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IA 12: Unit 6- Investigating the Properties of Blood Vessels

Aim
To compare the recoil and subsequent elastic limit of a mammalian aorta and vena cava.

Introduction
Pumped by the muscular action of the heart, the blood is propelled around the body in tubular blood vessels. Blood flows through arteries, arterioles, capillaries, venules and veins. In this investigation we shall relate some of the physical properties of arteries and veins to their functions.

Data Collection and Processing

Raw data table to show the elastic recoil of vena cava

Mass (g)	Length of vena cava (±0.1cm)		
	Vena cava with mass	Vena cava without mass	Elastic recoil (±0.2%)
0 (original length)	2.2	2.2	0.0
100	3.6	3.4	5.9
200	4.2	4.0	5.0
300	4.5	4.4	2.2
400	4.6	4.5	2.2
500	4.6	4.5	2.2
600	4.6	4.6	0.0
700	4.7	4.7	0.0
800	4.7	4.7	0.0

Raw data table to show the elastic recoil of aorta

Mass (g)	Length of aorta (±0.1cm)		
	Aorta with mass	Aorta without mass	Elastic recoil (±0.2%)
0 (original length)	3.3	3.3	0.0
100	3.8	3.3	15.2
200	4.4	3.3	33.3
300	4.6	3.3	39.4
400	4.8	3.3	45.5
500	5.0	3.3	51.5
600	5.2	3.3	57.6
700	5.3	3.3	60.6
800	5.3	3.3	60.6

Calculations

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Elastic recoil of the first 100g	Formula	Working out	Answer (1 d.p)
Vena cava	**((length with mass-length without mass)/ length without mass) x100**	**((3.6-3.4)/3.4) x 100**	**5.8%**
Aorta		**((3.8-3.3)/3.3) x100**	**15.2%**

Observations

From observations, the walls of the aorta are clearly thicker and feel tougher than the vena cava. The aorta is also light in colour (light flesh pink) whilst the vena cava is a darker plum red.

Analysis

The first two tables of results above shows the elastic recoil of the vena cava and the aorta. It demonstrates as the length of the vena cava/aorta when the mass is put on and when the mass is removed to see if it has stretched. The mass increases down the table from no mass (0) to 800g. The table below it is evidence of my calculations for the elastic recoil.

For processing the data, I drew 2 graphs. Graph one represents the elastic recoil percentage of the aorta and the vena cava as the mass increases. Graph two shows the elasticity of the aorta and the vena cava. This is measured from the length of the artery/vein when a mass of 800g is put on. No averages and standard deviation is calculated as I only did one trial because I was unable to do another repeat as this means I will have to dissect another heart to obtain an aorta and vena cava again.

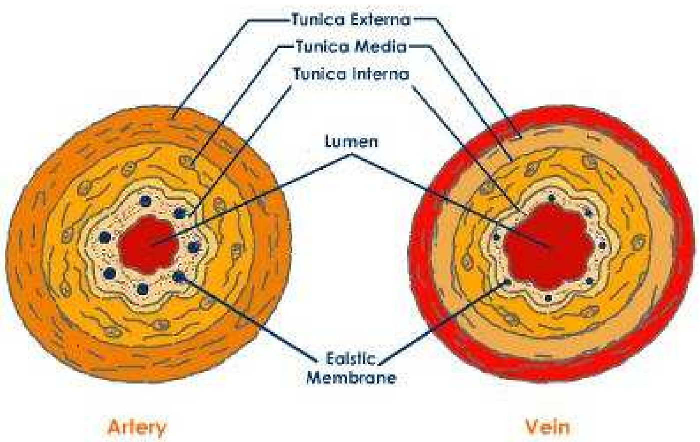
Conclusion

The aim of this experiment was to compare the recoil and elastic limit of an aorta and vena cava. This was done by hanging weights onto the aorta/vena cava and measuring the length of it when the mass was put on and afterwards to test the elasticity of it. In conclusion, I found out that the aorta has the ability to recoil and stretch a lot more than the vena cava. This can be supported from my results. The elastic recoil of the vena cava when 100g of weight is added on is 5.9% whereas for the aorta, it is 15.2%. The elasticity of the vena cava is limited. It stretched by 1.4cm from the original length to when 100g is added. But as the mass increases, the length when the masses are added only increases by a bit (ranging from 0 to 0.6). This can be seen from the elastic recoil of the vena cava. It first increased by 5.9% but as the mass load is increased, the elastic recoil decreases and gradually reached 0, meaning the elastic limit is reached (at 4.7cm).
On the other hand, for the aorta, as the mass of weights increases, the elastic recoil gradually increases till it reaches it's elastic limit (at 5.3cm) where the length wouldn't increase even though the mass increases. This is supported from the line labeled "aorta" on Graph one. In the graph, we can clearly see the line (elastic recoil)

steeply rising all the way up as the mass increases till 700g to 800g when the line levels off and remains at 60.6g.This means the elastic limit of the aorta has been reached.

However, even though the mass of weights increases, the aorta always return to its original length at 3.3cm, even when the 800g load is added to it. This can be seen on the results. When the 800g load is added on, the aorta stretched to 5.3cm (from 3.3cm) but when the load is taken off, it immediately returns to the original length. This proves that the aorta can recoil effectively, thus meaning that arteries are more elastic and can recoil more than veins. In my results, I did not encounter any anomalous results.

There is a biological explanation to support this hypothesis and theory that aorta has the ability to stretch and recoil more than the vena cava. The function of the aorta is to distribute oxygenated blood to all parts of the body [1], thus arteries carry blood away from the heart. This means that the walls of the aorta (and arteries) are thicker than the vena cava (and veins). This can be seen from the diagram below.[2]



In the diagram, we can see the walls of the artery is thicker then the vein thus causing the lumen of the artery to be smaller than the vein. The elastic muscle fibers and smooth muscles from the tunica media that make up the walls enable the aorta to withstand high blood pressure as it is pumped from the heart. When the aorta expands as the pulse of blood passes through, the elastic recoil of the elastic fibers causes it to spring back quickly afterwards thus pushing the blood along. Also, the artery walls contain collogen fibers, which provide the arteries with firmness and strength to prevent overstretching. This reinforces that the aorta has good recoil. Therefore, veins (vena cava) will have less elastic fibers and thinner walls due to their lower pressure environment. This also proves that due to the vena cava having a larger lumen, it will not return to it's oringal length after an applied force have been taken off, but will be permanently stretched.

Weaknesses and improvements

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[1] Maton, Anthea (1995). *Human Biology Health*. Englewood Cliffs, New Jersey: Prentice Hall. ISBN 0-13-981176-1.

[2] "Circulatory Systems - Biology Encyclopedia - Body, Animal, Organs, Blood, Separated, Major." *Biology Reference*. Web. 12 Feb. 2012. <http://www.biologyreference.com/Ce-Co/Circulatory-Systems.html>.

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Weakness	Improvement
There may be some minor systematic errors caused by uncertainties from the equipment, which may cause my results to be unreliable.	Improve the number of trials and repeats to reduce these random uncertainties
I did not time how long each weight should be hanged onto the vena cava/aorta each time. These may cause my readings to be inaccurate as the timings for extensions need to be sufficient in order to make sure the vein/artery is completely stretched under the mass	When each mass is applied onto the aorta/vena cava, I will time for 1 minute before removing the mass and calculating the length after the mass. This will make the experiment a fair test thus my results will be reliable
The preparations of the samples (vena cava and aorta) may have been damaged. For example, there were some tiny cuts on my vena cava, which can affect the elasticity and the elastic limit of it.	Use scissors to prepare and cut the sample of aorta and vena cava instead of using a scalpel so the cutting is more precise. This will ensure the samples won't be damaged when the load of mass is added
When measuring the length of the aorta/ vena cava both when the mass is added and after the mass, it is not precise enough. This is because sometimes the ruler may be slanted or wobbly causing the readings to be inaccurate.	Use a clamp and a stand to hold the ruler vertically to ensure accuracy when measuring the length of the vena cava/aorta
Using only a pig's aorta/vena cava may be insufficient to support they hypothesis	Repeat the experiment using other mammalian veins and arteries in order to have further evidence to support the hypothesis thus making the results more reliable