

BACKGROUND

Bovine aortic arch:

- most common variation of the aortic arch characterized by the presence of a common origin of the innominate and left carotid artery [1];
- its prevalence (13.6%) in the general population is likely to be underestimated;
- associated with higher growth rates of the thoracic aorta and a **higher prevalence of thoracic aortic dissection** [2]

! The prognostic value of bovine arch configuration remains to be established and the mechanisms potentially underlying the onset of thoracic aortic dissections still represent a largely unaddressed issue within the scientific community.

PURPOSE

To assess whether the bovine anatomical variant configures a consistent helical flow pattern, which may elucidate its association with thoracic aortic dissections (TADs).

DISCLOSURES

Authors have nothing to declare.

METHODS

1. Computed tomography (CT) scans of healthy aortas stratified in Type I, II and III arches (each n=5, Fig. 1).
2. Computational fluid dynamics (CFD) of intra-aortic helical flow field, within *Ishimaru's* landing zones, to extract systolic velocity (**V**) pathlines and quantify:
 - vorticity (**ω**), the local fluid spinning, and absolute helicity (**|H|**), quantifying the corkscrew-like fluid motion;
 - absolute local normalized helicity **|LNH|** to discern irrotational (**|LNH|≈0**) from highly rotational flow (**|LNH|≈1**).
3. *Serret-Frenet* theory [4] to measure curvature (**κ**) and torsion (**τ**) of blood velocity pathlines.

RESULTS

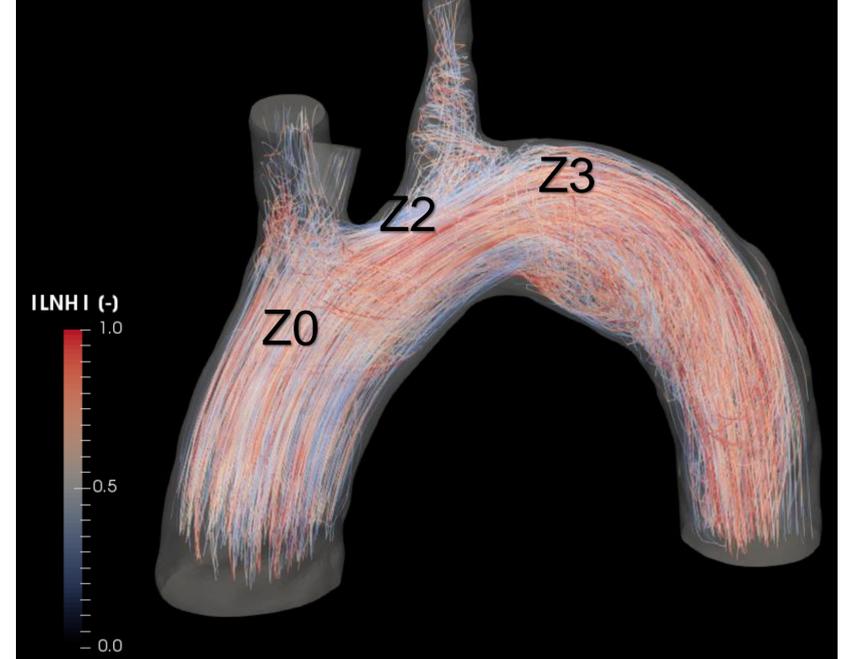
The bovine aortic arch variant pinpointed hemodynamic flow alterations localized in Zone 0 and 3, which identifies the most frequent site for proximal entry tear in aortic dissection. Specifically:

- **ω** and **|H|** remained comparable ($P>0.15$) progressively increasing from Zone 0 to 3;
- **|LNH|** exhibited no significant differences between arch Types with median values ranging between 0.48 (Type III, Zone 0) and 0.72 (Type II, Zone 3, Fig. 2);
- Curvature **κ** revealed significant differences in Zone 0 ($P=0.0139$) and Zone 3 ($P<0.0001$), respectively;
- Torsion (**τ**) resulted consistent ($P>0.0694$) between the different bovine arch Types.

CONCLUSION

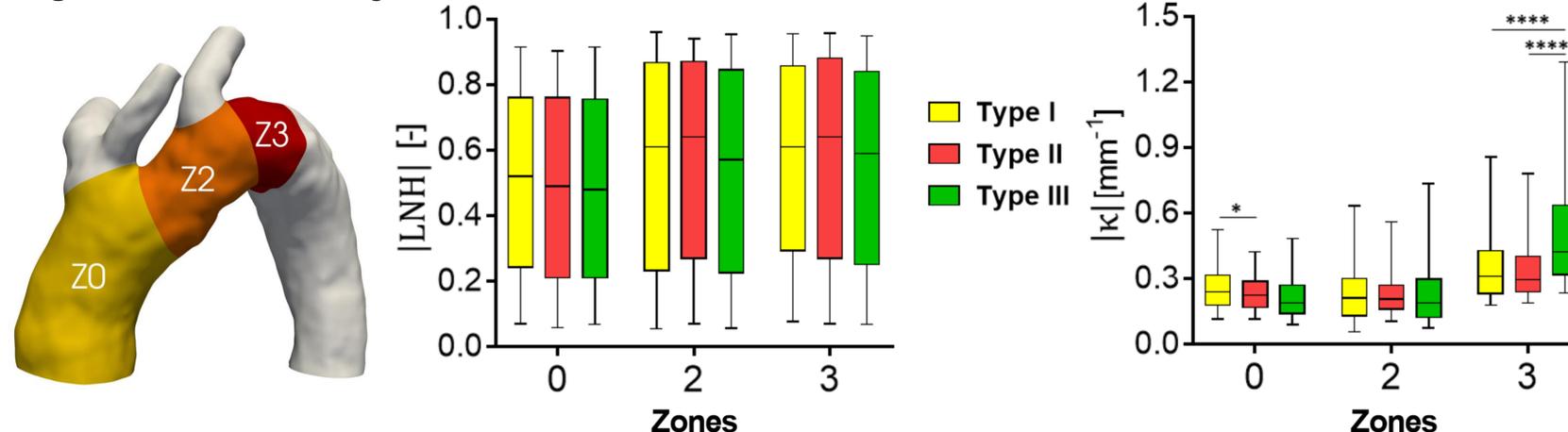
Hemodynamic flow alterations consistently reflect the geometric peculiar pattern revealed by previous analyses on bovine arch anatomies [4].

Fig. 2. LNH-coded velocity pathlines in a Type II arch



The analysis can shed light on the increased risk associated to the bovine aortic arch to develop TADs.

Fig. 1. Aortic arch landing zones and CFD helical flow results



References

1. Rylski et al. *Eur J Cardiothorac Surg* 2019
2. Marrocco-Trischitta et al. *Eur J Cardiothorac Surg* 2019
3. Shalhub et al. *J Vasc Surg* 2018
4. Marrocco-Trischitta et al. *Eur J Vasc Endovasc Surg (In Press)*