

## Significance of Six Minute Walking Distance in Predicting Functional Capacity Status of Patients with Pulmonary Hypertension Complicating an Atrial Septal Defect

Anggia Endah Satuti<sup>1</sup>, Dyah Wulan Anggrahini<sup>1</sup>, Lucia Kris Dinarti<sup>2</sup>

<sup>1</sup>Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta / Sardjito General Hospital Yogyakarta

<sup>2</sup>Echocardiography Division, Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Gadjah Mada / Sardjito General Hospital Yogyakarta

### Abstract

**Background:** Six minute walk test (6 MWT) is a sub-maximal exercise test that measures an integrated response of all systems responsible during exercise. Pulmonary arterial hypertension (PAH) is a problem encountered by patients with atrial septal defect (ASD). Assessment of functional capacity in patients with PAH based on the WHO functional classification remains a powerful predictor of survival in these patients. The World Health Organization functional classification is a subjective tool because it is based on anamnesis of ordinary activity. On the contrary, 6 MWT is an objective tool to measure functional capacity of patients with pulmonary hypertension.

**Objective:** To determine the walking distance obtained using 6 MWT as a measurement of functional capacity in ASD patients with PAH.

**Methods:** A cross sectional study was used to determine the walking distance as a measurement of functional capacity in ASD patient with PAH. This study was a sub-study of an Atrial Septal Defect Registry done in RSUP Dr. Sardijto, Yogyakarta, since 2012. Pulmonary arterial pressure was measured using Pulmonary Arterial Systolic Pressure (PASP) obtained from echocardiography. Pulmonary hypertension was divided into three categories based on PASP, mild with PASP of less than 45 mmHg, moderate with PASP of 45-59 mmHg and severe with PASP of more than 60 mmHg. All patients did 6 MWT to measure their functional capacity. The relationship between 6 MWT distance and severity of PAH was measured using Pearson correlation analysis.

**Results:** Forty-three patients were included in this study with 32 female patients (74%) and 11 male patients (26%) with an age range of 17-70 years old. Forty-four patients (44%) with ASD had severe PAH. The mean of 6 MWT distance was 337 m. There were significant differences between mild, moderate and severe PAH in correlation with the 6 MWT distance ( $p=0.001$ ). The patients with severe PAH had only 278 m walking distance compared to those with mild PAH who had 394 m walking distance. There was a significant relationship between the 6 MWT distance and severity of PAH ( $p=0.01$ ). This study showed that 6 MWT correlates negatively with the severity of PAH. We found that the higher pulmonary arterial pressure, the shorter walking distance ( $p=0.01$ ,  $r=-0,506$ ).

**Conclusion:** ASD defect patients with severe PAH had shorter walking distance compared to those with mild PAH. The 6 MWT is a reliable and objective measurement of functional capacity for ASD patients with PAH.

### Background

Assessment of functional capacity is traditionally done using anamnesis. However, anamnesis sometimes causes overestimation or underestimations of patients' true functional capacity. Objective measurement is usually better than subjective measurement. There are many modalities to assess functional exercise capacity; one of which is a '6 Minute Walk Test' (6 MWT). The '6 Minute Walk Test' is a simple test using 100 feet hallway without exercise equipment or advanced training for technicians. This test evaluates the global and integrated responses of all the systems

involved during exercise, including pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units and muscle metabolism.<sup>1</sup>

Atrial septal defect (ASD) is an acyanotic congenital heart defect with minimal symptoms that can cause delay in diagnosis until adulthood. Hence, ASD is the most frequent congenital heart defect in adult.<sup>2</sup> Generally, patients come to see a doctor due to the development of pulmonary arterial hypertension (PAH). Assessment of functional capacity in ASD patients with PAH can help predict their survival. Pulmonary arterial

hypertension (PAH) functional classification using symptoms was determined by the World Health Organization (WHO) in 1998. Patients with WHO class IV have median survival of 6 months compared to 6 years for WHO class I and II.<sup>3</sup>

The use of 6 MWT in PAH is to determine prognosis and post therapy assessment and daily activity assessment is used to determine functional classification. Assessment of daily activity is subjective and variative measurement.

The objective of this study was to determine functional capacity of ASD patients with PAH using a 6 MWT. By using 6 MWT, we can measure functional capacity and determine functional classification and prognosis of ASD patients with PAH.

**Methods**

This was a cross-sectional study, sub-study using data obtained from Atrial Septal Defect Registry of RSUP Dr. Sardjito, Yogyakarta. The inclusion criteria were ASD patients with PAH and within the age of 17-70 years. The exclusion criteria were ASD patients with PAH of other cause and who were unable to follow 6 MWT. The assessment of PAH was done using echocardiography with Pulmonary Arterial Systolic Pressure (PASP). There were three groups of PAH using PASP, namely mild, moderate, and severe PAH, determined respectively when the PASP obtained was less than 45 mmHg, between 45 to 59 mmHg, and more than 60 mmHg.

The 6 MWT was done by the examiner in Rehabilitation Centre of RSUP Dr. Sardjito, Yogyakarta. The location of the test was a closed hallway with 20 meters tract. Each turn was given a mark to ease patients in determining the turn. The assessment of Borg Scale and walking distance was measured during 6 MWT.

**Results**

There were 43 patients in this study, consisting of 32 female patients (74%) and 11 male patients (26%). The mean age of ASD patients was 39.8 years (17-70 years). The mean size of the defect was 2.58 millimeters (mm). The mean of right ventricular (RV) enlargement was 45.19 mm (30-66 mm). The mean PASP was 72.9 mmHg (25-182 mmHg). Table 1 shows the baseline characteristics of the patients.

**Table 1.** Baseline characteristics of ASD patients with PAH

Category	Mean Value
Age (years)	39.8 (17-70)
Atrial septal defect diameter (mm)	2.58 (0.4-4.3)
Right ventricular diameter (mm)	45.19 (30-66)
Pulmonary arterial pressure (mmHg)	72.9 (25-182)
Six minute walk test walking distance (m)	337.19 (134-800)
O2 arterial saturation (%)	95.7 (79-99)

The proportion of ASD patients with PAH obtained in this study was that 19 patients (44%) had severe PAH with PASP less than 60 mmHg. Moderate PAH was experienced by 30% of the patients and 26% patients had mild PAH. Figure 1 shows the proportion of ASD with PAH in this study.

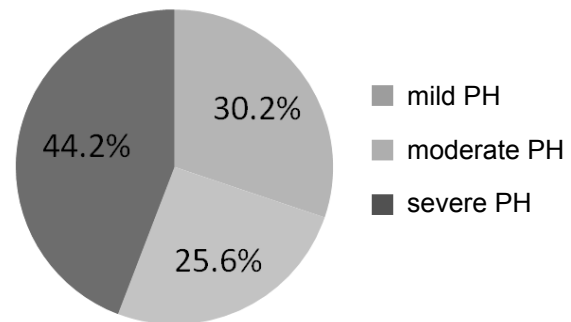


Figure 1. Proportion of PH in ASD patients

From 6 MWT, walking distance data was obtained from ASD patients with mild, moderate and severe PAH. The mean walking distance was 337 m with the shortest walking distance 134 m. In ASD patients with mild, moderate, and severe PAH, the mean walking distance was 394 m, 370 m and 278 m, respectively (p=0.001). Figure 2

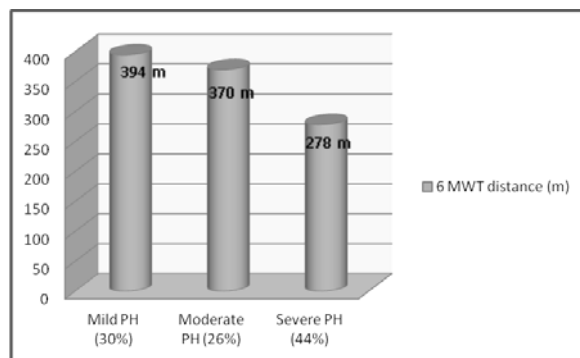


Figure 2. Mean 6 MWT distance between ASD patients with mild, moderate and severe PAH (p=0.001).

shows the mean walking distance in ASD patients with mild, moderate and severe PAH.

Pearson correlation test was done to determine the correlation between PASP and walking distance in 6 MWT. There was a significant correlation between PASP and 6 MWT ( $p=0.01$ ,  $r -0.506$ ). Figure 3 shows a negative correlation between PASP and the mean walking distance in 6 MWT.

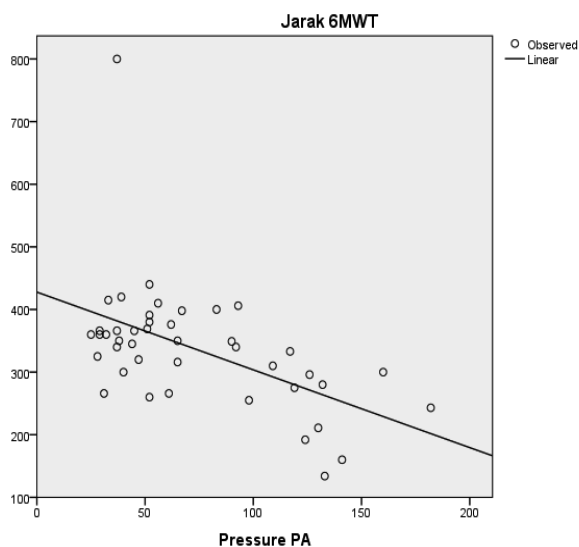


Figure 3. Relation between pulmonary arterial pressure and 6 MWT distance ( $p=0.01$ ,  $r -0.506$ )

## Discussion

Atrial septal defect diagnosed in adulthood usually has already accompanied with PAH. Pulmonary arterial hypertension is an important risk factor in ASD because its severity can complicate the decision to perform correction.<sup>5</sup> In adult patients with uncorrected ASD, PAH will develop in the second or third decades.<sup>6</sup> The mean age of ASD patients in this study was 39.8 years and in this age PAH would likely develop. The proportion of ASD patients with PAH in this study was 44% with the mean PASP of 72.9 mmHg. In severe PAH, symptoms of activity intolerance would also appear.

The '6 Minute Walk Test' is a submaximal test for patients that cannot tolerate well with exercise. Patients with PAH caused by ASD are a group of patients that need assessment of functional capacity for correction decision and evaluation of therapy. In general, the 6 MWT is a simple, affordable, and standardized tool for evaluating patient with PAH. The parameters that can be used are walking

distance, oxygen saturation and Borg scale to assess dyspnea on activity.<sup>3</sup> In this study, we found a negative and significant correlation between PASP and walking distance obtained using 6 MWT. This result showed that an increase in severity of PAH caused a decrease of walking distance in 6 MWT.

The patients with severe PAH in this study showed the mean walking distance of 278 m. This was significantly different between the patients with mild PAH that obtained the mean walking distance of 394 m. Prognosis of patients with PAH will decrease in walking distance less than 300 m. Guidelines on PAH classify this condition as unstable and have possibility to deteriorate.<sup>3</sup> Other conditions that correlate with worse prognosis are the worsening conditions of functional classification from WHO II to III or from III to IV. Objectively, PAH patients with walking distance less than 300 m are classified as PAH with WHO III-IV. This shows that 6 MWT can be used as an objective tool to determine functional classification other than self-report.

The disadvantage of using 6 MWT as exercise test is that patients' motivation influences the test result. Age, sex, and adequate standardization from exercise test protocol and motivation to the patient can determine the result 6 MWT.

## Conclusion

There was a negative correlation between severity of PAH and walking distance in patients with ASD. Six Minute Walk Test is a simple and affordable test and can objectively help determine functional capacity and functional classification of ASD patients with PAH.

## References

1. American Thoracic Society. 2002. ATS Statement: Guidelines for the Six-Minute Walk Test. *American Journal of Respiratory Critical Care Medicine*; 166: 111-117.
2. Nagaya, N., Nishikimi, T. 1998. Secretion patterns of brain natriuretic peptide and atrial natriuretic peptide in patients with or without pulmonary hypertension complicating atrial septal defect. *American Heart Journal*; 136(2): 297-301.
3. Galie, N., Hoepfer, M.M., Humbert, M. (2009) Guidelines for the diagnosis and treatment of pulmonary hypertension. *European Heart Journal*; 30: 2493-2537.

4. Pillai M.V., Killam J., Legasto A.C., Eden E., Tartell L. 2013. Prediction and Grading of Pulmonary Hypertension Severity with Computerized Tomography. *Am J Respir Critic Care Med*; 187: A4697.
5. Craig R.J., Selzer A. 1968. Natural History and Prognosis of Atrial Septal Defect. *Circulation*; XXXVII:805-815.
6. Park M.K. 2008. *Pediatric Cardiology for Practitioner*. 5 Ed. St. Louis: Elsevier Mosby.