

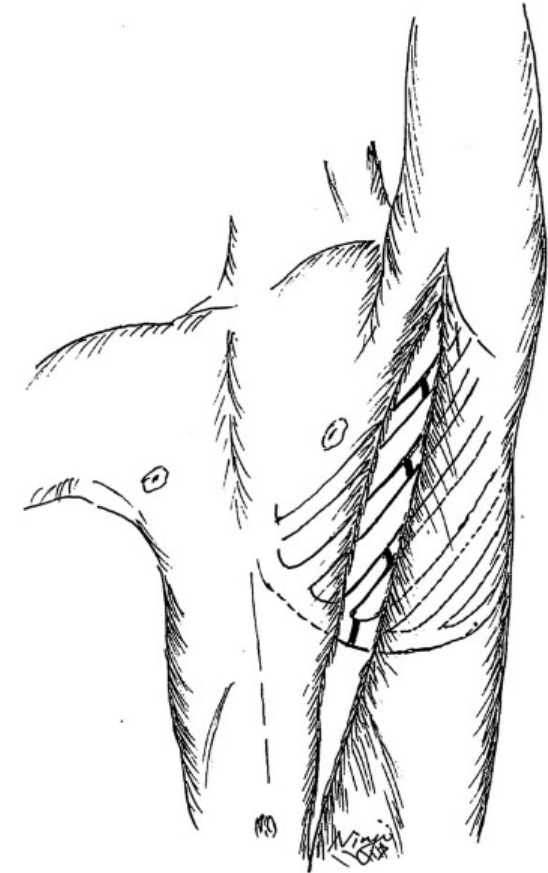
Size and Morphological Differences of Thoracic Cage in Marfan vs Non-Marfan Patients

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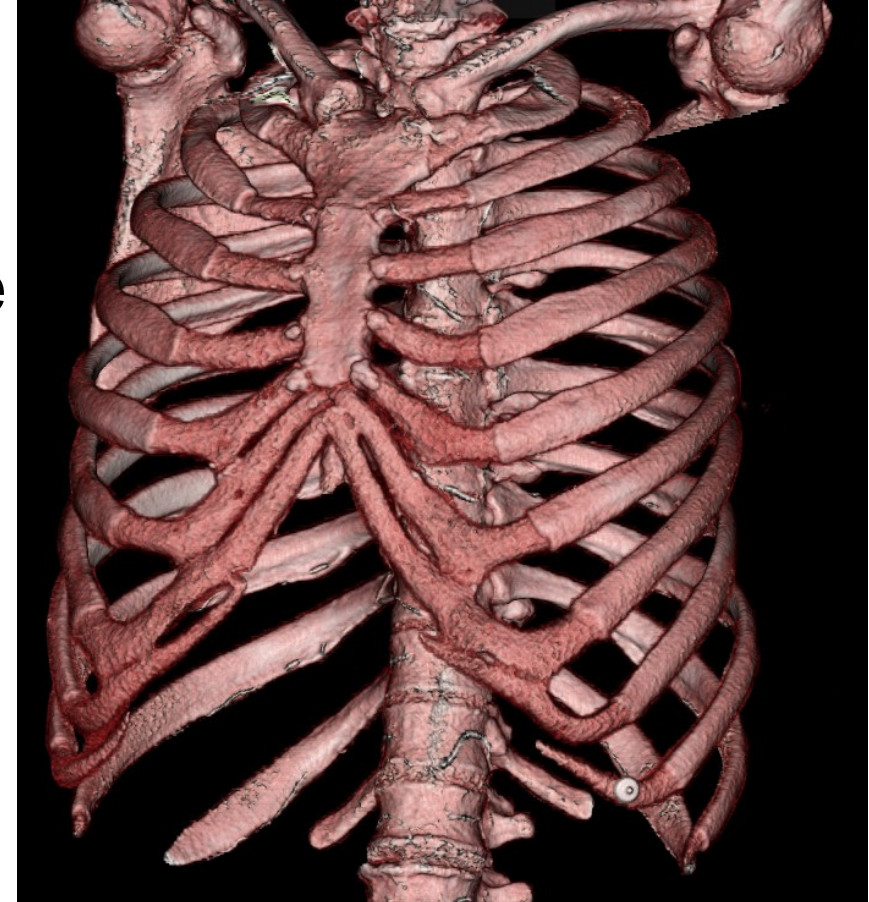
Backgrounds

- The standard spiral incision sometimes fails to secure adequate exposure of the proximal descending aorta and aortic arch, particularly in patients with flat chests, such as those with Marfan syndrome.
- The straight incision with rib-cross (SIRC) approach has been reported to offer improved exposure for such patients.



Objective

- When discussing the optimal incision and approach for the thoracic aortic surgeries, Few data on the size and morphology of the thoracic cage is found.
- This study aimed to describe the size and morphological differences in the thoracic cage between Marfan and non-Marfan patients.

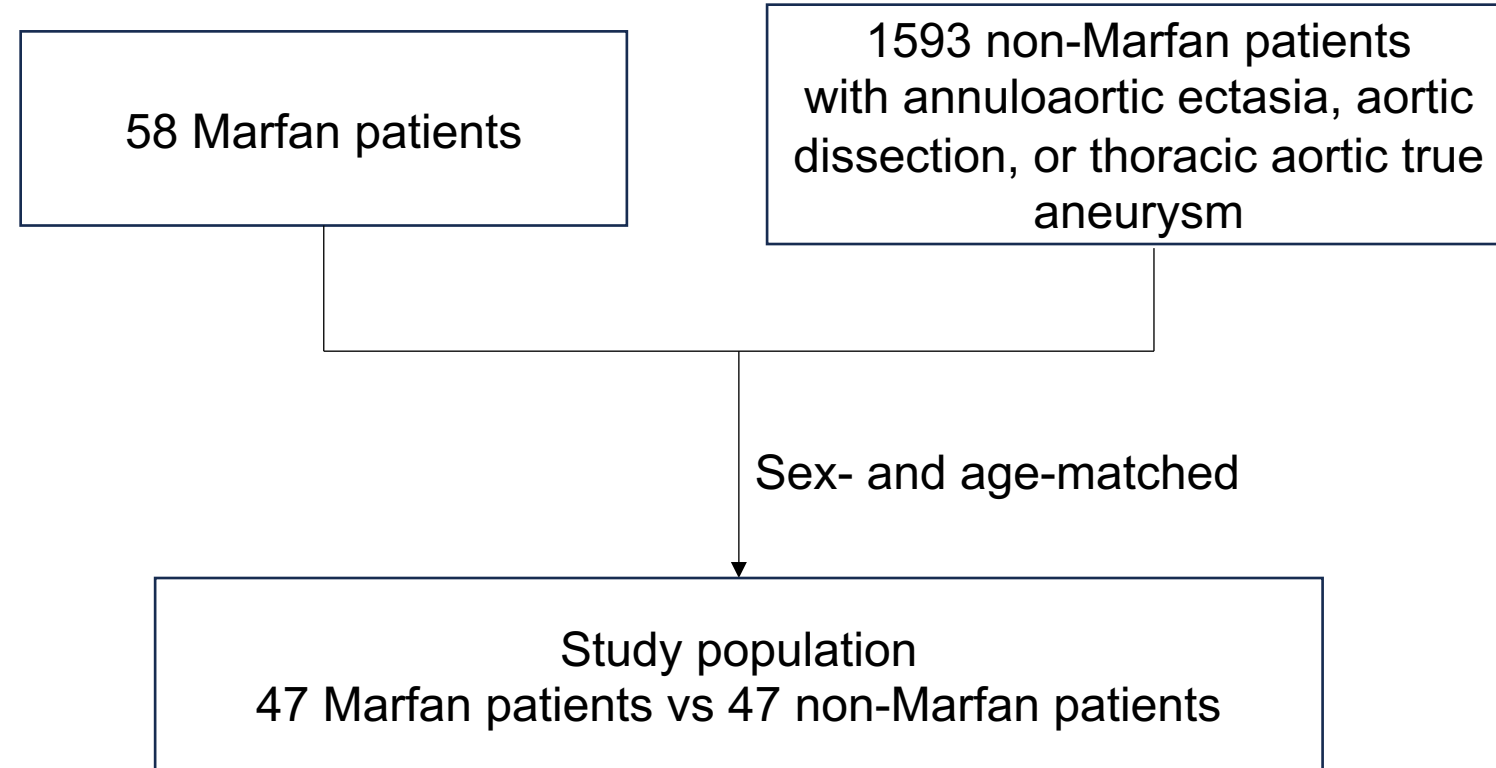


Study design

- Single-center retrospective cohort study

- Patients

- 18 years or older
- chest CT performed

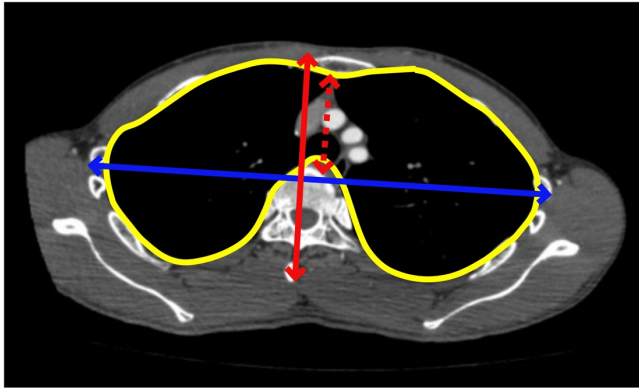


- Statistical analysis

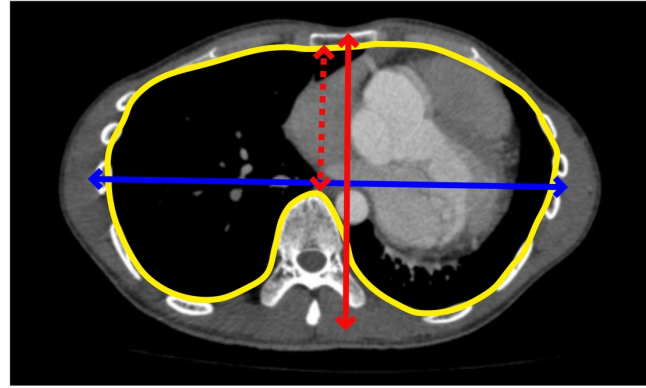
- multiple linear regression
- Pearson's correlation coefficient (rib angles and AP distance, sternum-vertebra)

CT measurements

- Anteroposterior distance, Sternum-vertebra distance, Transverse distance, Thoracic cage area (axial view)



Aortic arch level



Aortic valve level

- Rib angles (sagittal view)
- Thoracic cage volume (3D)

Rib angles



Baseline characteristics

Characteristics	Non-Marfan (N = 47)	Marfan (N = 47)	P value
Age, years	41.6 (14.1)	40.9 (13.2)	0.8
Men	26 (55%)	26 (55%)	>0.9
Height, cm	166.3 (12.1)	177.1 (10.7)	<0.001
Weight, kg	62.6 (15.5)	63.3 (15.2)	0.8
BMI, kg/m ²	22.3 (3.6)	20.0 (3.4)	0.002
BSA, m ²	1.7 (0.3)	1.8 (0.2)	0.091
Annuloaortic ectasia	10 (21%)	40 (85%)	<0.001
Thoracic aortic true aneurysm	17 (36%)	2 (4.3%)	<0.001
Aortic dissection	24 (51%)	8 (17%)	0.001

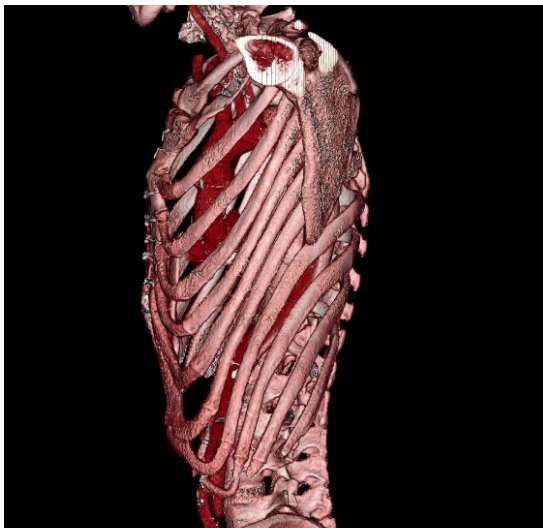
Mean (SD) or n (%)

Size of thoracic cage in the axial section

Characteristics	Non-Marfan (N = 47)	Marfan (N = 47)	P value
Aortic arch level			
AP distance, mm	134.6 (18.6)	138.9 (20.4)	0.3
Sternum-vertebrae, mm	54.4 (12.4)	58.8 (15.0)	0.12
Transverse distance, mm	219.7 (23.1)	233.0 (27.3)	0.012
AP/Transverse	0.61 (0.06)	0.60 (0.10)	0.5
Thoracic cavity area, cm ²	146.0 (49.0)	176.9 (43.3)	0.002
Aortic valve level			
AP distance, mm	178.3 (23.8)	175.3 (26.1)	0.6
Sternum-vertebrae, mm	101.3 (18.7)	96.7 (22.9)	0.3
Transverse distance, mm	264.3 (24.4)	256.2 (27.3)	0.13
AP/Transverse distance	0.67 (0.06)	0.69 (0.12)	0.4
Thoracic cavity area, cm ²	316.6 (68.5)	294.9 (60.2)	0.11

Volume and rib angles

Characteristics	Non-Marfan (N = 47)	Marfan (N = 47)	P value
Volume of thoracic cage, cm ³	6,250.5 (1,888.3)	6,340.7 (1,460.3)	0.8
Rib angles			
The 4th rib, degrees	55.4 (8.8)	45.0 (8.9)	<0.001
The 5th rib, degrees	51.3 (8.4)	42.2 (8.4)	<0.001
The 6th rib, degrees	49.3 (8.7)	39.7 (8.2)	<0.001



Marfan patients had significantly acute rib angles than non-Marfan patients.

Adjusted analysis (sex, age, BSA)

Characteristics	Crude			Adjusted		
	Beta	95% CI	p-value	Beta	95% CI	p-value
Aortic arch level						
AP distance, mm	4.34	-3.54, 12.23	0.3	1.62	-4.16, 7.41	0.6
Sternum-vertebrae, mm	4.41	-1.16, 9.98	0.12	2.83	-2.46, 8.12	0.3
Transverse distance, mm	13.35	3.11, 23.59	0.012	9.12	1.31, 16.94	0.025
Thoracic cavity area, cm ²	30.91	12.22, 49.61	0.002	25.70	9.63, 41.78	0.002
Aortic valve level						
AP distance, mm	-3.05	-13.14, 7.05	0.6	-7.63	-14.31, -0.95	0.028
Sternum-vertebrae, mm	-4.58	-13.04, 3.88	0.3	-7.98	-14.59, -1.36	0.020
Transverse distance, mm	-8.16	-18.61, 2.29	0.13	-13.43	-20.36, -6.50	<0.001
Thoracic cavity area, cm ²	-21.72	-47.80, 4.36	0.11	-36.08	-50.96, -21.19	<0.001
Rib angles						
The 4th rib, degrees	-10.46	-14.04, -6.88	<0.001	-11.38	-14.63, -8.13	<0.001
The 5th rib, degrees	-9.16	-12.55, -5.77	<0.001	-9.96	-13.17, -6.76	<0.001
The 6th rib, degrees	-9.63	-13.06, -6.21	<0.001	-10.69	-13.87, -7.52	<0.001

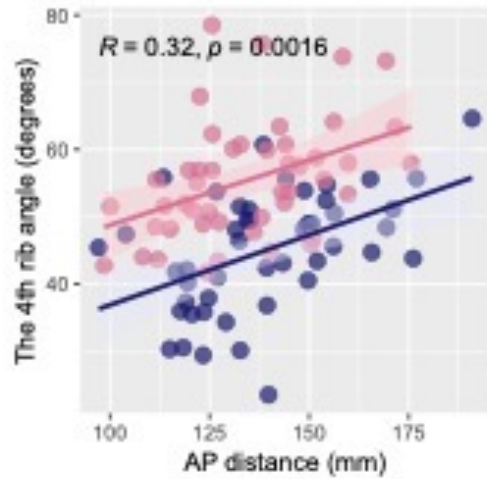
Beta: Difference between Marfan and non-Marfan patients

CI: confidence interval
AP: anteroposterior

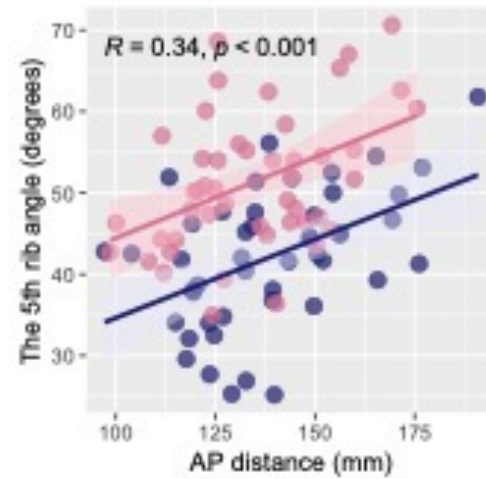
Marfan patients

- flatter chest wall
- more acute rib angle

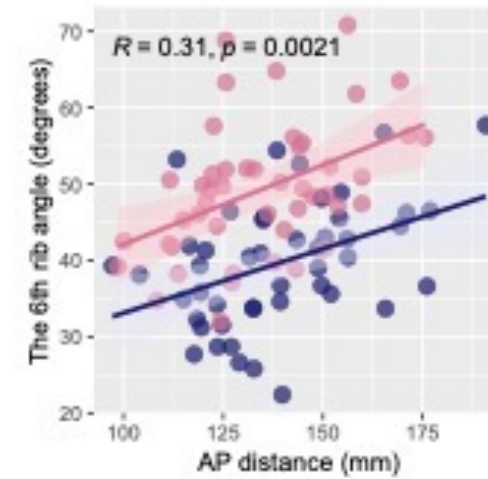
Rib angles and AP distance, sternum-vertebra distance at the aortic arch level



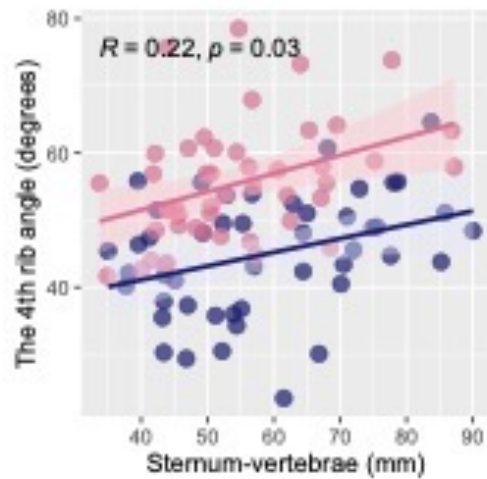
Group ● Non-Marfan ● Marfan



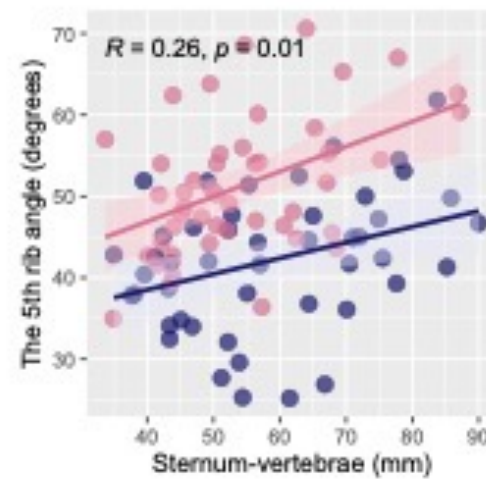
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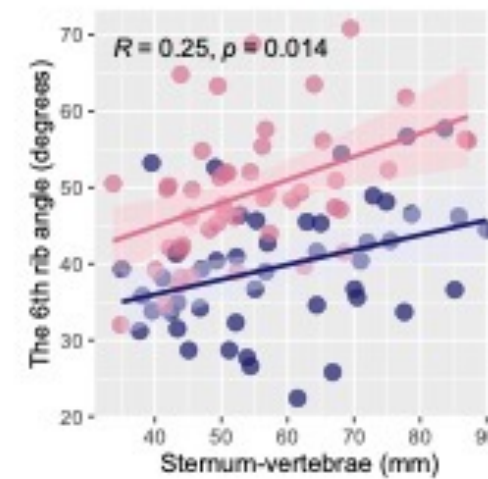
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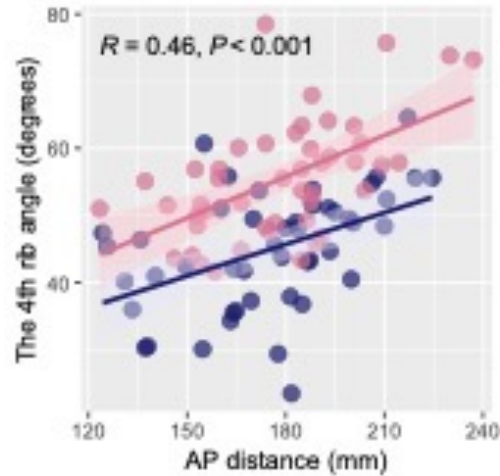


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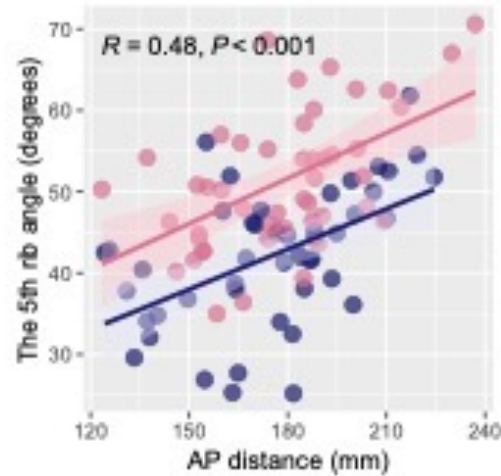


Group ● Non-Marfan ● Marfan

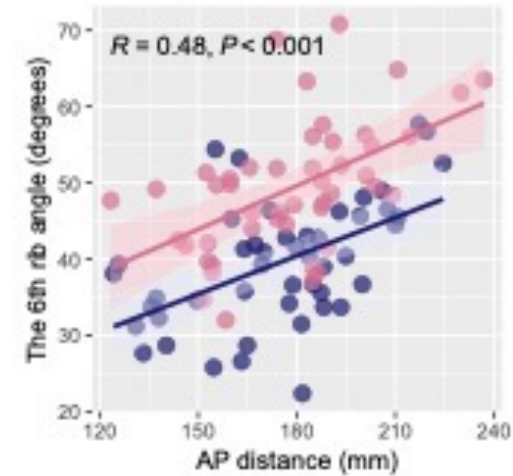
Rib angles and AP distance, sternum-vertebra distance at the aortic valve level



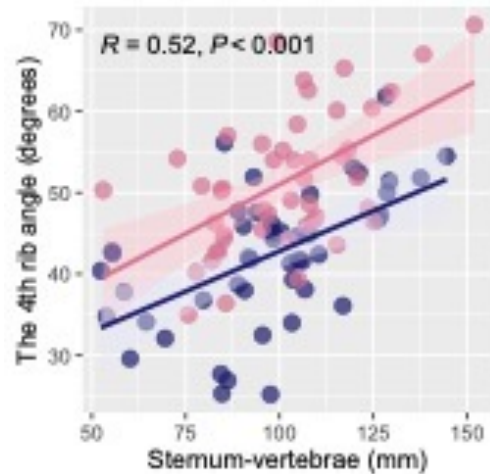
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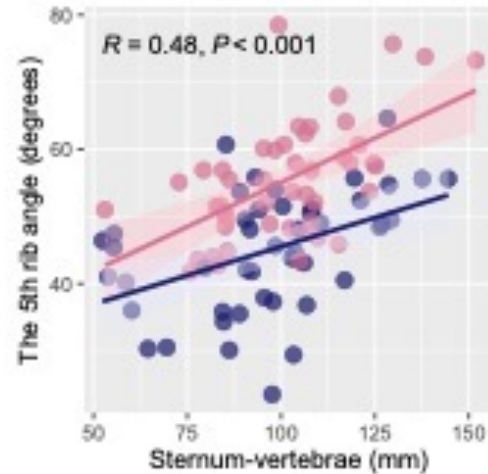
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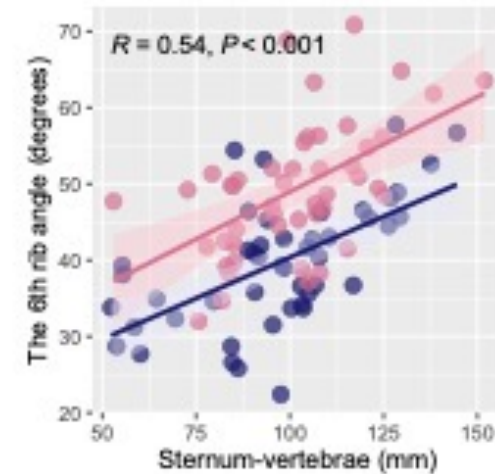
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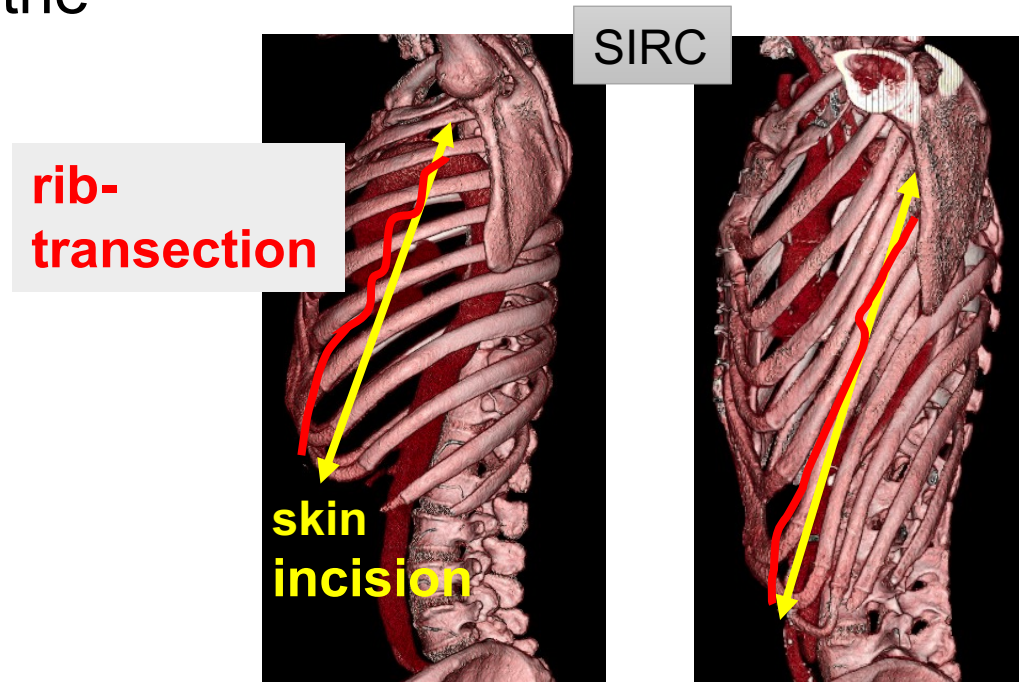
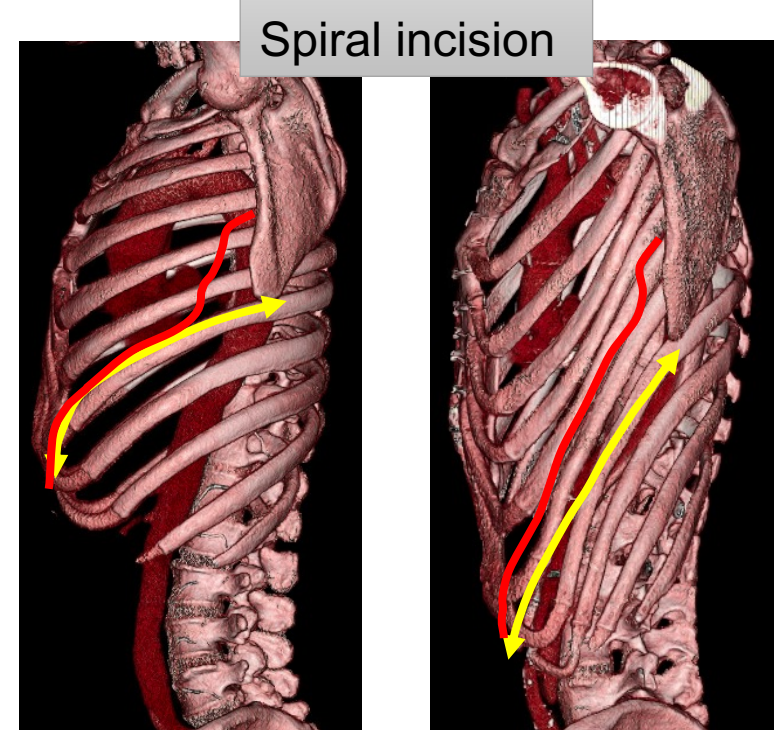
Group ■ Non-Marfan ■ Marfan



Group ■ Non-Marfan ■ Marfan

Discussion

- The spiral incision offers an optimal surgical field, particularly in patients with a large thoracic cage, while the surgical field is often limited for patients with flatter chest.
- The SIRC approach offers better exposure of the proximal descending aorta and aortic arch.
- The number of ribs for the exposure to be transected is usually less in Marfan patients.



Conclusions

- Marfan patients had a flatter chest wall and acute rib angles than non-Marfan patients.
- The SIRC approach for thoracic and thoracoabdominal aortic aneurysms might be more suitable for patients with a flatter chest wall, such as those with Marfan syndrome.
- Further studies are necessary to clarify the impact of thoracic cage morphological differences on the procedures and their outcomes.