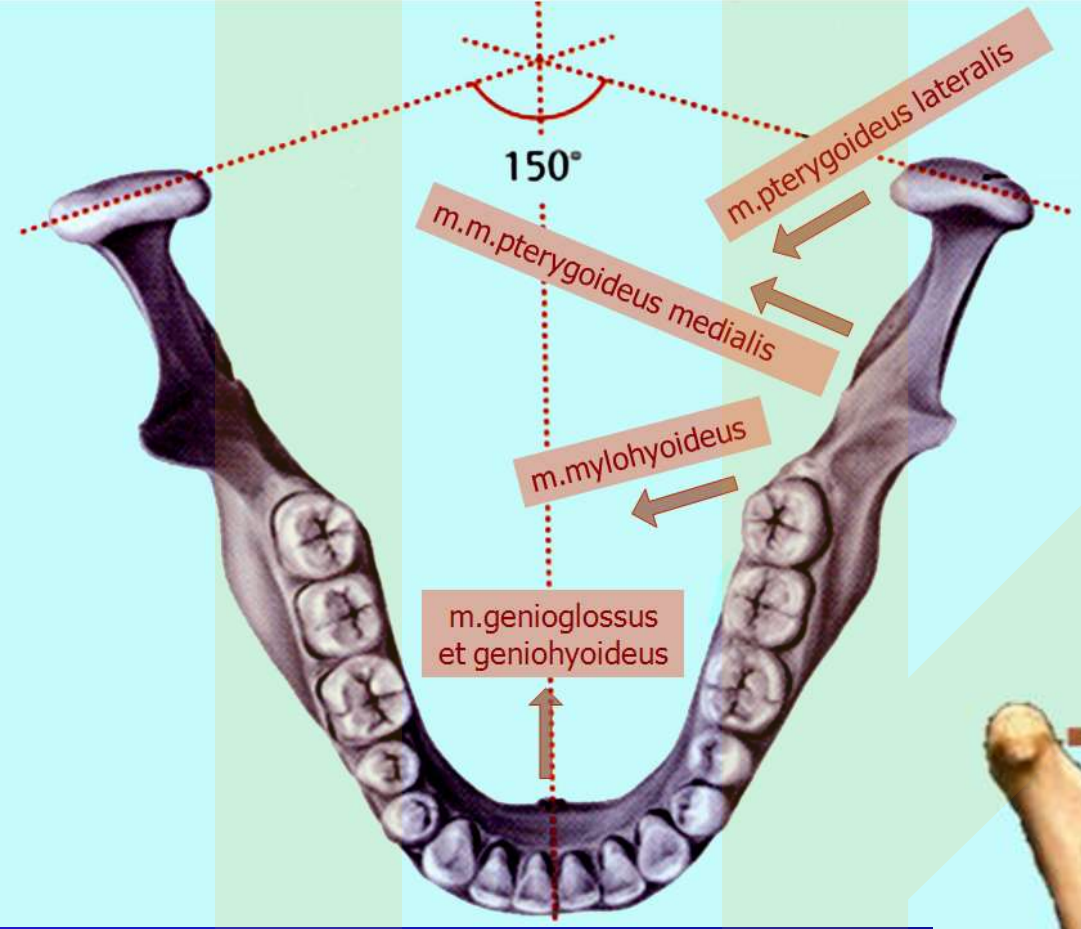

a
b
thick lamina fibroelastica
d
e
f
1
2
3
4
5
6
7
8
9
Medial
Central
Lateral
Retroarticular hydroelastic pillow Zenker´s cushion (it containes vesels)
Thin lamina elastica
Anterior band
Intermediate zone
Posterior band
Superior
Inferior

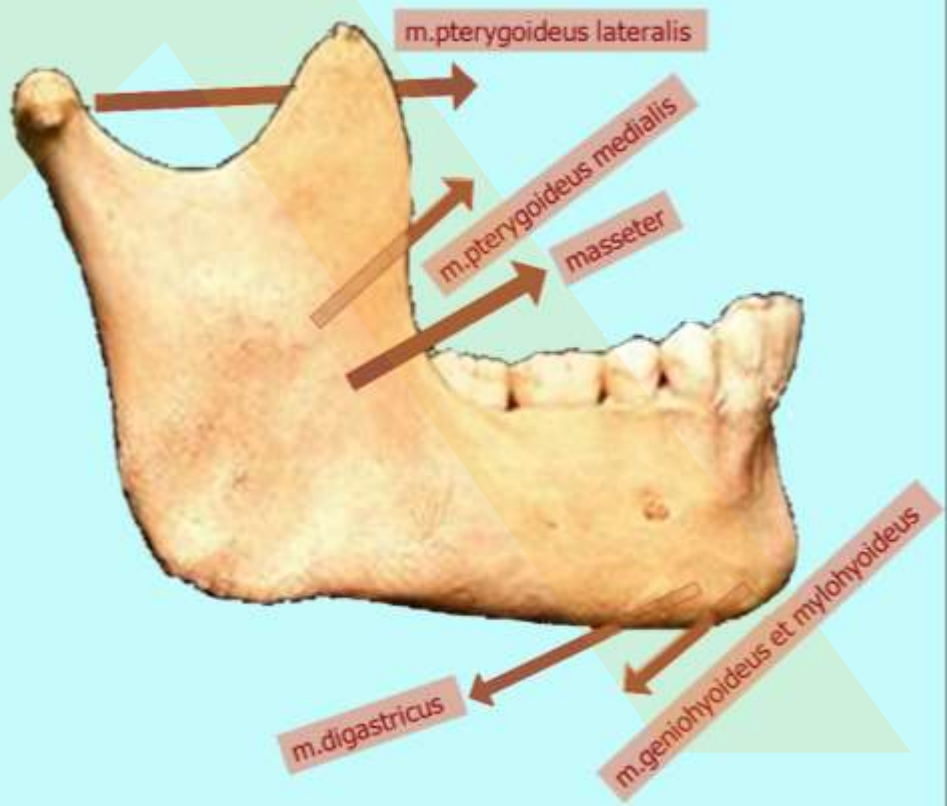


MAIN
and
Accessory masticatory muscles
(masticatory muscles from the protetic aspect)

venter anterior m. digastrici
m. mylohyoideus
Innervation:
CN V_3

m. geniohyoideus





The basic terms helping us to describe mandible movements in transverse plane

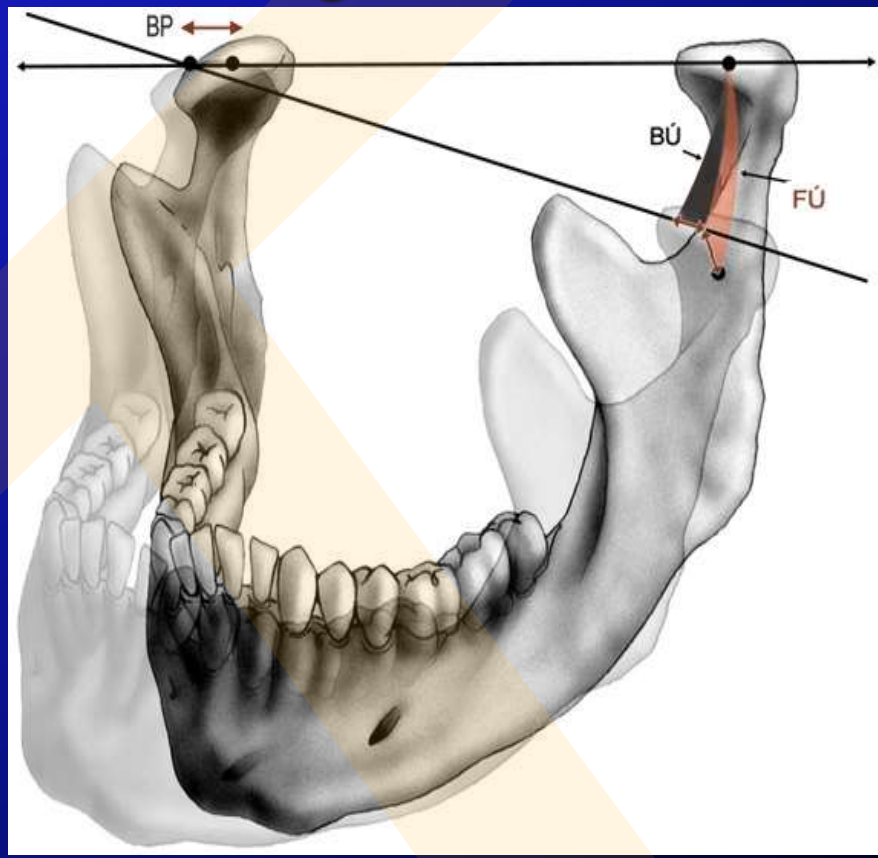
Arbeitsgemeinschaft für Funktiondiagnostik 1992

Working side moves **from** the sagittal plane
Non balancing side moves **to** the sagittal side

Bennett´s movement BP - shift of the working condyle (first phase of the working movement – immediate side shift
Through the last phase of the movement – progressive side shift)

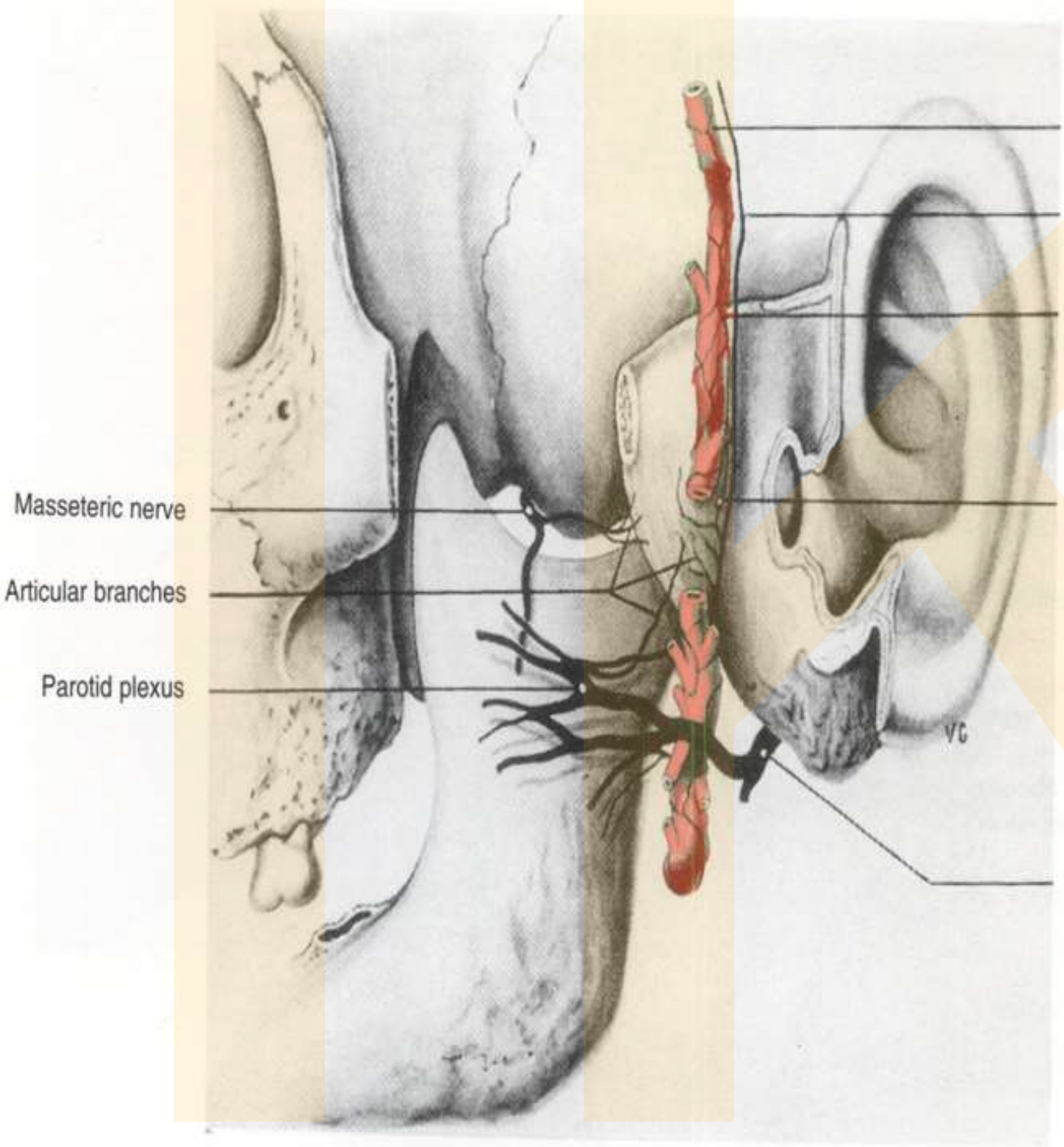
Bennett´s angle BÚ: 10 – 20°
Fischer´s angle FÚ: 5°

Lower and flatten tubercles of the lateral teeth facilitate lateral movement of the mandible



Working side
Non balancing side

Non working side
Balancing side

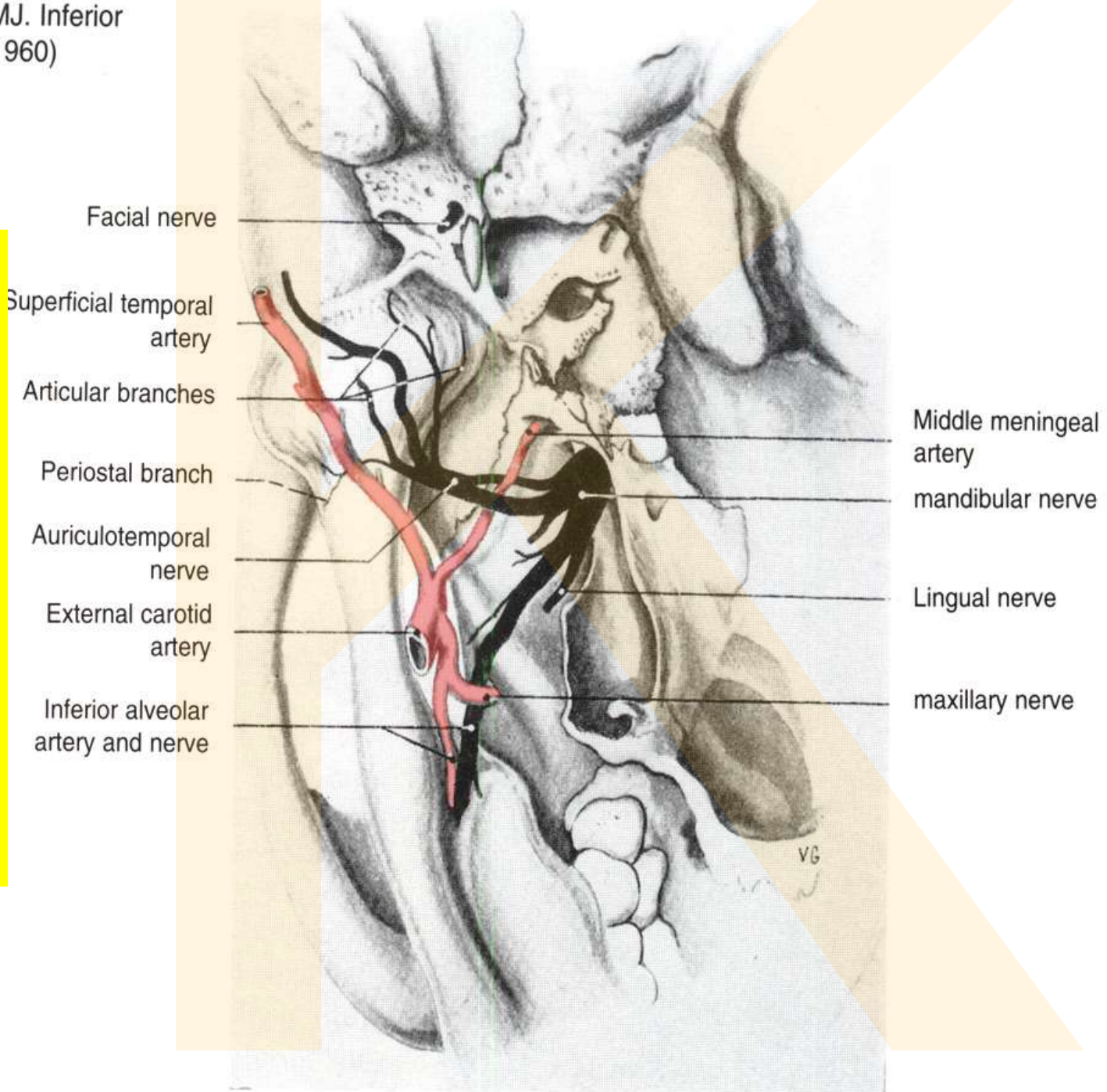


Nerve supply of the TMJ. Lateral aspect (Hromada and Králové 1960)

N. facialis:

- lateral surface of the joint capsule

Nerve supply of the TMJ. Inferior aspect (Hromada and Králové 1960)



N. auriculotemporalis nerve is branched into four nerves:

- lateral branch
- Medial branch
- branch from the middle nerve segment
- branch from the area where nerve crosses n. temporalis superficialis

Nerve supply of the TMJ. Anterior aspect (Hromada and Králové 1960)

m. temporalis profundus:

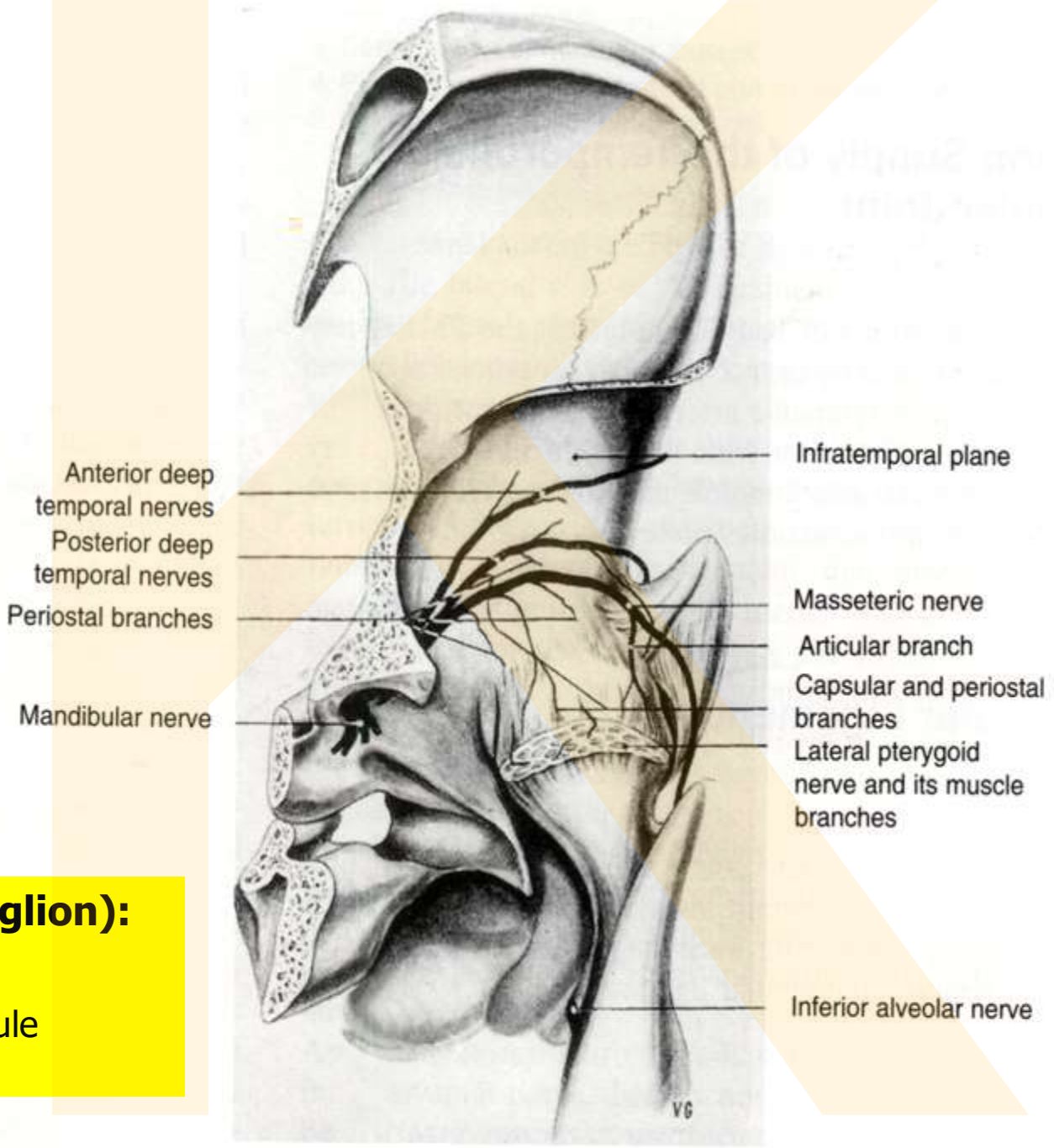
- supplies rostromedial part of the disc and capsule

n. massetericus send four branches:

- branch below oval foramen
- branch from the first nervous segment closely below skull base
- two branches from the first segment below

Ganglion oticum (otic ganglion):

- supplies dorsal part (pars discosquamalis) of the joint capsule



Arteries:

a. temporalis superficialis
a. maxillaris

a. transversa faciei
a. temporalis media
a. auricularis profunda
a. tympanica anterior
a. meningea media

Veins:

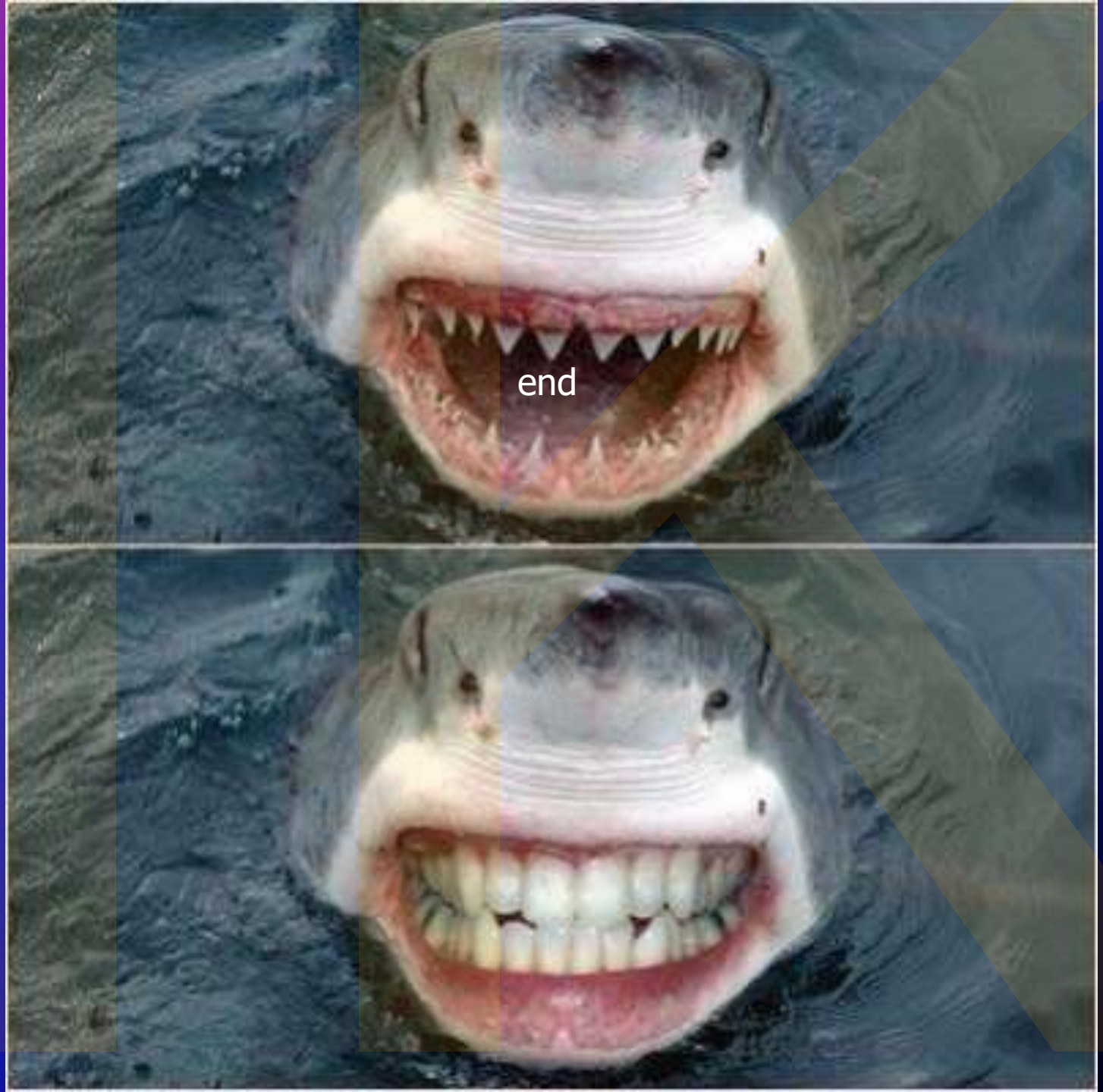
Plexus intracapsularis
Plexus periarticularis
Plexus pterygoideus

Nerves:

rr. articulares n. auriculotemporalis
rr. masseterici
rr. temporales profundi trigemini

Sensitive for the Zenker´s pillow, lig. laterale and joint capsule;

Forced elongation of the ligamentum laterale results in mouth closure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