# CHARACTERISTIC DIMENSIONS OF HUMAN THORACIC CAVITY FOR TOTAL ARTIFICIAL HEART IMPLANTATION FROM CHEST COMPUTED TOMOGRAPHY

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## INTRODUCTION

The development of orthotopically positioned totally implantable artificial heart requires a knowledge of the detailed structure of the thoracic cavity to guide the design of the blood pump system. Most institutes reported the dimensional criteria for their own artificial heart [1~3] or the information of the interfacial geometry from the reconstructed heart model. [4~7] This study determined characteristic anatomic dimensions for *in vivo* evaluation of our KORTAH.

## MATERIALS AND METHODS

We previously reported the dimensional design criteria of 3 cardiomyopathy patients and 3 healthy persons using computed tomography of magnetic resonance image. [8] In present study, we extended this study to evaluate the more detailed structures of the great vessels, heart and thoracic cavity using chest computed tomography. Chest CTs of 48 patients with lung and/or liver problems were studied. Three-dimensional anatomic data were required from the reconstructed heart-vessel model.

## RESULTS

To clarify the chest dimensions, characteristic chest dimensions were acquired from the CT of mitral valvular plane level. (**Table 1**) Critical anatomic dimensions of human heart which were gotten from the chest CT and reconstructed heart-vessel model were listed in **Table 2**. Aortic arch dimensions from the CT of aortic arch peak level (**Table 3**) and pulmonary bifurcation geometries from the reconstructed model (**Table 4**) were important to evaluate the outlet directions of total artificial heart and to determined the position of the remnants for anastomosis during operation.

## DISCUSSION

These data describe the dimensions of the pericardial space and great vessel's geometry for orthotopic cardiac replacement devices. Some correlations existed between the dimensions of heart and chest. (**Table 5** and **Table 6**) And there was little or no correlation between anatomic dimensions and body mass, sex, or diagnosis.

Some dimensions, especially apex angles, were distorted from the position of patients. Computed tomographies were not synchronized with heart beat, which increase the standard deviations of anatomical data. Finally, this dimensional data can help to design the implantable total artificial heart.

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*Table 1. Chest dimension data from mitral valve level*

| | |
|---|---|
| Max. Lateral Length at Mitral Valve Plane : | 217.05 ± 14. 85 mm |
| Max. Length from Sternum to Posterior : | 148.86 ± 13.27 mm |
| Sternum to Posterior Pericardium : | 95.00 ± 10.90 mm |
| Sternum to Descending Aorta : | 99.90 ± 10.34 mm |

*Table 2. Characteristic dimensions of human hart from CT*

| | |
|---|---|
| Maximum Length of Heart to Apex Direction : | 113.18 ± 9.95 mm |
| Maximum Diameter of AV Ring : | 75.23 ± 8.78 mm |
| Aortic Root (AoV) to Peak of Aortic Arch : | 53.41 ± 9.68 mm |
| Apex Angle with respect to Vertebra : | 50.23 ± 7.15 degree |
| Aortic Root (AoV) to Diaphragm : | 73.67 ± 7.30 mm |
| Maximum Lateral Length of Heart from axial Plane : | 109.55 ± 13.44 mm |
| Left End of Heart from Vertebra : | 80.28 ± 11.90 mm |
| Right End of Heart from Vertebra : | 29.32 ± 7.12 mm |
| Sternum to Posterior of Heart : | 85.91 ± 9.21 mm |
| Sternum to Center of Tricuspid Valve : | 27.96 ± 6.11 mm |
| Sternum to Center of Mitral Valve : | 67.73 ± 11.52 mm |
| Septum Angle : | 73.82 ± 5.27 degree |

*Table 3. Aortic arch geometry from chest CT*

| | |
|---|---|
| Aortic Root (AoV) to Peak of Aortic Arch : | 53.41 ± 9.68 mm |
| Sternum to SVC : | 30.01 ± 5.78 mm |
| Sternum to Ascending Aorta : | 22.46 ± 7.41 mm |
| Sternum to Descending Aorta : | 72.51 ± 10.99 mm |
| Aortic Arch Axis Direction : | 15.55 ± 6.32 degree |
| Max. Diameter of Aortic Arch : | 45.05 ± 9.91 mm |

*Table 4. Pulmonary trunk geometry*

| | |
|---|---|
| Sternum to Center of Pulmonary Trunk : | 23.68 ± 3.07 mm |
| Angle between Pulmonary Trunk and Right PA : | 108.77 ± 11.03 mm |
| Angle between Pulmonary Trunk and Left PA : | 145.41 ± 11.56 mm |
| Sternum to Aorta : | 30.46 ± 4.50 mm |

*Table 5. Correlation between dimensions of heart and chest*

| | |
|---|---|
| Max. Width Length at Mitral Valve Plane vs. Septum Angle : | 0.658 |
| Max. Lenth from Sternum to Posterior vs. Sternum to Posterior Pericardium : | 0.658 |
| Max. Lenth from Sternum to Posterior vs. Sternum to Descending Aorta : | 0.664 |
| Sternum to Posterior Pericardium vs. Sternum to Descending Aorta : | 0.986 |
| Sternum to Posterior Pericardium vs.Sternum to Center of Tricuspid Valve : | 0.597 |
| Sternum to Descending Aorta vs. Sternum to Center of Tricuspid Valve : | 0.631 |

*Table 6. Correlation between dimensions of heart*

| | |
|---|---|
| Max. Length of Heart to Apex Direction vs. Maximum Lateral Length of Heart (axial) : | 0.688 |
| Max. Length of Heart to Apex Direction vs. Left End of Heart from Vertebra : | 0.597 |
| Max. Diameter of AV Ring vs. Sternum to Posterior of Heart : | 0.645 |
| Maximum Lateral Length of Heart (axial) vs. Left End of Heart from Vertebra : | 0.849 |
| Sternum to Posterior of Heart vs. Sternum to Center of Mitral Valve : | 0.593 |
| Sternum to Descending Aorta vs. Max. Diameter of Aortic Arch : | 0.753 |
| Sternum to Center of Pulmonary Trunk vs. Sternum to Aorta : | 0.719 |