

ORIGINAL RESEARCH

A cadaveric study on the difference in thickness between the right ventricle and the left ventricle of the adult human heart in the Eastern Indian population

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ABSTRACT

Aim and objectives: The objective of this study is to determine the thickness difference between the adult human heart's right and left ventricles, as well as their clinical importance in the eastern Indian population, and compare it to the incidence in other races throughout the world.

Introduction: Heart is a muscular motor that supplies blood to all parts of the body so that it provides oxygen and nutrients to all the body parts. As we all know that this heart muscle consists of four chambers viz., right atrium, right ventricle, left atrium and left ventricle. The right ventricle receives from the right atrium and pumps the deoxygenated blood to the lungs. The left ventricle directly pumps oxygenated blood to the rest of the body parts. The left ventricle is usually narrower and longer than the right ventricle which extends from its base of the atrio-ventricular groove to the cardiac apex. Moreover, the left ventricle walls are three times thicker (8 – 12 mm) than those of the right ventricle which is relatively thin measuring 3 – 5 mm and the ration of the thickness between left to right ventricle is 3:1. There are four borders of the heart. The right border is completely formed by the right atrium. The inferior border is formed by the left & right ventricle. The left border is being formed by left ventricle and little contribution from left atrium. Finally, the superior border is formed by right and left atrium with the great vessels.

Materials and Methods: An observational cross-sectional study was conducted on cadavers which are available in the Departments of Anatomy, Forensic Medicine & Toxicology of Nalanda medical college, Patna, Bihar (India), Patna Medical, Patna, Bihar (India) after obtaining consents and permission for the study from heads of the department. Dissections were performed in the thoracic region of 50 cadavers of both sexes (40 males and 10 females) ranging in age from 20-70 years old. The study's sample size is 50 human hearts. The research was carried out over a two years period, from July 2019 to June 2021. The heart was cut open along the borders namely the right, inferior and left border of the heart. The superior border of the heart was kept to be intact so that the specimen can still be super-used for education purpose and other research works. The measurement of the right and left ventricular walls were done with digital vernier calliper. The measurements were done by marking at three levels in both right and left ventricle namely upper, middle and lower part.

Results: The mean thickness of each ventricle was calculated after measuring the thickness of the ventricular wall at three different levels. The mean wall thickness of right ventricle was

calculated to be 9 mm. The mean thickness of left ventricle was estimated to be 13 mm. The mean ratio was found to be 1:1.4 when comparing the thickness of right and left ventricle. The middle part of the right ventricle had a mean thickness of 8 mm. The middle part of the left ventricle had a mean thickness of 8 mm. In the middle portion, the mean thickness ratio of the right and left ventricles is 1:1.8.

Conclusion: The ratio of the thickness of the wall of left and right ventricle is well known as 3:1. Quite oppositely, in our study we found the ratio as 1:1.4. The thickness of the right ventricle was found to be greater than the usual thickness reported in previous research.

We wish to continue the study with a larger sample size to compare the results obtained from the present study. This study is important for the teaching and acknowledgment of undergraduate and postgraduate students in the department of anatomy, as well as for routine cardiothoracic surgery procedures that require knowledge of anatomical variations in the thickness of the ventricular wall of the human heart.

Keywords: Hypertrophy, left ventricle, Hypertrophied Cardiomyopathy

INTRODUCTION

The heart is a muscular motor that supplies blood to all parts of the body so that it provides oxygen and nutrients to all the body parts. As we all know, this heart muscle consists of four chambers: the right atrium, right ventricle, left atrium, and left ventricle. The right ventricle receives blood from the right atrium and pumps the deoxygenated blood to the lungs. The left ventricle directly pumps oxygenated blood to the rest of the body parts.¹ The heart's protrusion on the anterior chest wall during quiet respiration can be classified into one of three general types that continue into one another:

1. The oblique (most common);
2. The horizontal; and
3. The vertical.

These outlines may be related to the overall body build and mostly to the position of the diaphragm. The horizontal outline of the heart tends to occur in a high diaphragm and a shorter body trunk, whereas the vertical one is related to a low-level diaphragm and a slender body trunk.² The left ventricle is usually narrower and longer than the right ventricle, which extends from the base of the atrio-ventricular groove to the cardiac apex. Moreover, the left ventricle walls are three times thicker (8–12 mm) than those of the right ventricle, which is relatively thin, measuring 3–5 mm, and the ration of the thickness between the left and right ventricle is 3:1.1. There are four borders around the heart. The right border is completely formed by the right atrium. The inferior border is formed by the left and right ventricles. The left border is being formed by the left ventricle and a little contribution from the left atrium. Finally, the superior border is formed by the right and left atriums with the great vessels. Obese children aged 2 years or less have a greater left ventricular mass compared with normal weight controls.³ Hypertrophic cardiomyopathy is characterised by the thickening of myocardial walls, particularly a haphazard thickening of the interventricular septum in comparison to the posterior wall. Likewise, an athlete's heart might be physiologically hypertrophied in a uniform fashion.¹ So, the purpose of this study is to evaluate the thickening of the walls of the left and right ventricles of the adult human heart.

AIM AND OBJECTIVES

The objective of this study is to determine the thickness difference between the adult human heart's right and left ventricles, as well as their clinical importance in the eastern Indian population, and compare it to the incidence in other races throughout the world.

MATERIALS AND METHODS

This prospective and observational study was conducted on cadavers which are available in the Departments of Anatomy, Forensic Medicine & Toxicology of Nalanda medical college (Patna, Bihar, India), Patna Medical college (Patna, Bihar, India) after obtaining consents and permission for the study from heads of the department and after receiving approval from the institutional ethical committee. Dissections were performed in the thoracic region of 50 cadavers of both sexes (40 males and 10 females) ranging in age from 20-70 years old. The study's sample size is 50 human hearts. The research was carried out over a two-years period, from July 2019 to June 2021. The thyroid gland was exposed according to Cunningham's practical manual of anatomy guideline. The heart was cut open along the borders namely the right, inferior and left border of the heart. The superior border of the heart was kept to be intact so that the specimen can still be super-used for education purpose and other research works. A digital vernier calliper was used to measure the right and left ventricular walls. The measurements were done by marking at three levels in both right and left ventricle namely upper, middle and lower part.

CRITERIA FOR INCLUSION

The study will include normal adult human heart.

CRITERIA FOR EXCLUSION

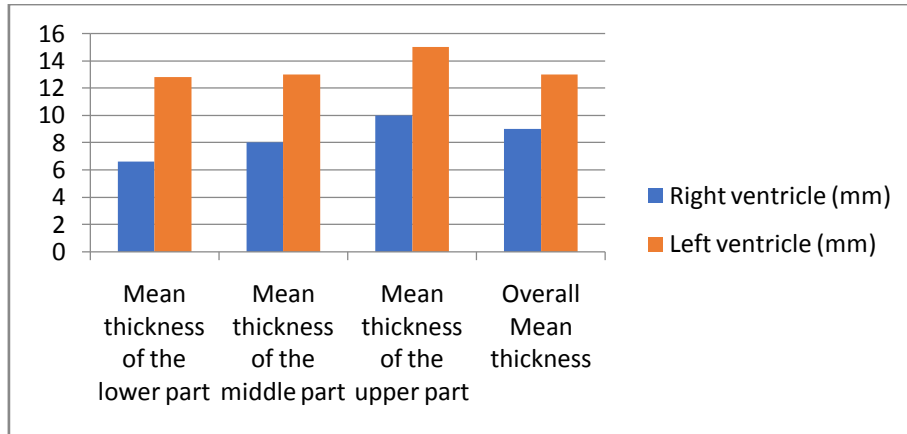
1. Partially deformed specimens will be excluded from the study.
2. The study will exclude any specimens with abnormalities or heart disorders.
3. The heart of children were not included in the study.

RESULTS

After measuring the thickness of the wall of the ventricles at three different levels, the mean thickness of each ventricle was calculated. The mean wall thickness of right ventricle was calculated to be 9 mm. The mean thickness of left ventricle was estimated to be 13 mm. The mean ratio was found to be 1:1.4 when comparing the thickness of right and left ventricle (Table 1). The mean ratio of the thickness of lower part of the right and left ventricle was found to be 1: 1.9 (Table 1). The middle part of the right ventricle had a mean thickness of 8 mm. The mean thickness of left ventricle was estimated to be 13 mm. The mean ratio of the thickness of right and left ventricle in the middle part is 1: 1.8 (Table 1). The mean thickness of the upper part of the upper part of the right ventricle is 10 mm. The mean thickness of the upper part of the left ventricle is 15 mm, the ratio is 1: 1.5 (Table 1). The wall of both right and left ventricle is the thickest in the upper part and thinnest in the lower part as mentioned in Table 1.

Table 1: A chart showing the mean thickness of the right and left ventricles

Parameters	Right ventricle (mm)	Left ventricle (mm)	Ratio
Overall Mean thickness	9.0	13.0	1:1.4
Mean thickness of the lower part	6.60	12.8	1.1.9
Mean thickness of the middle part	8.0	13.0	1:1.8
Mean thickness of the upper part	10.0	15.0	1:1.5



Graph 1: A Graph showing the mean thickness of the right and left ventricles in human hearts



Fig. 1: Section of human heart showing the measurement of ventricular wall.

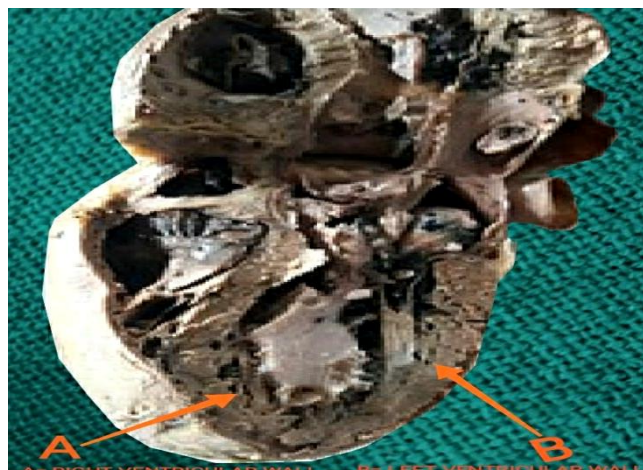


Fig. 2: The thickness of the ventricular wall is indicated by an arrow in a section of the human heart (A = right ventricular wall, B = left ventricular wall).

DISCUSSION

The mean difference in the size of the two ventricles in an adult is well known and the ratio of right to left ventricular is 1:3. This is the reason behind the difference in the resistance of

the two circulations, which are systemic and pulmonary. In foetal life, the difference in ventricular size remains unknown.⁴ Unfortunately, the present study showed varying results for this well-established ratio of the thickness of the right and left ventricular walls. In our present study, the mean ratio of the right and left ventricle thickness was found to be 1: 1.4. In fact, there are few studies on the thickness of the ventricles of a normal human adult heart. After the age of 1 year, cardiomyocytes have reached their final number as in adults, and changes in LVM reflect the growth of myocytes (hypertrophy) as a response to high pressure or volume load.⁵ Although feeding can influence infant growth, the relationship between coronary heart disease mortality and weight at one year is unaffected by the method of feeding in infancy.⁶ One link between under nutrition in late 30s gestation and a persisting increase in left ventricular mass could be mediated through cardiovascular adaptive changes that are happening in-utero.⁷ When cardiovascular risk factors are present from childhood, they usually persist into adulthood and predispose those children to an increased risk of cardiovascular events in adult life.⁸ The RV wall is about 2–5 mm in thickness and weighs 25–5g/m². It is mainly composed of deep and superficial muscle layers.⁹ In our study, the mean thickness of the right ventricular wall was found to be 9 mm. The muscular wall of the normal RV is usually 3 to 5 mm in thickness, but in certain situations, like pressure overload, the RV wall thickness may even exceed that of the LV.¹⁰ The right ventricular wall thickness in our study was likewise a little thicker than usual. This could be attributed to the adaptive changes of the heart musculature due to pressure overload. The wall of the left ventricle is 8–12 mm thick.¹ In our present study, the mean thickness of the left ventricle was measured to be 13 mm. Due to the oblique positioning of the heart, the RV apex is inferior to the LV apex, and at times when the RV is conspicuous, the heart can appear to have a bifid apex.¹¹ When the pericardium is removed, the major part of the heart that is visible from the front is the ventricular mass. Here, the morphologically right ventricle occupies the greater part. The left ventricle appears only as a narrow slit along the left cardiac border. The shape of the heart generally looks like a pyramid with a base and an apex. The apex points downward, forward, and to the left, whereas the base faces posteriorly and to the right.¹² The myocardium in patients with hypertrophied cardiomyopathy is heterogeneously thickened, and the fractional thickening and circumferential shortening of the abnormally thickened myocardium are reduced compared with healthy subjects.¹³ In our study, the thickness of the right ventricle and also of the left ventricle were not the same at different levels. We discovered that the ventricular walls are thickest in the upper part and gradually thin out after that the ventricular walls are the thinnest in the lower part. The differentiation between physiological left ventricular (LV) hypertrophy secondary to exercise and hypertrophic cardiomyopathy (HCM) is a complex and increasingly common clinical enigma.¹⁴ As observed in our study, the wall of both the right and left ventricle is the thickest in the upper part and the thinnest in the lower part.

CONCLUSION

The ratio of the thickness of the walls of the left and right ventricles is well known as 3:1. Quite the oppositely, in our study, we found the ratio to be 1:1.4. In this study, the thickness of the right ventricle was found to be greater than the normal thickness reported in previous research. We wish to continue the study with a larger sample size to compare the results obtained from the present study. This study is important for the teaching and acknowledgment of undergraduate and postgraduate students in the department of anatomy, as well as for routine cardiothoracic surgery procedures that require knowledge of anatomical variations in the thickness of the ventricular wall of the human heart.

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