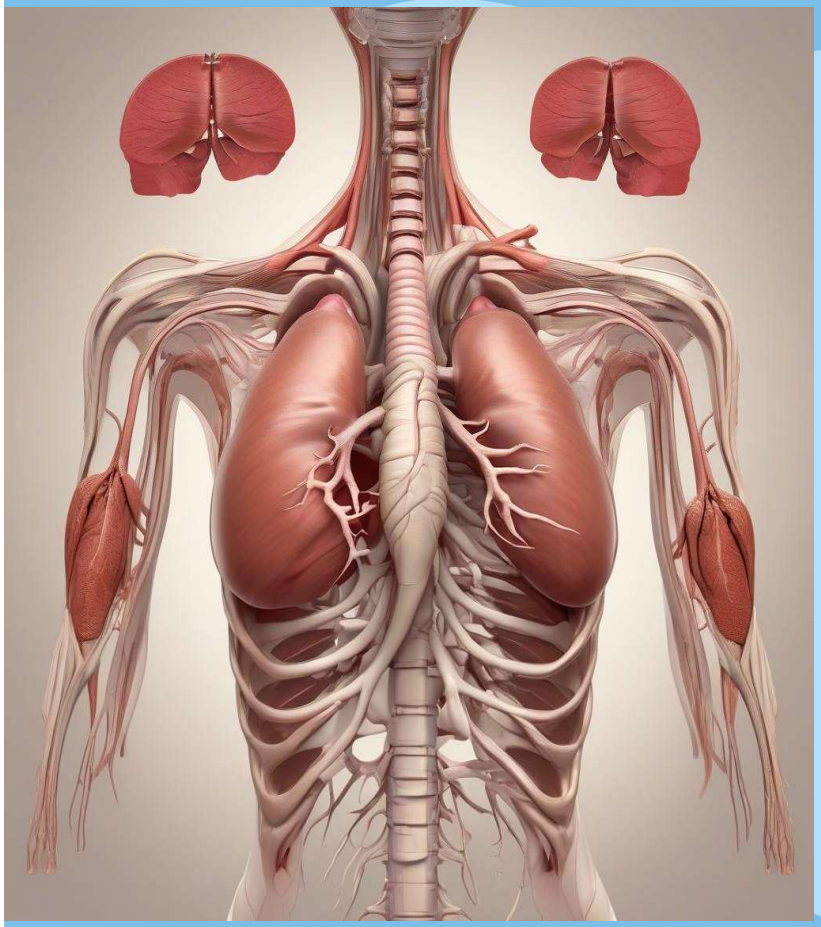


Jak hrudní aortu správně zobrazit a měřit očima kardio-radiologa

Michal Klán
Nemocnice Na Homolce

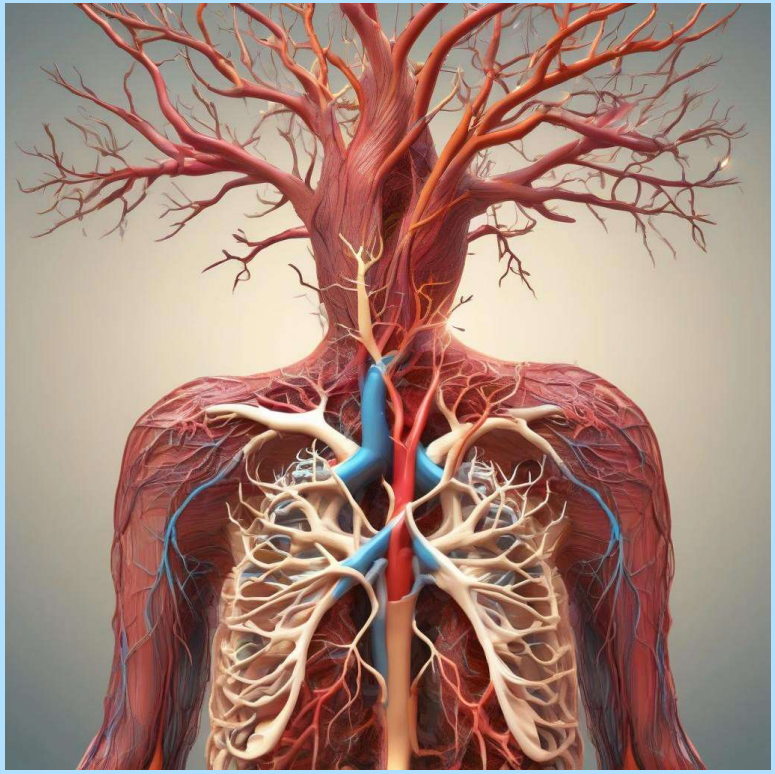
Pohled radiologa

CT

MR

RTG

UZ



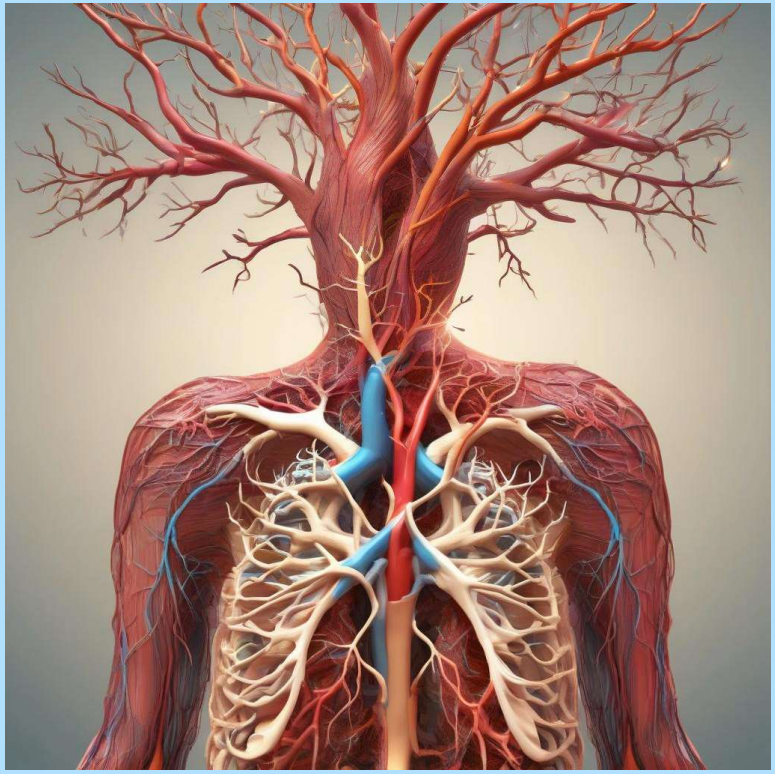
Pohled radiologa

CT

MR

RTG

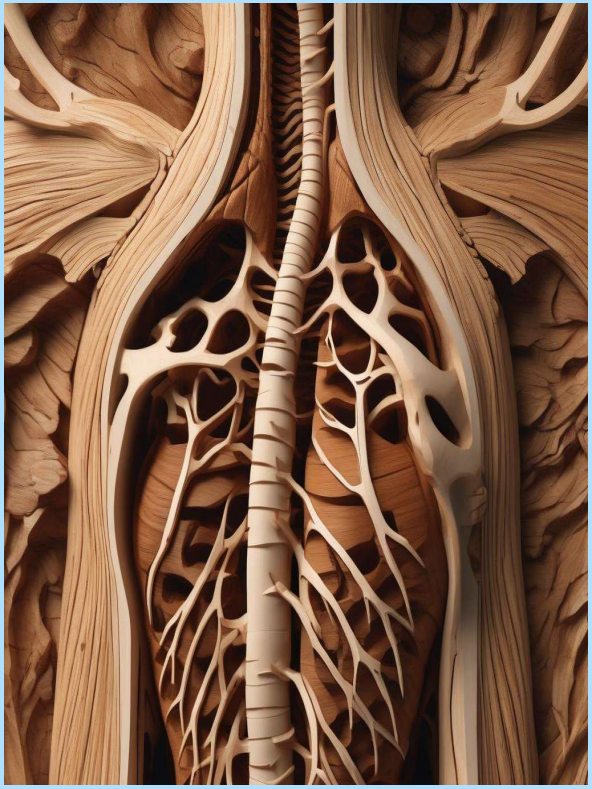
UZ



Úkol radiologa

01

Správně zobrazit



02

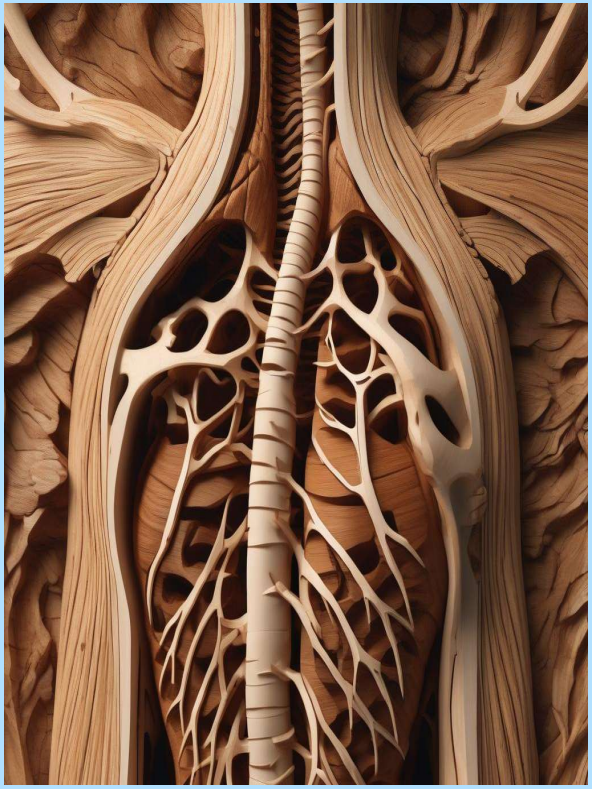
Správně změřit

Úkol radiologa

01

Správně zobrazit

Hezké obrázky



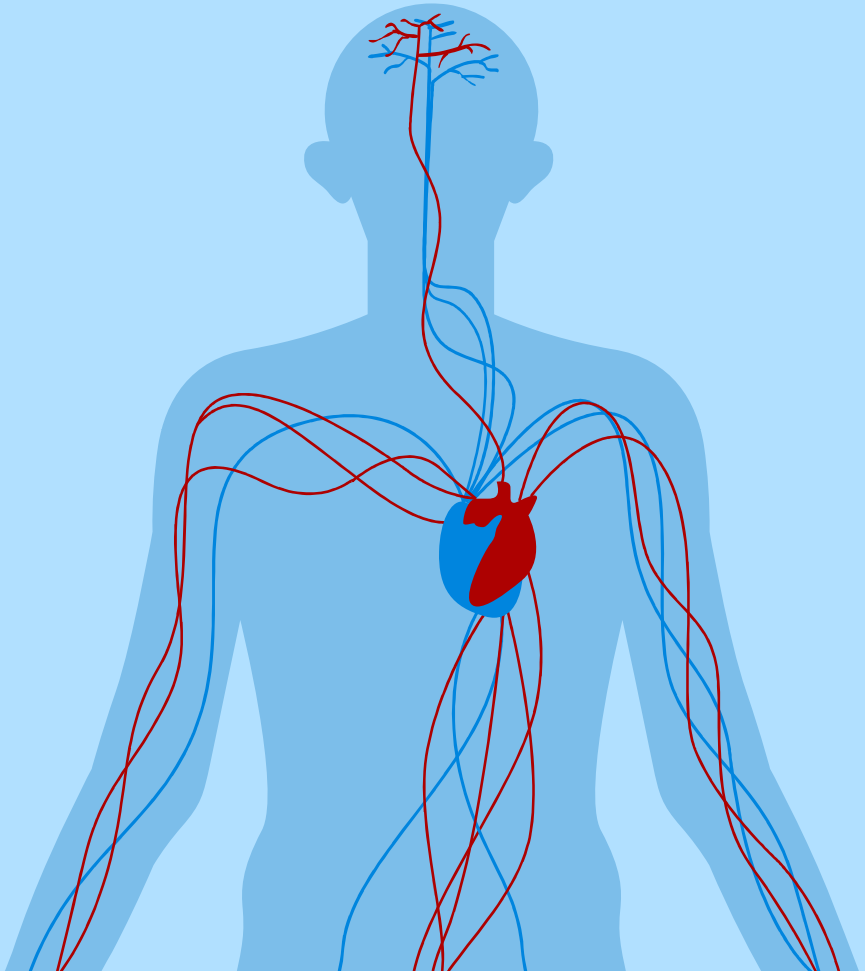
02

Správně změřit

Objektivní hodnoty

01

Správné zobrazení



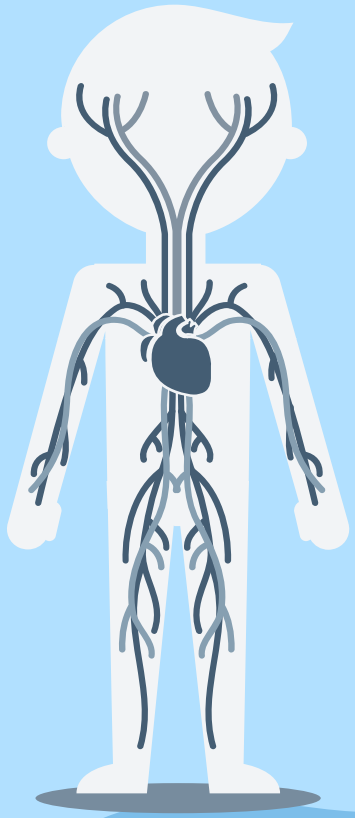
Co vlastně chceme?

- **3D zobrazení hrudní aorty**

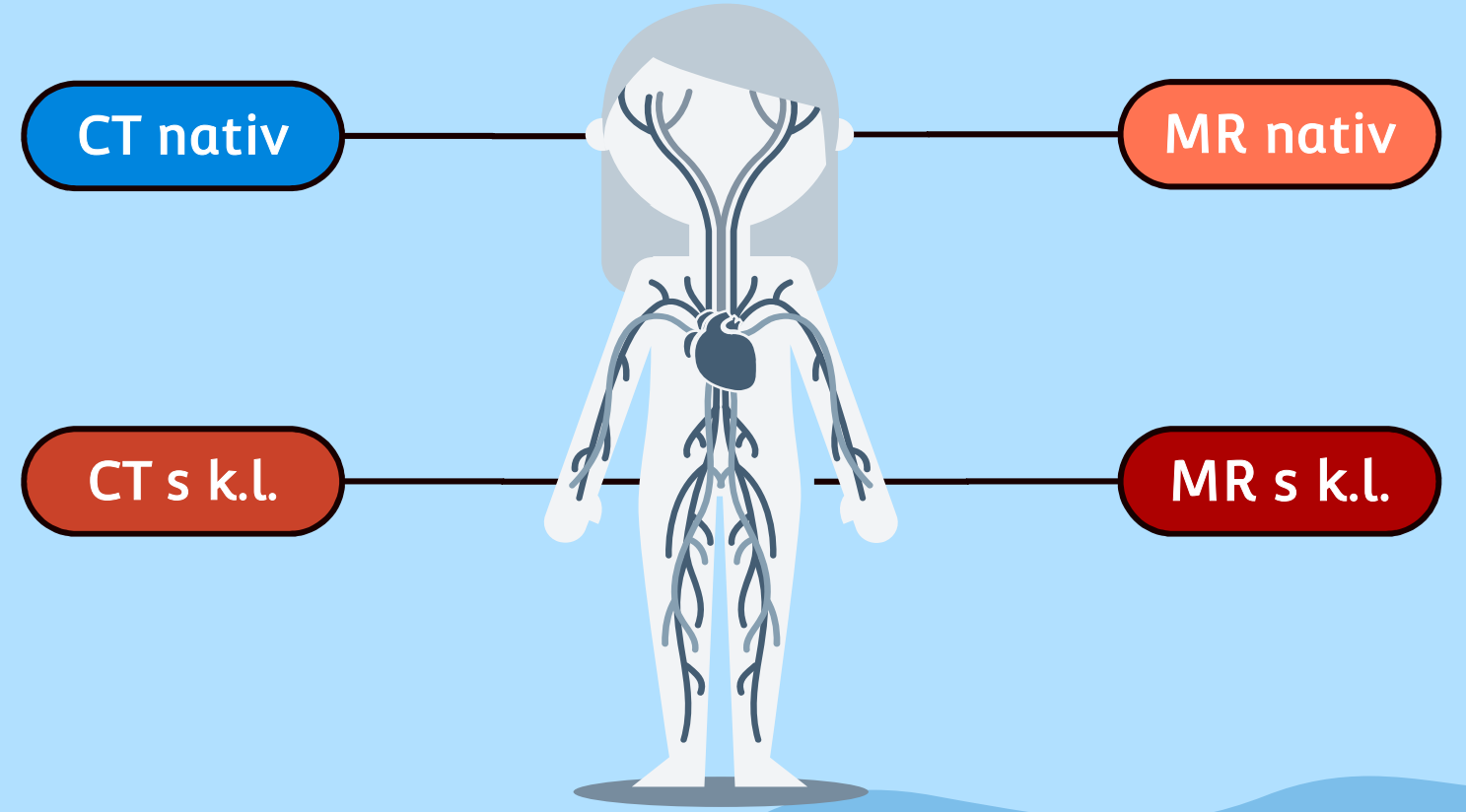
  tzn. vysoké rozlišení, to je technická záležitost

- **bez pohybových artefaktů**

  tzn. EKG synchronizace (tachykardie, arytmie), spolupracující pacient (nadechnout a nehýbat se)



Kontrastní látku?



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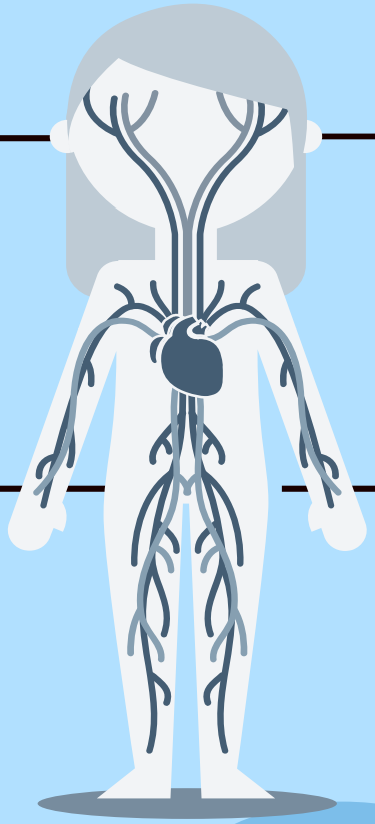

CT nativ

- vidíme jen zevní konturu

MR nativ

CT s k.l.

MR s k.l.

Kontrastní látku?

CT nativ

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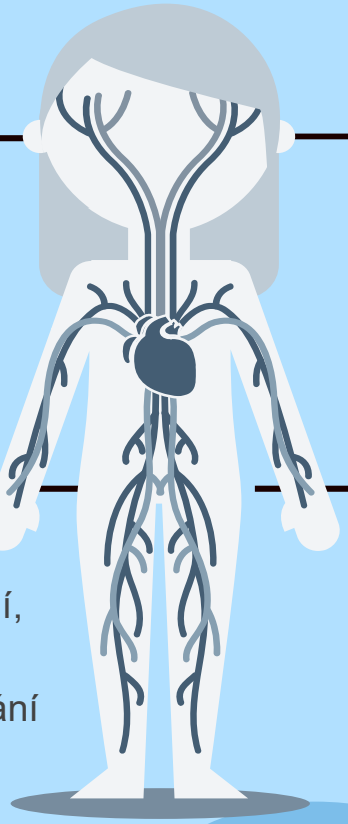


CT s k.l.

- lépe dostupné, rychlé, nejvyšší rozlišení, vidíme celý hrudník
- nutnost aplikace a správného načasování kontrastní látky, radiační zátež

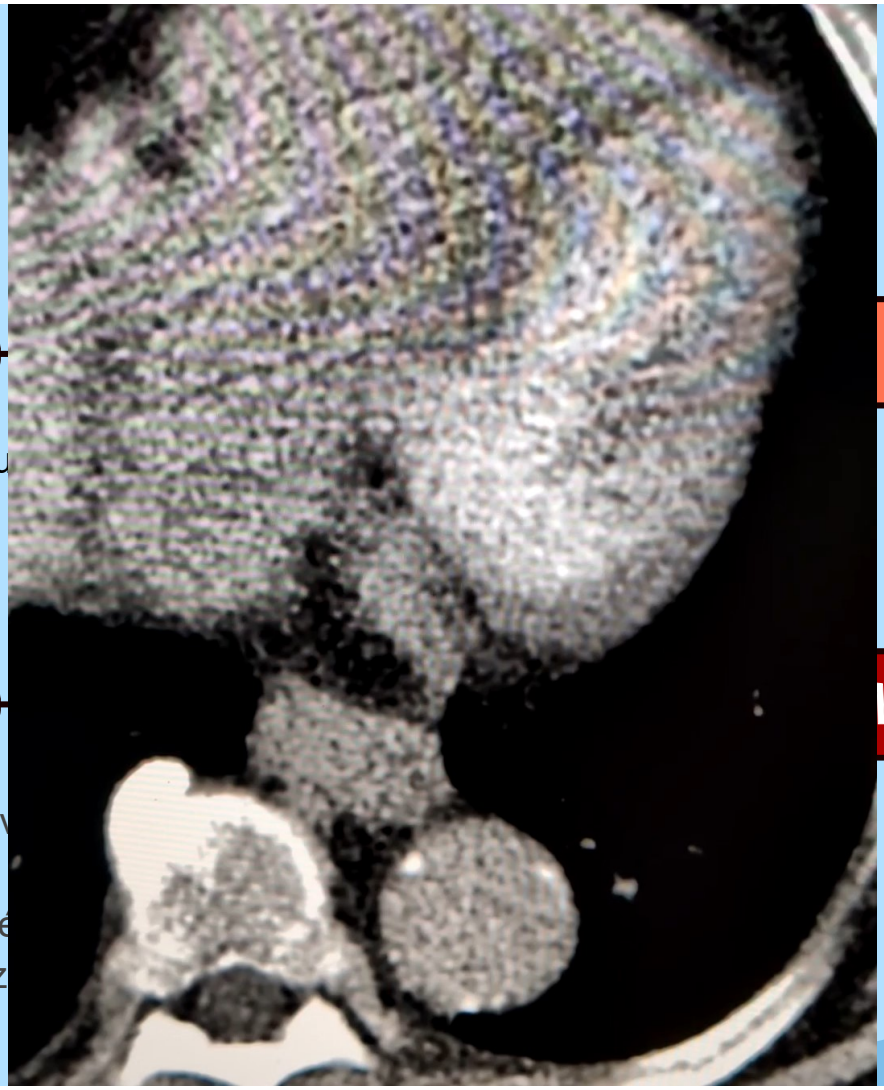
MR s k.l.

CT nativ

- vidíme jen zevní konturu

CT s k.l.

- lépe dostupné, rychlé, nejv
  vidíme celý hrudník
- nutnost aplikace a správné
  kontrastní látky, radiační z

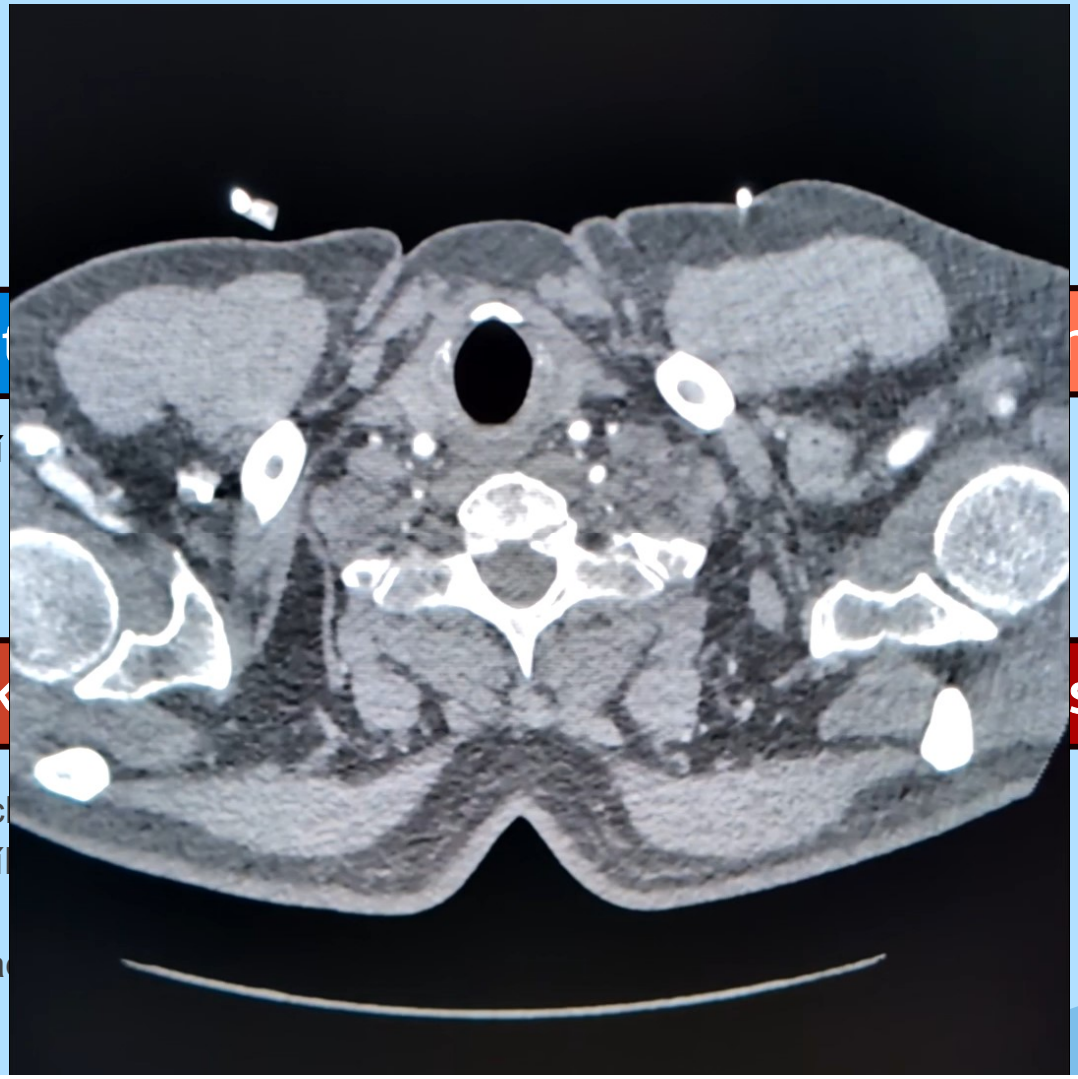


R nativ

IR s k.l.

CT nat … nativ

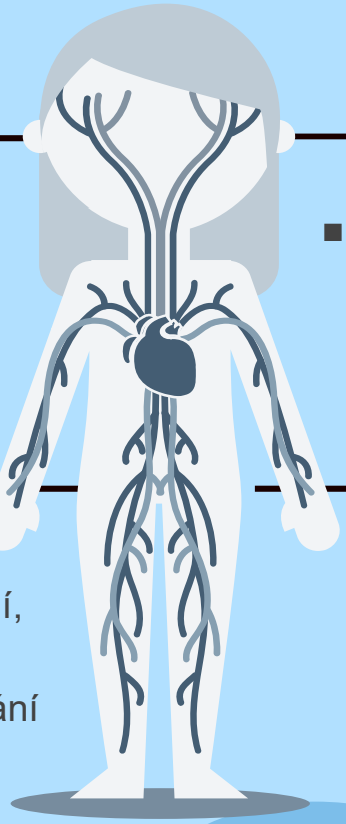
- vidíme jen zevní …



CT s k … s k.l.

- lépe dostupné, rych…
  vidíme celý hrudní…
- nutnost aplikace a…
  kontrastní látky, ra…

Kontrastní látku?



CT nativ

- vidíme jen zevní konturu

MR nativ

- bez radiační zátěže, nižší rozlišení než CT ale stále dostačující, velmi dlouhá sekvence vyžadující spolupráci pacienta, využití u follow-up, screening

CT s k.l.

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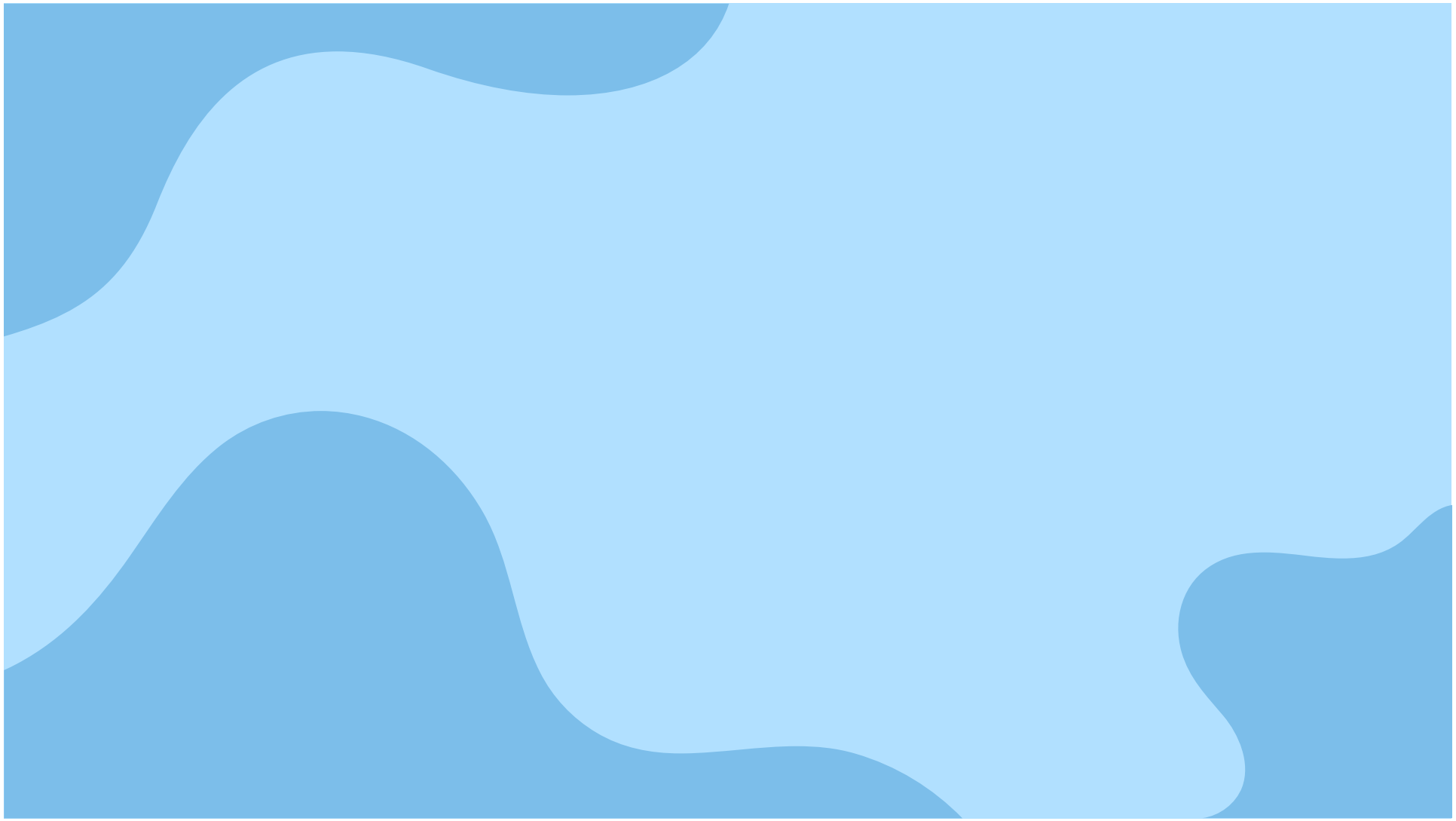
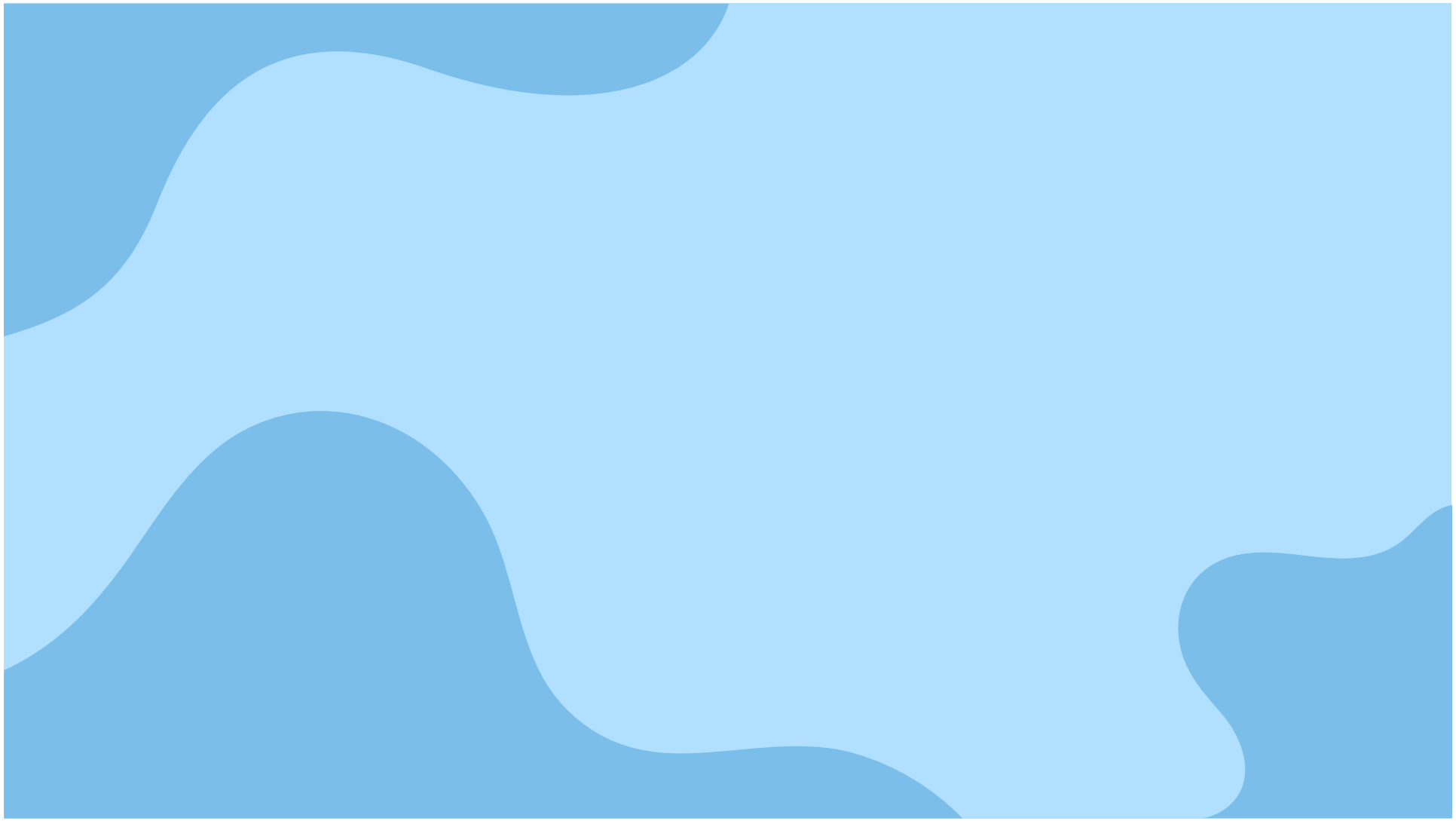
MR s k.l.





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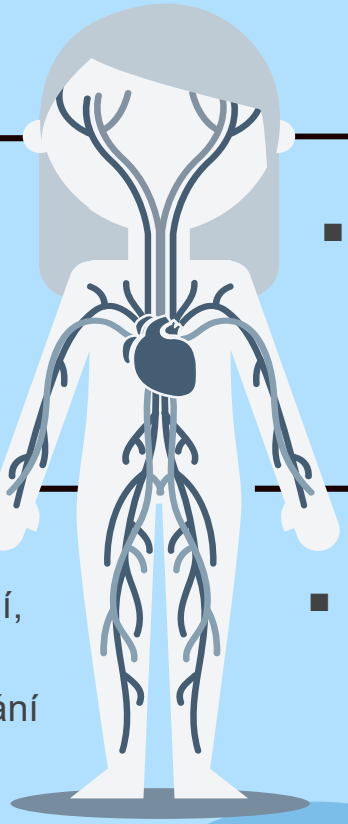

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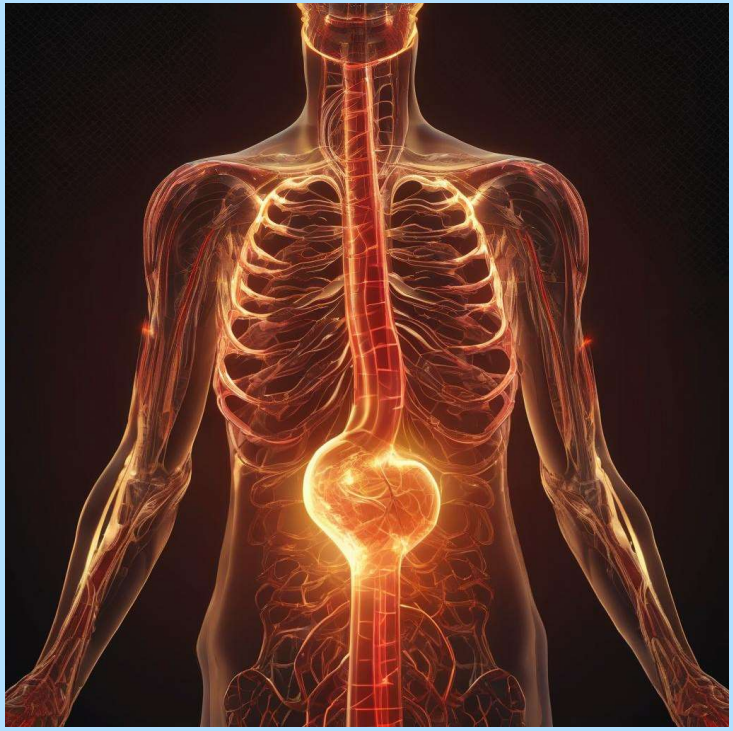
- nutnost aplikace a správného načasování kontrastní látky, radiační zátež

MR s k.l.

- podobné jako CT ale má nižší rozlišení a obecně více artefaktů (hlavně v oblasti kořene aorty), trvá déle, oproti CT zas tolik výhod nemá

Přidat břišní aortu a pánevní tepny?

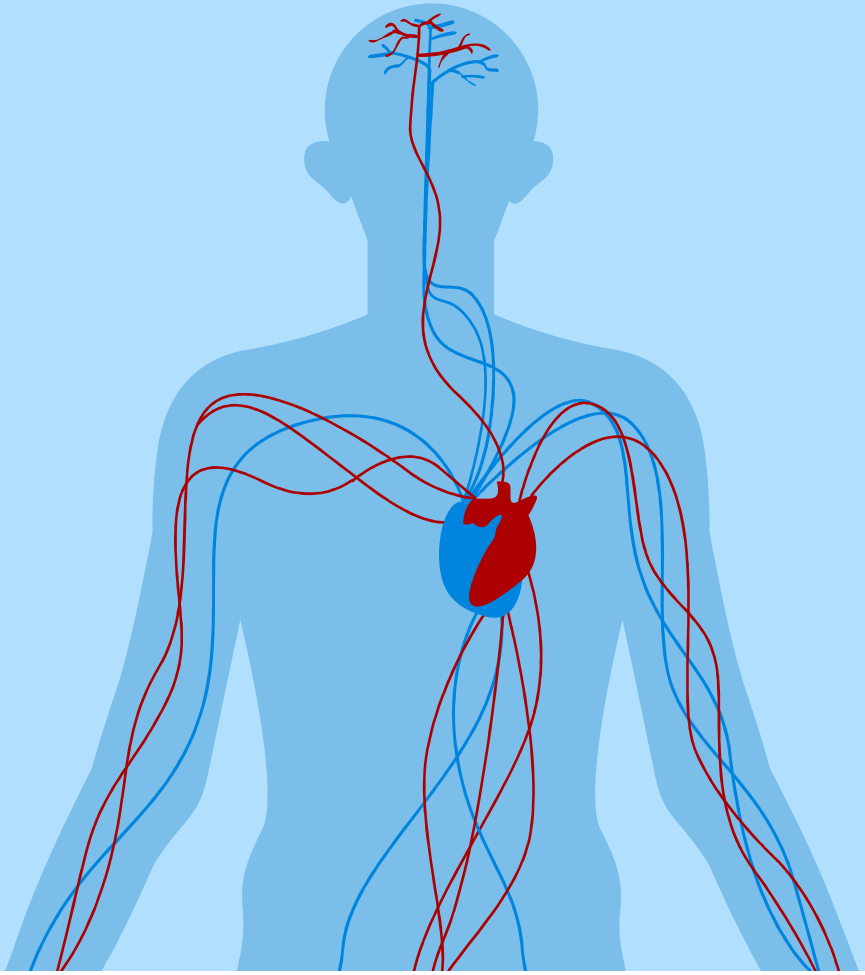


- Pokud je chceme na CT v jedné akvizici s hrudní aortou, znamená to, že bude s EKG synchronizací - většinou vyšší radiační zátěž i nutnost aplikace většího množství kontrastní látky

- Na MR omezení velikostí cívky a velikostí pacienta, většinou se dá zobrazit nad bifurkaci břišní aorty

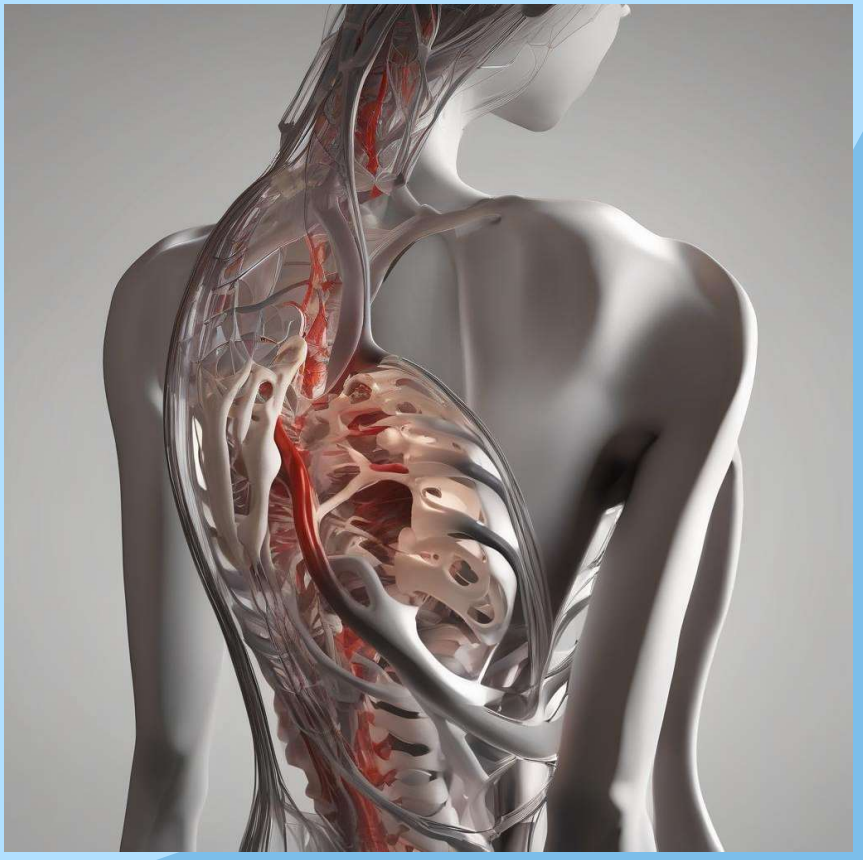
02

Správné měření



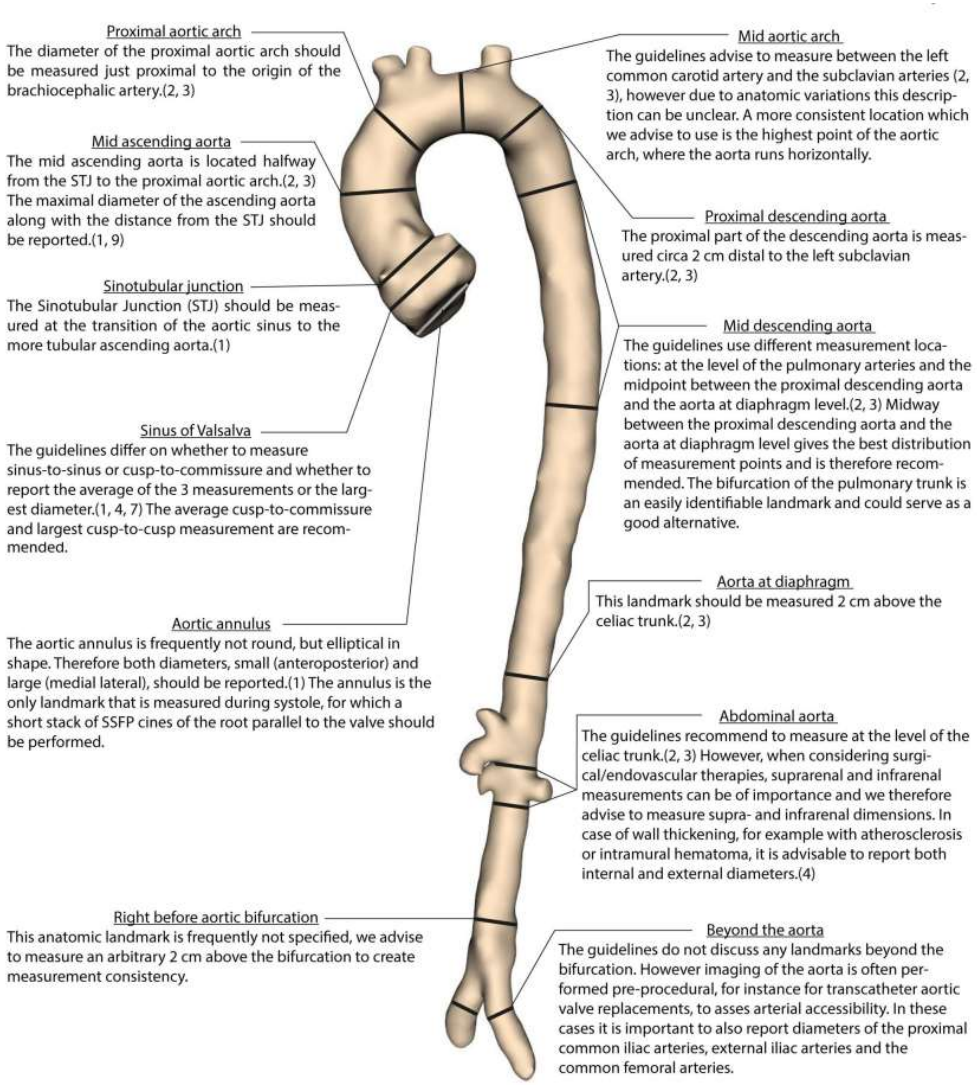
Problémy…

- máme několik způsobů jak aortu zobrazit
- mnoho zobrazovacích center s různými typy přístrojů
- v každém centru více lékařů s různými zkušenostmi



… Řešení

- jednoduchá a rychlá metoda
- referenční úrovně a měření
- jednotná technika měření



Proximal aortic arch
The diameter of the proximal aortic arch should be measured just proximal to the origin of the brachiocephalic artery.(2, 3)

Mid ascending aorta
The mid ascending aorta is located halfway from the STJ to the proximal aortic arch.(2, 3) The maximal diameter of the ascending aorta along with the distance from the STJ should be reported.(1, 9)

Sinotubular junction
The Sinotubular Junction (STJ) should be measured at the transition of the aortic sinus to the more tubular ascending aorta.(1)

Sinus of Valsalva
The guidelines differ on whether to measure sinus-to-sinus or cusp-to-commissure and whether to report the average of the 3 measurements or the largest diameter.(1, 4, 7) The average cusp-to-commissure and largest cusp-to-cusp measurement are recommended.

Aortic annulus
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Right before aortic bifurcation
This anatomic landmark is frequently not specified, we advise to measure an arbitrary 2 cm above the bifurcation to create measurement consistency.

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Proximal descending aorta
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The guidelines use different measurement locations: at the level of the pulmonary arteries and the midpoint between the proximal descending aorta and the aorta at diaphragm level.(2, 3) Midway between the proximal descending aorta and the aorta at diaphragm level gives the best distribution of measurement points and is therefore recommended. The bifurcation of the pulmonary trunk is an easily identifiable landmark and could serve as a good alternative.

Aorta at diaphragm
This landmark should be measured 2 cm above the celiac trunk.(2, 3)

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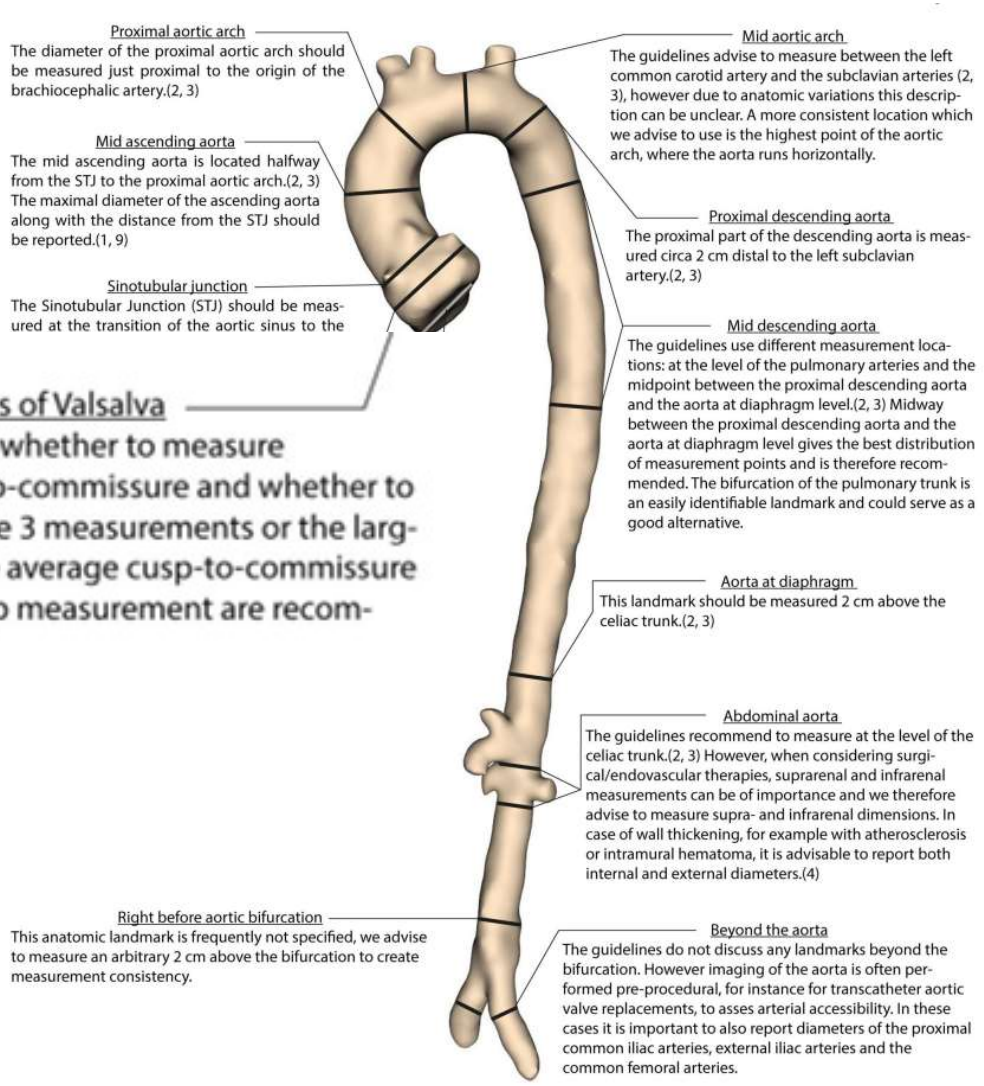
Beyond the aorta
The guidelines do not discuss any landmarks beyond the bifurcation. However imaging of the aorta is often performed pre-procedural, for instance for transcatheter aortic valve replacements, to asses arterial accessibility. In these cases it is important to also report diameters of the proximal common iliac arteries, external iliac arteries and the common femoral arteries.



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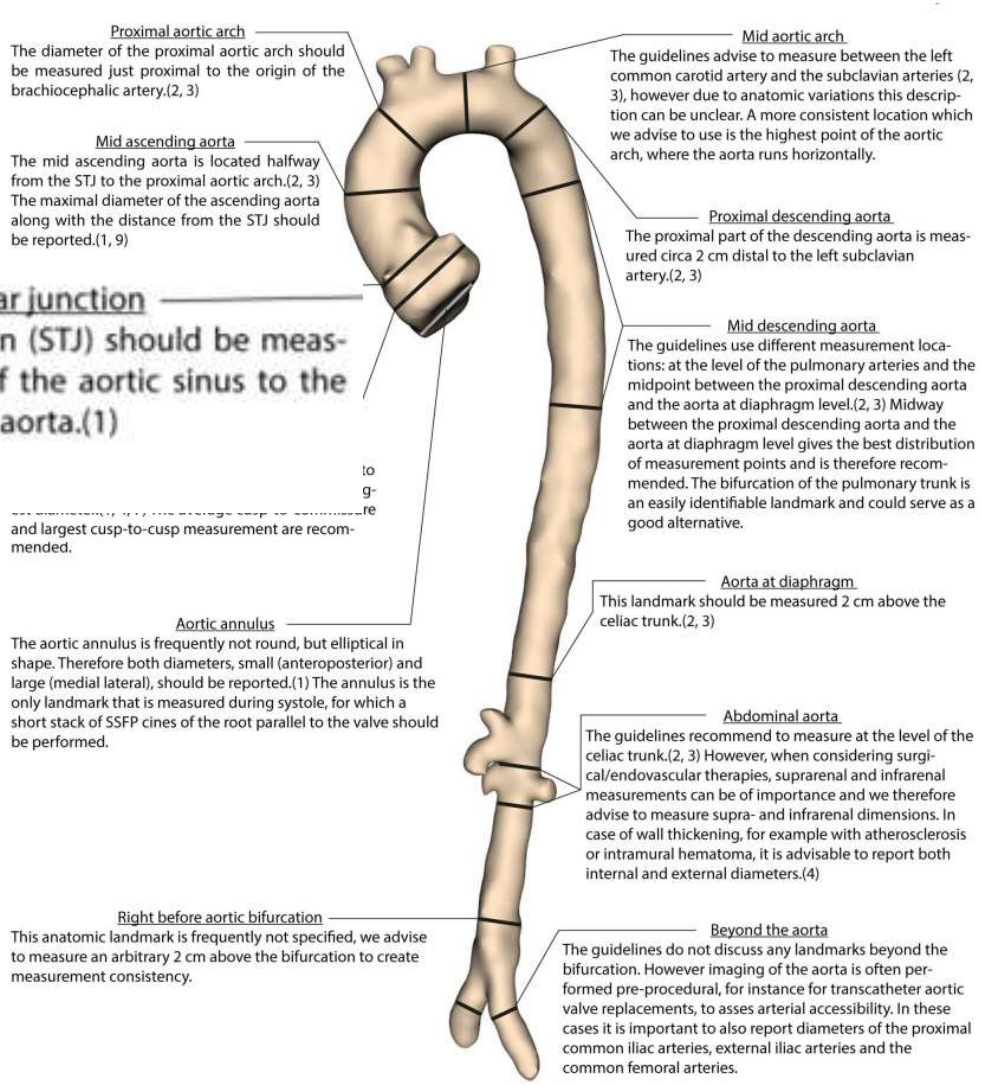

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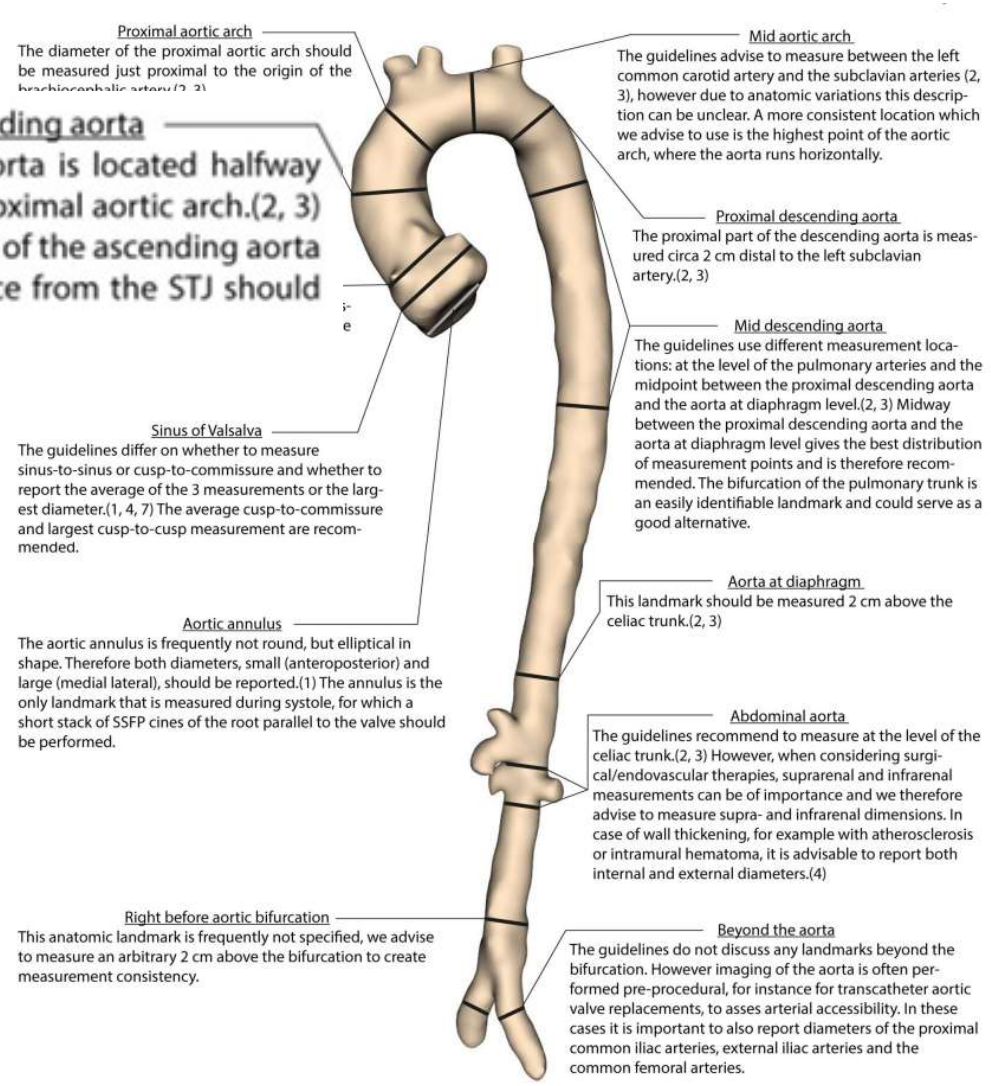

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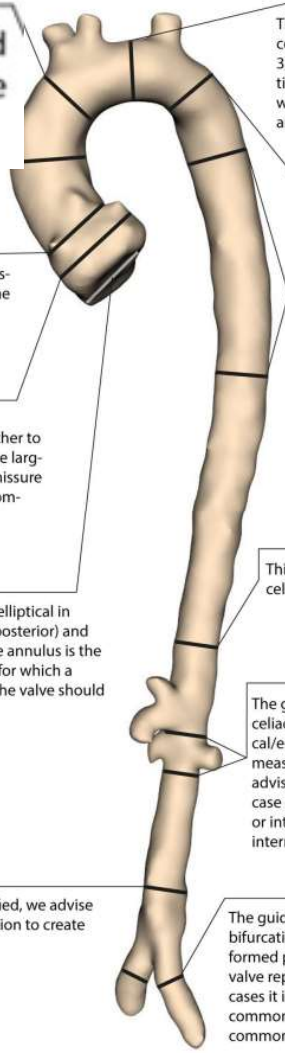

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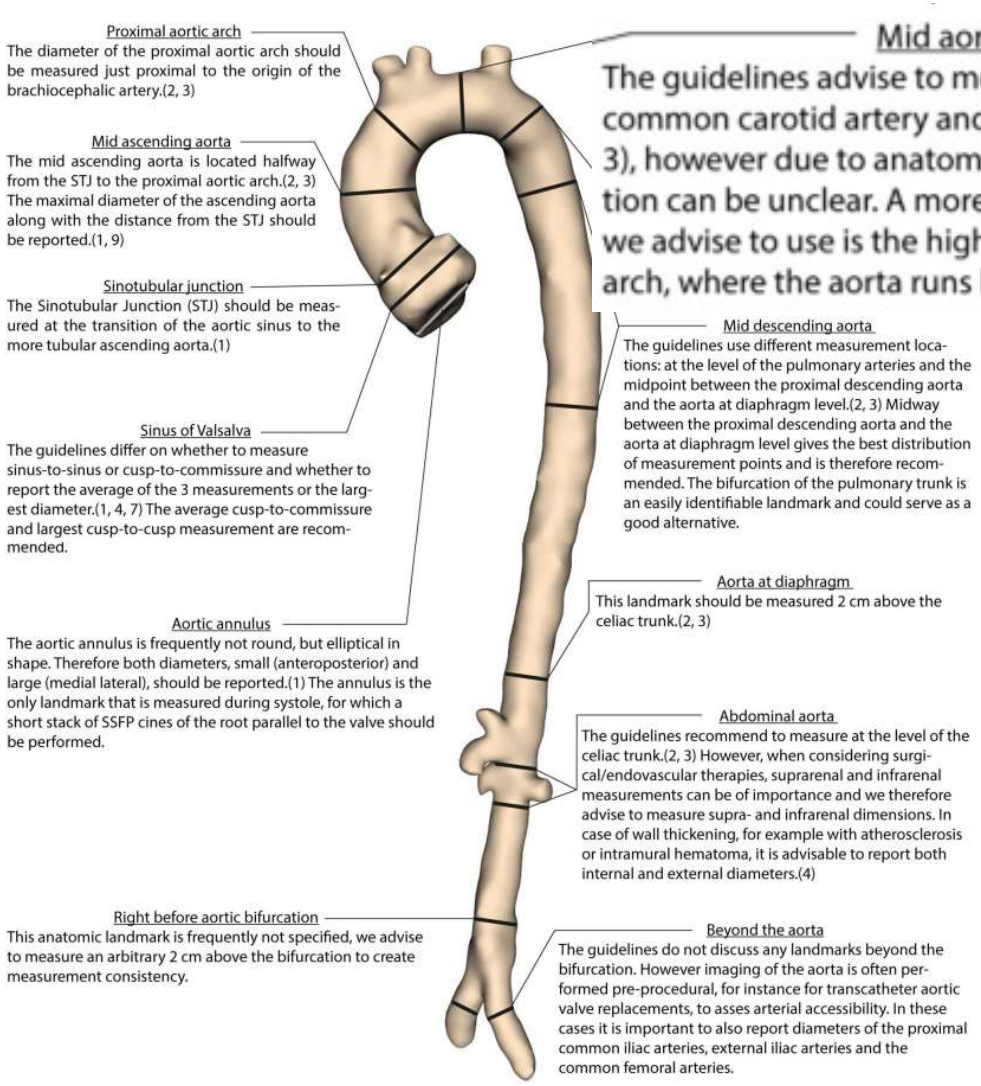

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This anatomic landmark is frequently not specified, we advise to measure an arbitrary 2 cm above the bifurcation to create measurement consistency.

Mid aortic arch
The guidelines advise to measure between the left common carotid artery and the subclavian arteries (2, 3), however due to anatomic variations this description can be unclear. A more consistent location which we advise to use is the highest point of the aortic arch, where the aorta runs horizontally.

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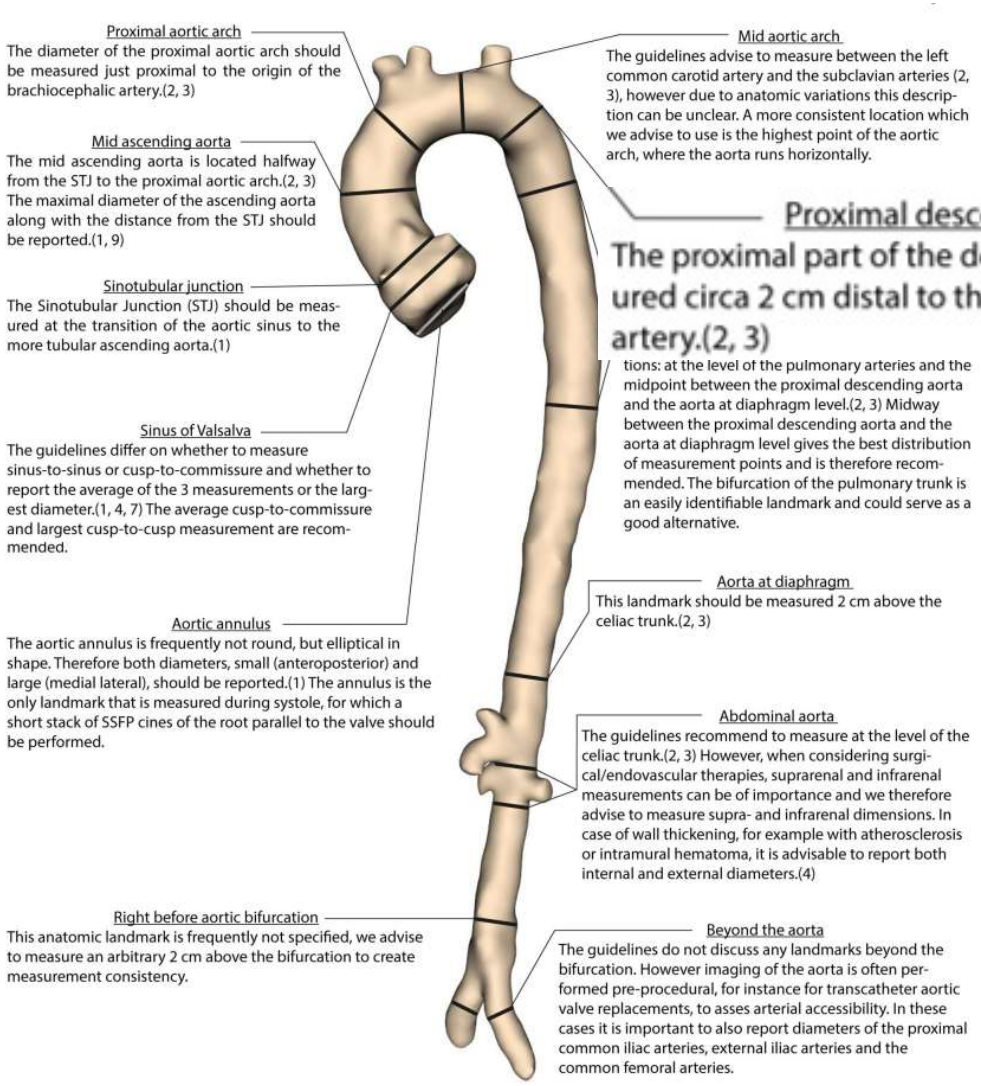
The guidelines use different measurement locations: at the level of the pulmonary arteries and the midpoint between the proximal descending aorta and the aorta at diaphragm level.(2, 3) Midway between the proximal descending aorta and the aorta at diaphragm level gives the best distribution of measurement points and is therefore recommended. The bifurcation of the pulmonary trunk is an easily identifiable landmark and could serve as a good alternative.

Aorta at diaphragm
This landmark should be measured 2 cm above the celiac trunk.(2, 3)

Abdominal aorta
The guidelines recommend to measure at the level of the celiac trunk.(2, 3) However, when considering surgical/endovascular therapies, suprarenal and infrarenal measurements can be of importance and we therefore advise to measure supra- and infrarenal dimensions. In case of wall thickening, for example with atherosclerosis or intramural hematoma, it is advisable to report both internal and external diameters.(4)

Beyond the aorta
The guidelines do not discuss any landmarks beyond the bifurcation. However imaging of the aorta is often performed pre-procedural, for instance for transcatheter aortic valve replacements, to asses arterial accessibility. In these cases it is important to also report diameters of the proximal common iliac arteries, external iliac arteries and the common femoral arteries.



Proximal aortic arch
The diameter of the proximal aortic arch should be measured just proximal to the origin of the brachiocephalic artery.(2, 3)

Mid ascending aorta
The mid ascending aorta is located halfway from the STJ to the proximal aortic arch.(2, 3) The maximal diameter of the ascending aorta along with the distance from the STJ should be reported.(1, 9)

Sinotubular junction
The Sinotubular Junction (STJ) should be measured at the transition of the aortic sinus to the more tubular ascending aorta.(1)

Sinus of Valsalva
The guidelines differ on whether to measure sinus-to-sinus or cusp-to-commissure and whether to report the average of the 3 measurements or the largest diameter.(1, 4, 7) The average cusp-to-commissure and largest cusp-to-cusp measurement are recommended.

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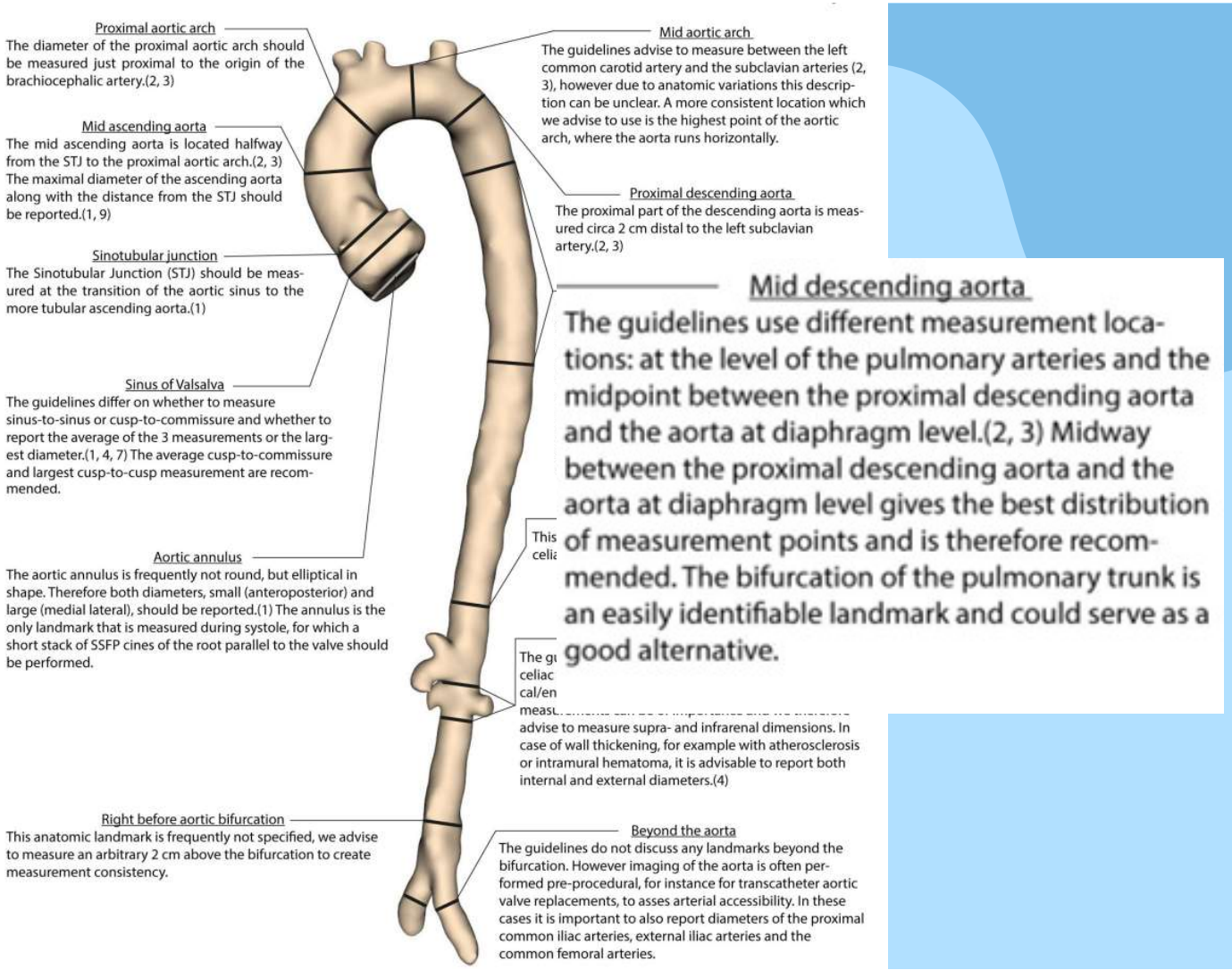
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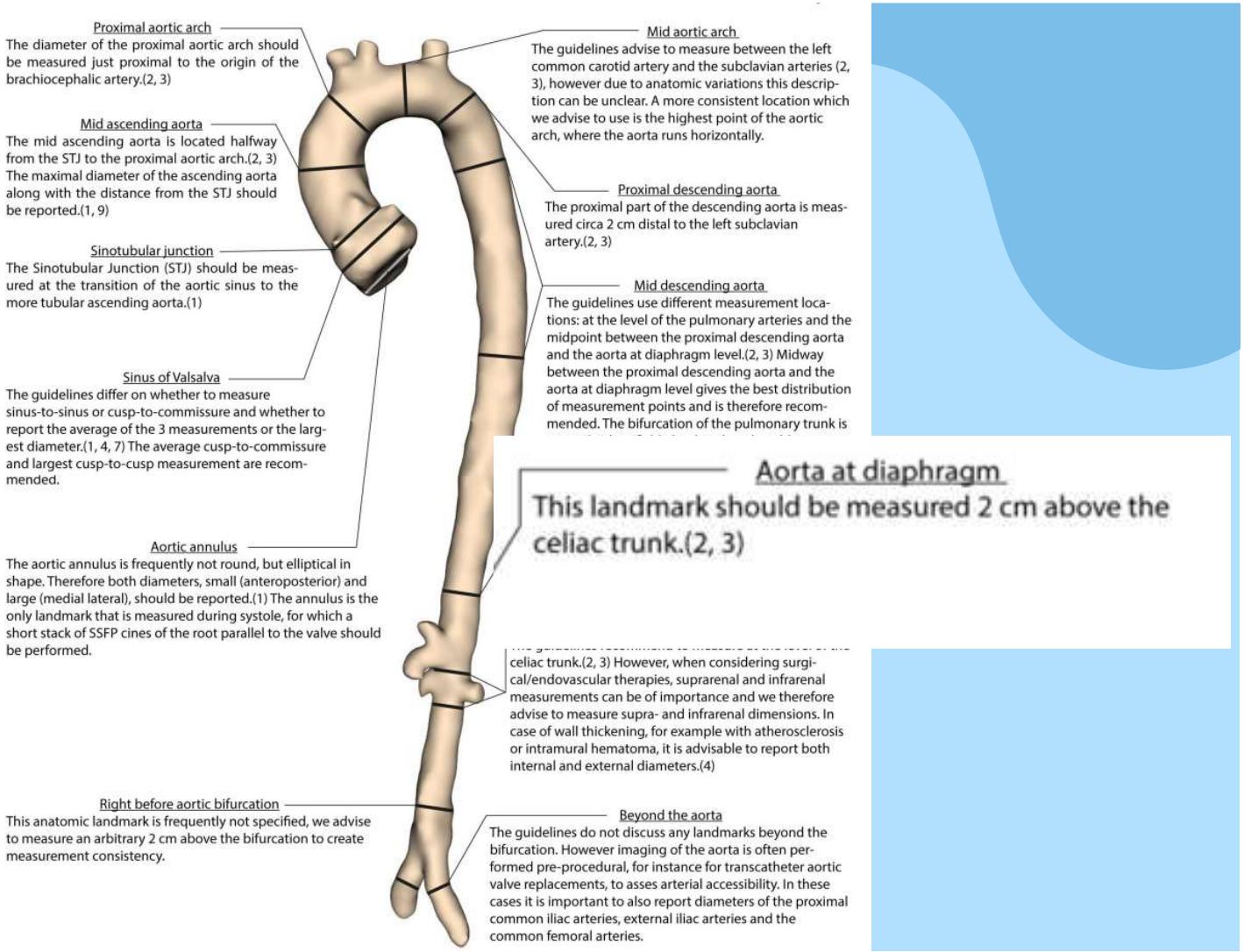

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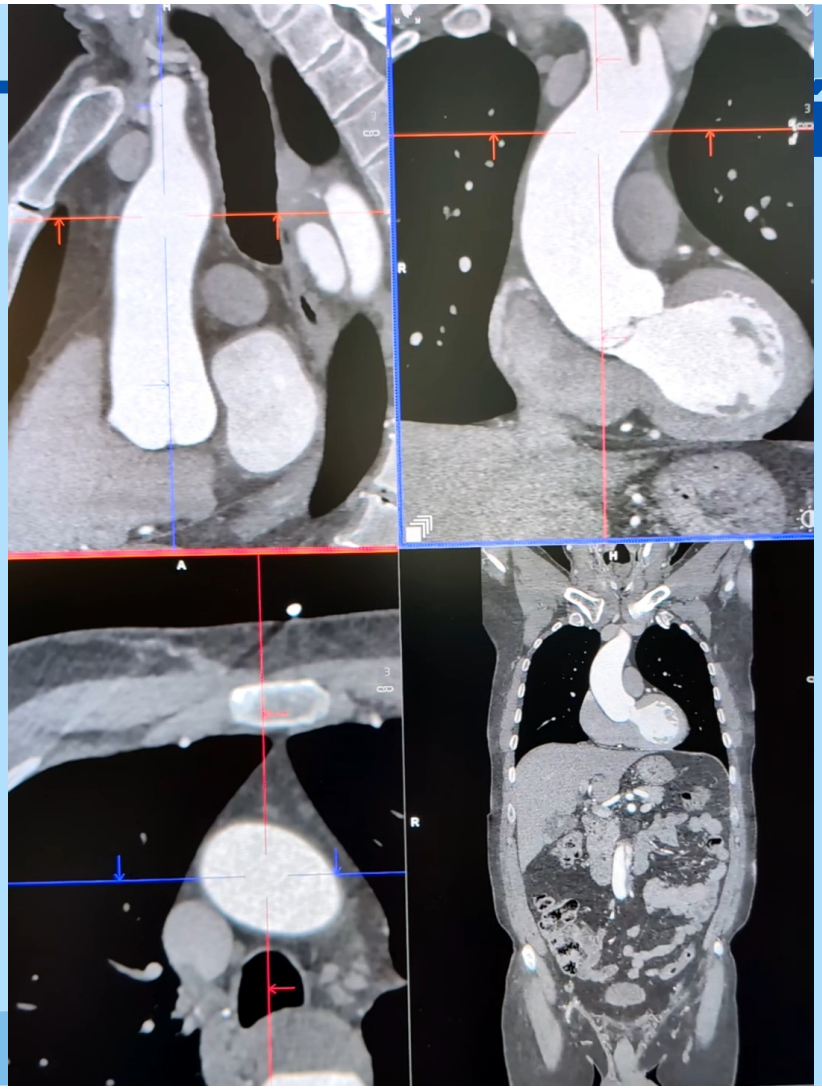
Double oblique multiplanar reconstruction



Pravidla měření

Doporučení ESC z 03/2023

ESC European Society of Cardiology

European Heart Journal - Cardiovascular Imaging (2023) **24**, e65–e85
https://doi.org/10.1093/ehjci/jead024

EACVI DOCUMENT

Multimodality imaging in thoracic aortic diseases: a clinical consensus statement from the European Association of Cardiovascular Imaging and the European Society of Cardiology working group on aorta and peripheral vascular diseases

Artur Evangelista[1]*, Marta Sitges [2,3], Guillaume Jondeau [4], Robin Nijveldt [5], Mauro Pepi [6], Hug Cuellar[7,8], Gianluca Pontone [9], Eduardo Bossone [10], Maarten Groenink[11], Marc R. Dweck[12], Jolien W. Roos-Hesselink[13,14], L. Mazzolai[15], Roland van Kimmenade[16], Victor Aboyans [17], and Jose Rodríguez-Palomares[1]

[1]Servei de Cardiologia, Hospital Vall d'Hebron, CIBERCV, Universitat Autonoma de Barcelona, Vall d´Hebron Research Institute, VHIR, Barcelona, Spain; [2]Cardiovascular Institute, Hospital Clinic, University of Barcelona, Villarroel 170, 08036 Barcelona, Spain; [3]CIBERCV, Institut Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS), Villarroel 170, 08036 Barcelona, Spain; [4]Reference Center for Marfan Syndrome and related diseases, Cardiology Department, VASCERN HTAD European Reference Centre, Hopital Bichat, APHP, INSERM U1148, Université de Paris, France; [5]Department of Cardiology, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands; [6]Centro Cardiologico Monzino IRCCS, Via Carlo Parea 4, Milano, Italy; [7]Radiology Department, Institut de Diagnòstic per la Imatge, Hospital Vall d'Hebron, Barcelona, Spain; [8]Universitat Autònoma de Barcelona, Vall d´Hebron Research Institute (VHIR), Barcelona, Spain; [9]Department of Perioperative Cardiology and Cardiovascular Imaging, Centro Cardiologico Monzino IRCCS, Milan, Italy; [10]Cardiology Division, Antonio Cardarelli Hospital, Via Antonio Cardarelli 9, 80131, Naples, Italy; [11]Department of Cardiology and Radiology, Amsterdam University Medical Center, Amsterdam, The Netherlands; [12]BHF Centre for Cardiovascular Science, University of Edinburgh, Chancellors Building, Little France Crescent, Edinburgh EH16 4SB, UK; [13]Cardiology Department, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands; [14]VASCERN HTAD European Reference Centre; [15]Division of Angiology, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland; [16]Department of Cardiology, Radboud University Medical Center, Nijmegen, The Netherlands; and [17]Department of Cardiology, Dupuytren University Hospital, Inserm U1094, Limoges, France

Received 29 January 2023; accepted 30 January 2023; online publish-ahead-of-print 7 March 2023

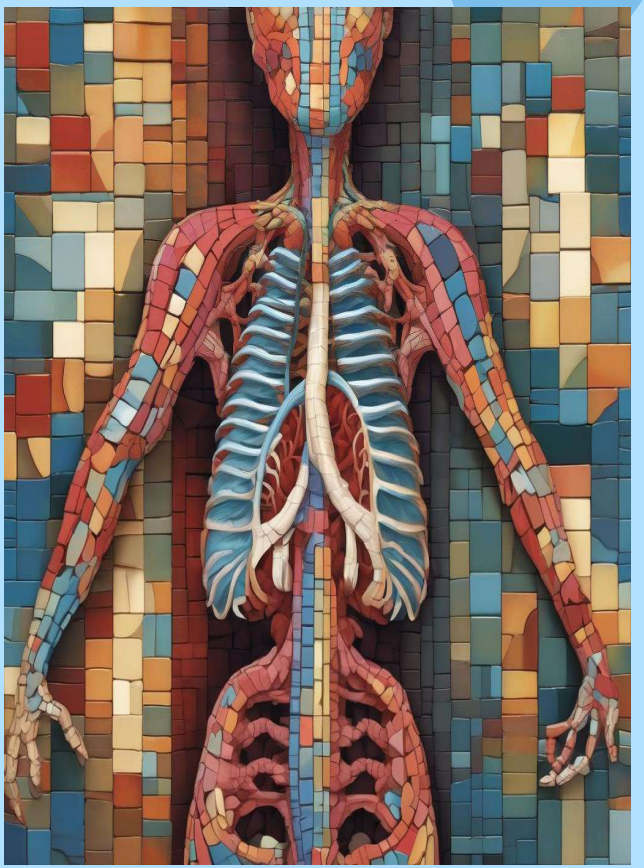
Pravidla měření

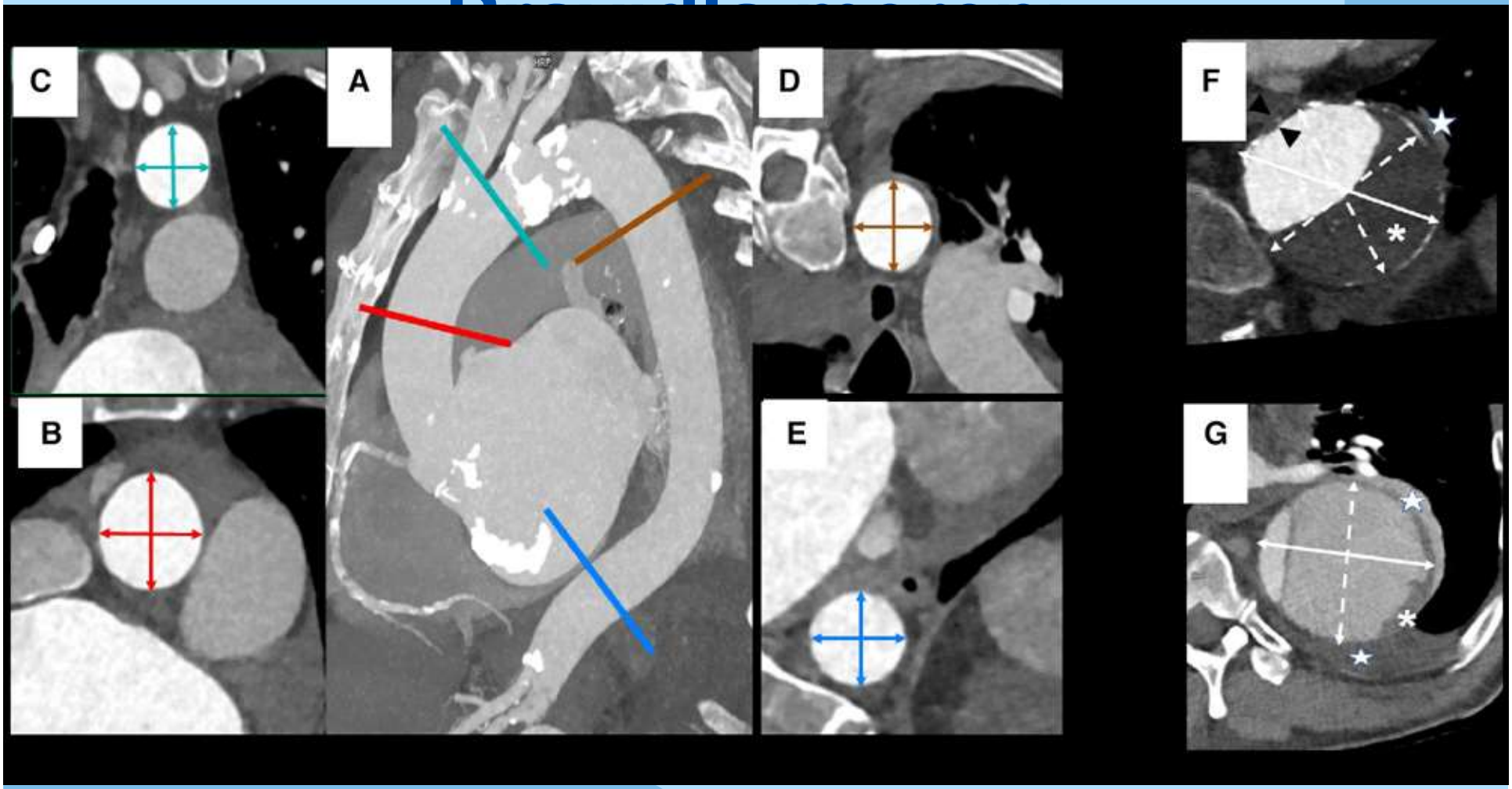
(a) Vnitřní průměr (inner-to-inner diameter), v diastole

(a) Pokud je stěna zesílena (ateromy, IMH, aortitida), měříme zevní průměr (outer-to-outer diameter)

(a) Pokud je přítomen trombus, měříme vnitřní průměr včetně trombu. Pokud je trombus crikulární, měříme zevní průměr.

(a) U disekcí měříme vnitřní průměr obou lumen dohromady.

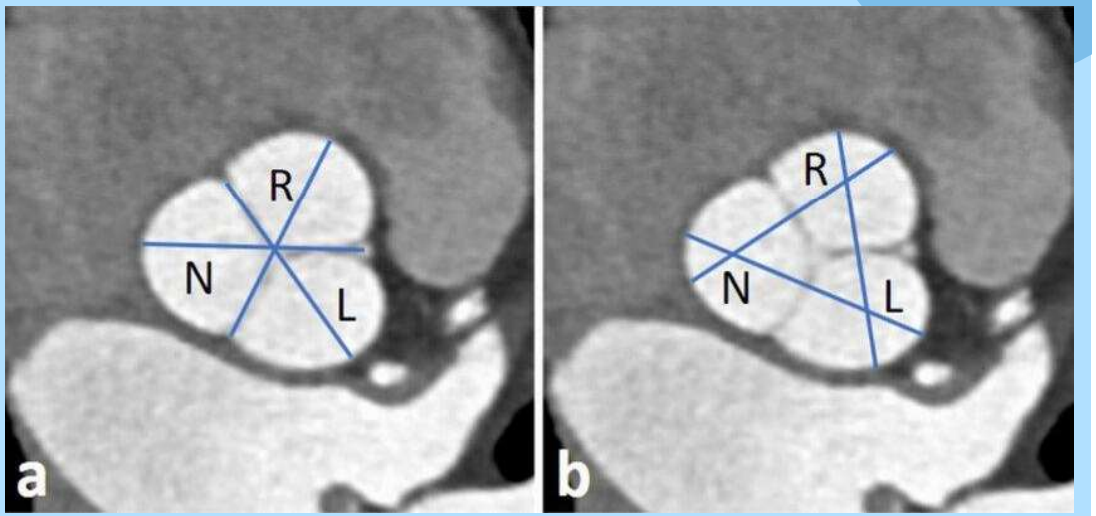



C
A
D
F
B
E
G

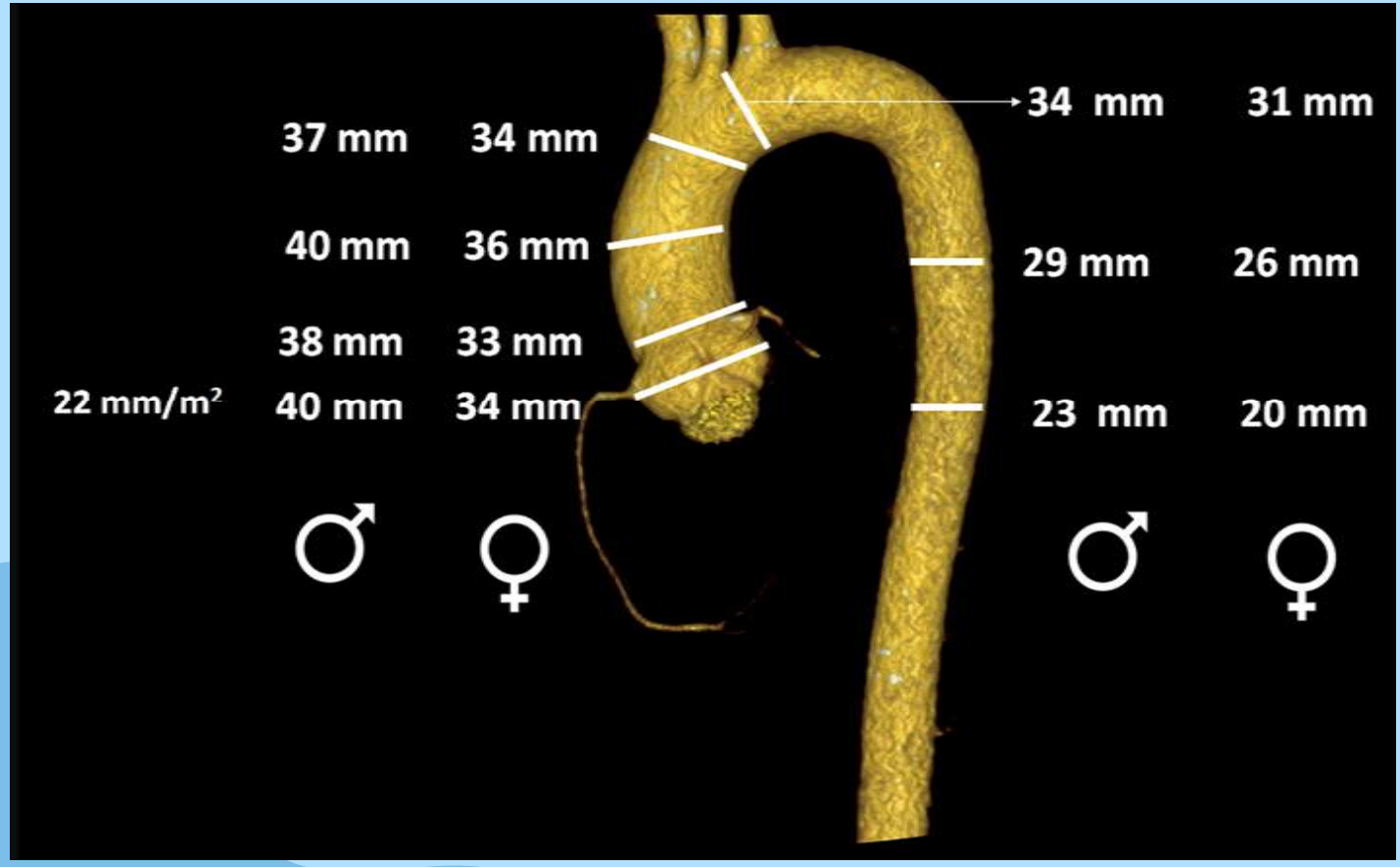
Kořen aorty - Valsalvovy siny

- můžeme měřit sinus-sinus, sinus-komisura, systola / diastola
  - to je celkem 12 rozměrů

- maximální rozměr sinus-sinus v diastole
  - většinou stačí udat jeden rozměr
  - pokud se rozměry liší o 5 mm a více, udávají se dva rozměry



Normální hodnoty dle ESC



Follow up

- Variabilita měření je obvykle ≤ 2mm.
- Proto by měla být změna velikosti uvažována pouze pokud je rozdíl mezi měřeními 2mm a více.
- Pokud jde o významnou změnu velikosti (tj. většinou alespoň 3mm za rok), je nutné změřit současně minulé a aktuální vyšetření.

Děkuji za pozornost

Další otázky?
michal.klan@homolka.cz

Podpořeno grantem studie Eleanor

Zdroje

Hout, Max & Scholte, Arthur & Juffermans, Joe & Westenberg, Jos & Zhong, Liang & Zhou, Xuhui & Schalla, Simon & Hope, Michael & Bremerich, Jens & Kramer, Christopher & Dewey, Marc & Ordovas, Karen & Bluemke, David & Lamb, Hildo. (2020). How to Measure the Aorta Using MRI A Practical Guide. Journal of Magnetic Resonance Imaging. 52. 10.1002jmri.27183.

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Hamid, Aws & Gupta, Monesha & Rajiah, Prabhakar & Abbara, Suhny & Hanneman, Kate & Allen, Bradley. (2023). The current and future role of imaging of thoracic aortic disease: a North American society for cardiovascular imaging commentary on the 2022 AHA/ACC guidelines for the diagnosis and management of aortic disease. The International Journal of Cardiovascular Imaging. 40. 1-10. 10.1007/s10554-023-02964-1.