Original Article/นิพนธ์ต้นฉบับ

Correlation Between Aortic Oxygen Saturation and Pulmonary Artery Size in Cyanotic Congenital Heart Disease With Decreased Pulmonary Blood Flow

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Abstract

Background: One of the indications for surgical planning in cyanotic congenital heart disease patients is the appropriate pulmonary artery size. Patient must be evaluated by an expert and in need of high-technology instruments. This is a limitation in situation with long waiting list of cardiac surgery.

Objective: To find the correlations between McGoon ratio/Nakata index and aortic oxygen saturation in patients with cyanotic congenital heart disease with decreased pulmonary blood flow, and to identify the appropriate oxygen saturation for planning the surgical repair.

Methods: The author reviewed angiograms of the patients who had cardiac catheterization at Thammasat Hospital from 2008 to 2017. The McGoon ratio and Nakata index were calculated and correlated to the aortic oxygen saturation by using the Pearson product moment correlation (r). The oxygen saturations that correspond to the surgical criteria values of McGoon ratio/Nakata index were estimated by using linear regression analysis.

Results: A total of 100 cardiac catheterizations were performed in 82 patients. The correlation between McGoon ratio/Nakata index and aortic oxygen saturation were moderately correlated (r = 0.61 and r = 0.46 respectively). The patients were divided into 3 groups. Prediction of the oxygen saturations that corresponded to the surgical values of McGoon ratio and Nakata index were 73.47% (95% confidence interval [CI], 70.34 -76.62) and 75.87% (95% CI, 72.41 - 79.33) in Biventricular repair group, 76.23% (95% CI, 73.76 - 78.70) and 76.73% (95% CI, 74.24 - 79.23) in Univentricular repair without Glenn operation group, 82.29% (95% CI, 79.87 - 84.70) and 85.03% (95% CI, 81.57 - 88.49) in Univentricular repair with previous Glenn operation group, respectively.

Conclusions: In this study, the lowest value of 95% CI of the predicted oxygen saturation in each group is selected to determine the patient who is not benefit to further investigation for total correction or Glenn/Fontan operation. For the Biventricular repair group, total correction should not be considered if oxygen saturation is less than 70%. In the Univentricular repair without Glenn operation group and the Univentricular repair previous Glenn operation group, the Glenn/Fontan operation should not be considered if oxygen saturation is less than 74% and 80%, respectively.

Keywords: Cyanotic congenital heart disease, Pulmonary artery branches, Oxygen saturation, McGoon ratio, Nakata index

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Introduction

There are various operation methods to treat cyanotic congenital heart disease with decreased pulmonary blood flow. Palliative surgery, such as modified Blalock-Taussig (MBT) shunt, is performed to increase pulmonary blood flow in small infants. Corrective surgery, such as total correction for tetralogy of Fallot, is performed in the biventricular repair group. Glenn and Fontan operations are the surgical techniques of choice in the univentricular repair group such as complex congenital heart disease (single ventricle physiology), tricuspid atresia, etc. The operation method chosen depends upon the size of the pulmonary artery branches. The MBT shunt is suitable for patients with small pulmonary artery branches. This surgical method decreases severity of cyanosis and promotes growth of the pulmonary artery. Likewise, appropriate size of the pulmonary artery branches is one of the indications for suitability for total correction, Glenn operation or Fontan operation. Currently, the evaluation of the pulmonary artery size still needs special tests with high technological methods such as echocardiogram, cardiac catheterization, computerized tomography (CT) scan, etc.

The McGoon ratio[1-4] is a method to evaluate the size of pulmonary artery branches by measuring the summation of right and left pulmonary artery diameter at the point before its branching, divided by the diameter of the descending aorta at the level of the diaphragm. Normal range of the ratio is 2 - 2.5. The patients in the biventricular repair group who have a ratio less than 1.2, are not suitable for total correction and MBT shunt procedure is suggested, while for those with a ratio equal to or higher than 1.2, further investigations for total correction are suggested. For the patients in the univentricular repair group, the appropriate ratio for Glenn operation and Fontan operation is equal to or higher than 1.8.

The Nakata index, presented by Nakata et al[5] in 1984, is measured by a summation of cross-sectional area of right and left pulmonary arteries, divided by body surface area (BSA). Normal range is 330 ± 30 mm^2/m^2. Patients in the biventricular repair group, the index should be higher than 100 mm^2/m^2 for total correction in patients with tetralogy of Fallot and higher than 150 mm^2/m^2 for Rastelli's operation in patients with pulmonary atresia with ventricular septal defect. For patients in the univentricular repair group, the index should be higher than 250 mm^2/m^2 for Glenn operation or Fontan operation.

The size of the pulmonary artery branches probably varies with the amount of pulmonary blood flow. Since amount of pulmonary blood flow determines the level of oxygen saturation, the size of the pulmonary artery will probably correlate with oxygen saturation as well. Cutaneous oxygen saturation can be easily measured by pulse oximetry, and it may be a simple method to estimate the size of the pulmonary artery branches. The objective of this study was to find the correlation between the McGoon ratio, Nakata index and aortic oxygenation and to define an appropriate oxygen saturation value for planning the surgical operations in patients with cyanotic heart disease.

Methods

Study Design

This retrospective study reviewed the 10 years cardiac catheterization data of patients with cyanotic congenital heart disease with decreased pulmonary blood flow (from 2008 - 2017). The angiograms were reviewed and the diameter of the right and left pulmonary arteries were measured to calculate the McGoon ratio and Nakata index. The procedures were performed with patients under general anesthesia and room air ventilation. The aortic oxygen saturation data was recorded. Patient hemodynamics had to be stable during the catheterization procedure in order for the subject to be included in this study.

Patients

A total of 82 patients were included in the study according to the following inclusion criteria: age between

2-month and 15-year, and the angiographic image showed confluent of pulmonary artery branches. Patients were excluded if they had main aortopulmonary collateral arteries (MAPCAs), non-confluence of the pulmonary artery branches, absent pulmonary valve syndrome and acute/chronic pulmonary disease. This study also excluded patients who developed hypoxic spell or hypotension during procedure.

Data Collection

Demographic and clinical data were recorded: age, sex, diagnosis, body weight, height, body surface area (BSA), and oxygen saturation in the ascending aorta during cardiac catheterization. Diameters of right and left pulmonary artery were measured prior to the first branching of the pulmonary artery branch (Figure 1A). In patients with previous MBT shunt or Glenn operation, the location of measurement was just lateral to the anastomosis site. Patients who had pulmonary artery branch stenosis (except for stenosis at confluent point of pulmonary artery branches which was usually narrowed from the pulmonary trunk hypoplasia), the point of maximum stenosis point was measured instead (Figure 1B). The descending aorta (DAO) diameter on an angiographic image was measured at the level of the diaphragm (Figure 1C).

Ethics

This study was approved by Human Research Ethics Committee of Thammasat University No.1 (Faculty of Medicine) on January 29, 2018. The certificate of approval number is 023/2561.

Data Calculation and Analysis

Data were calculated with the McGoon ratio[3] and the Nakata index[5] to reflect as pulmonary artery size. The McGoon ratio was calculated by the summation of right and left pulmonary artery diameter, divided by the diameter of DAO whereas the Nakata index was calculated by the summation of cross-sectional area of right and left pulmonary artery, divided by BSA.

Analyses of numerical data were represented by mean ± standard deviation (SD) and categorical data are represented by their respective rates or proportions. Correlation between McGoon ratio, Nakata index, and aortic oxygen saturation was evaluated by the Pearson product moment correlation (r), and the linear regression analysis was used for prediction of the aortic oxygen saturations which were associated with the proper McGoon ratio and Nakata index for each type of surgical repair.[6]

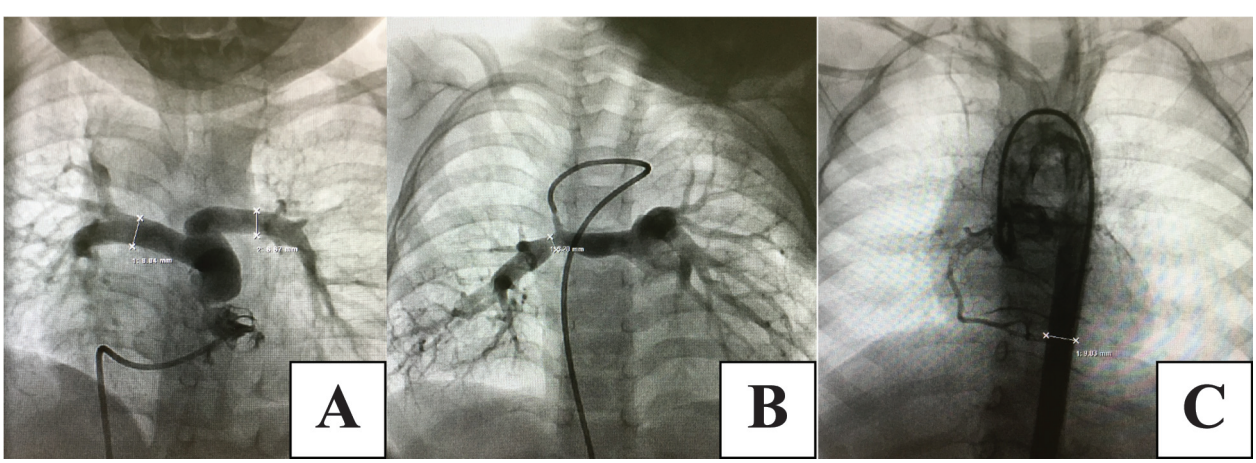

Figure 1 *Diameter Measuring Technique of Pulmonary Artery Branches and the Descending Aorta*

A, Diameter of the right and left pulmonary artery branches prior to the first branching. B, Diameter of the stenosis of pulmonary artery branch. C, Measuring the DAO diameter at the level of diaphragm.

Results

A total of 82 patients who had cyanotic congenital heart disease with decreased pulmonary blood flow underwent cardiac catheterization during the 10 years period. The total number of cardiac catheterizations was 115 procedures with 10 patients undergoing procedures twice and 14 patients undergoing 3 procedures. All patients who underwent more than 1 procedure had a different clinical status from their previous one, such as following a new palliative surgery or Glenn operation. The interval duration of re-cardiac catheterization was at least 11 months (average 22 months). Fifteen procedures were excluded from the study (Table 1).

Therefore, 100 catheterization procedures were included in the primary analysis. These 100 data sets were divided into two major groups (Table 2). The first group (54 procedures) were in the Biventricular repair group and the second group (46 procedures) were in the Univentricular repair group. The second group was divided into 2 subgroups, 28 procedures were in the Univentricular repair without Glenn operation group; and 18 procedures were in the Univentricular repair with previous Glenn operation group (Figure 2). The reason for this subgroup division was the different hemodynamic pattern of the patients without or with Glenn operation. The data of McGoon ratio, Nakata index, and aortic oxygen saturation in each group are presented in Table 3.

The Pearson correlations between McGoon ratio and Nakata index, McGoon ratio and aortic oxygen saturation, and Nakata index and aortic oxygen saturation in all procedures are shown in Table 4 and Figure 3.

The correlations between McGoon ratio and aortic oxygen saturation, Nakata index and aortic oxygen saturation in each group were studied and the equations were calculated from linear regression analysis to predict the aortic oxygen saturation from the values of the appropriate McGoon ratio and Nakata index for each type of operation. For McGoon ratio, the recommended value for total correction in the Biventricular repair group was equal to or higher than 1.2 and equal to or higher than 1.8 for Glenn operation and Fontan operation in the Univentricular repair group. The reference value of the Nakata index for total correction in the Biventricular repair group was higher than 100 mm^2/m^2 and higher than 250 mm^2/m^2 for Glenn operation and Fontan operation in the Univentricular repair group (Table 5).

Discussion

According to the cardiac catheterization procedure with room air, the data of aortic oxygen saturation might have suffered interference with a little bit oxygen in the anesthetic circuit machine in which the fraction of inspired oxygen (FiO_2) of air flow was nearly 0.21. The correlation between McGoon ratio and Nakata index was statistically significant with high positive correlation ($r = 0.85$, $P < 0.01$). This correlation is similar to the study from Klandima et al[7] in 2006 which compared these parameters in patients with tetralogy of Fallot by measuring the angiographic imaging. In this study, both McGoon ratio and Nakata index had statistically significant correlation to aortic oxygen saturation. The correlation between McGoon ratio and aortic oxygen saturation was statistically significant with moderate positive correlation ($r = 0.61$, $P < 0.01$), while the correlation between Nakata index and aortic oxygen saturation was statistically significant with low positive correlation ($r = 0.46$, $P < 0.01$).

Table 1 Details of Exclusions

Details of Excluded Patients	No.
Unclear/poorly visualized angiographic image	9
Loss of angiogram	2
Not enough cardiac catheterization data (no information of aortic oxygen saturation)	1
Presence of main aortopulmonary collateral arteries (MAPCAs)	3

Table 2 Demographic and Clinical Characteristics of Patients Included in This Study

Characteristic	Data
Age, mean ± SD, mo	37 ± 19.8
Gender, No. (%)	
Male	54 (54)
Female	46 (46)
Weight, mean ± SD, kg	12.6 ± 3.7
Height, mean ± SD, cm	90.8 ± 12.1
Diagnosis, procedure	
Biventricular repair group (54 procedures)	
TOF	24
TOF, MBT shunt	11
DORV, PS	5
DORV, PS or PA, MBT shunt	3
PA, VSD, PDA	2
PA, VSD, MBT shunt	8
AVSD, PS	1
Univentricular repair group (46 procedures)	
Complex CHD, PA or PS, MBT shunt	16
Complex CHD, PS	5
PA Intact IVS , MBT shunt	3
TA, PS	2
TA, PA, MBT shunt	1
Severe PS (RV hypoplasia), MBT shunt	1
Complex CHD, PS or PA, Glenn operation	12
PA Intact IVS, Glenn operation	2
TA, PA or PS, Glenn operation	2
Severe PS (RV hypoplasia), Glenn operation	1
Ebstein's anomaly, severe PS, Glenn operation	1

Abbreviation: AVSD, atrioventricular septal defect; CHD, congenital heart disease; DORV, double outlet right ventricle; PA intact IVS, pulmonary atresia intact interventricular septum; PDA, patent ductus arteriosus; PS, pulmonary stenosis; RV, right ventricular; SD, standard deviation; TA, tricuspid atresia; TOF, tetralogy of Fallot; VSD, ventricular septal defect.

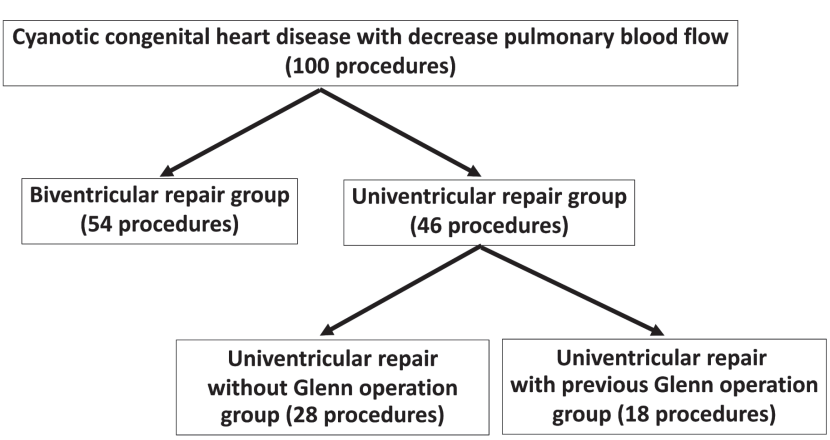

Figure 2 *Divisions of the Patients With Cyanotic Congenital Heart Disease With Decreased Pulmonary Blood Flow*

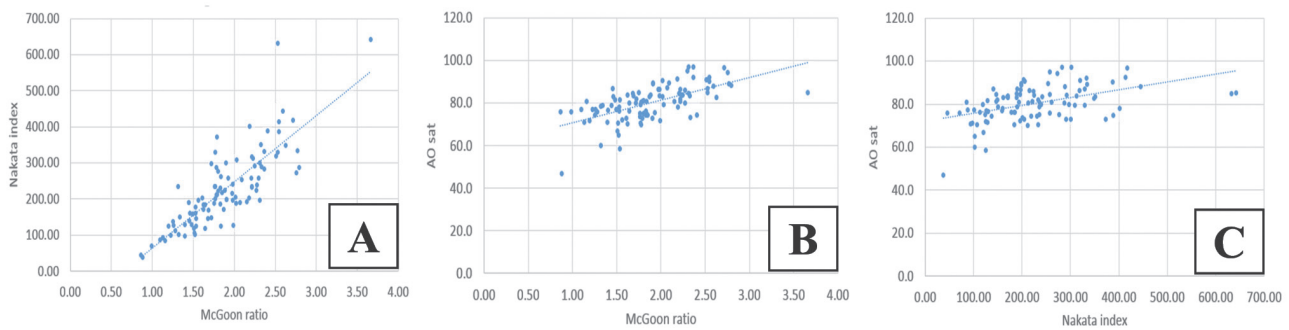

Figure 3 *The Graphic Correlation of McGoon Ratio, Nakata Index, and Aortic Oxygen Saturation (Total 100 Procedures)*
A, The graphic correlations between McGoon ratio and Nakata index. B, McGoon ratio and aortic oxygen saturation. C, Nakata index and aortic oxygen saturation.

Table 3 McGoon Ratio, Nakata Index, and Aortic Oxygen Saturation Data in Each Group

Group of Patients	Mean (Range)		
	McGoon Ratio	Nakata Index, mm^2/m^2	Aortic Oxygen Saturation, %
All patients with congenital cyanotic heart with decreased pulmonary blood flow (100 procedures)	1.88 (0.86 - 3.66)	224.89 (37.58 - 642.19)	80.2 (47 - 97.1)
Biventricular repair group (54 procedures)	1.94 (0.86 - 3.66)	238.94 (37.58 - 642.19)	81.7 (47 - 97.1)
Univentricular repair without Glenn operation group (28 procedures)	1.75 (1.16 - 2.79)	219.21 (85.61 - 632.21)	75.8 (58.4 - 88.3)
Univentricular repair with previous Glenn operation group (18 procedures)	1.87 (1.28 - 2.63)	191.56 (112.42 - 349.31)	82.7 (66.8 - 89.4)

Table 4 The Pearson Correlations Between McGoon Ratio and Nakata Index, McGoon Ratio and Aortic Oxygen Saturation, Nakata Index and Aortic Oxygen Saturation in 100 Procedures

Correlation	*r*	95% CI	*P* Value
McGoon ratio and Nakata index	0.82	0.75 - 0.88	< 0.01
McGoon ratio and aortic oxygen saturation	0.61	0.48 - 0.72	< 0.01
Nakata index and aortic oxygen saturation	0.46	0.29 - 0.60	< 0.01

Abbreviation: CI, confidence interval.

Table 5 Prediction of Aortic Oxygen Saturation by the Reference Values of McGoon Ratio and Nakata Index in Biventricular Repair Group, Univentricular Repair Without Glenn Operation Group and Univentricular Repair With Previous Glenn Operation Group

Correlation	Type	Reference Value	Aortic Oxygen Saturation, %	95% CI	*P* Value
Biventricular repair group	McGoon ratio	1.2	73.47	70.34 - 76.62	< 0.01
	Nakata index	100	75.87	72.41 - 79.33	< 0.01
Univentricular repair without Glenn operation group	McGoon ratio	1.8	76.23	73.76 - 78.70	< 0.01
	Nakata index	250	76.73	74.24 - 79.23	< 0.01
Univentricular repair with previous Glenn operation group	McGoon ratio	1.8	82.29	79.87 - 84.70	< 0.01
	Nakata index	250	85.03	81.57 - 88.49	< 0.01

As shown in Table 5, the lowest values of 95% CI in each group is the most appropriate aortic oxygen saturation to predict further management. The predicted aortic oxygen saturations from the reference McGoon ratio are lower than those from the reference Nakata index in each group. Therefore, the author suggests the lowest value of 95% CI of aortic oxygen saturation which is referenced from McGoon ratio is more reliable to predict the patients who won't be amenable for total correction, Glenn operation and Fontan operation.

The predicted lowest aortic oxygen saturation suitable for total correction in Biventricular repair group was 70.34%. This predicted value is lower than the other two groups because the reference value of McGoon ratio is lower than the others. The predicted aortic oxygen saturation in the Univentricular repair without Glenn operation group is 73.76% while the predicted aortic oxygen saturation in the Univentricular repair with previous Glenn operation group is 79.87%. One of the reasons for different oxygen saturation in each subgroup is the different hemodynamic pattern. In the Univentricular repair without Glenn operation group, the pulmonary blood flow depended on the partially oxygenated blood across the restricted part either via pulmonary stenosis or MBT shunt and then some of this oxygenated blood is recirculated to the lung again. On the other hand, in the Univentricular repair with previous Glenn operation group, the pulmonary blood flow comes from the deoxygenated SVC flow to the pulmonary artery branches (non-restrictive communication) resulting in higher efficiency of oxygen exchange in the lung, thus higher aortic oxygen saturation at the same level of pulmonary blood flow.

Conclusions

The result of the study shows statistically significant correlation between McGoon ratio, Nakata index and aortic oxygen saturation in cyanotic congenital heart disease with decreased pulmonary blood flow. In general, the correlation between the cutaneous oxygen saturation by pulse oximetry is not well correlated with the aortic oxygen saturation if aortic oxygen saturation is less than 75% - 80% but the value tends to overestimate the aortic oxygen saturation.[8-11] It is therefore simple to use cutaneous oxygen saturation to evaluate the patients for surgical planning. The patients in Biventricular repair group who have oxygen saturation equal to or higher than 70%, should be further investigated for total correction. By contrast, if they have oxygen saturation less than 70%, they should undergo MBT shunt to increase oxygen saturation and promote pulmonary artery size. The patients in Univentricular repair without Glenn operation group who have oxygen saturation less than 74%, are not good candidates for Glenn operation and Fontan operation. Likewise, the patients in Univentricular repair with previous Glenn operation group who have oxygen saturation less than 80%, are not good candidates for further investigation for Fontan operation.

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References

1. Piehler JM, Danielson GK, McGoon DC, Wallace RB, Fulton RE, Mair DD. Management of pulmonary atresia with ventricular septal defect and hypoplastic pulmonary arteries by right ventricular outflow construction. *J Thorac Cardiovasc Surg*. 1980;80(4):552-567.
2. Griod DA, Rice MJ, Mair DD, Julsrud PR, Puga FJ, Danielson GK. Relationship of pulmonary artery size to mortality in patients undergoing the Fontan operation. *Circulation*. 1985;72(3 Pt 2):II93- II96.
3. Zuberbuhler JR. Tetralogy of Fallot. In: Emmanouilides GC, Riemenschneider TA, Allen HD, Gutgesell HP, eds. *Moss and Adams - heart disease in infants, children, and adolescents including the fetus and young adult*. 5th ed. Baltimore: Williams & Wilkins; 1995:998-1017.
4. Fontan F, Fernandez G, Costa F, et al. The size of the pulmonary arteries and the results of the Fontan operation. *J Thorac Cardiovasc Surg*. 1989;98(5 Pt 1):711-779.
5. Nakata S, Imai Y, Takanashi Y, et al. A new method for the quantitative standardization of cross-sectional areas of the pulmonary arteries in congenital heart diseases with decreased pulmonary blood flow. *J Thorac Cardiovasc Surg*. 1984;88(4):610-619.
6. Hinkle DE, Wiersma W, Jurs SG. *Applied Statistics for the Behavioral Sciences*. 5th ed. Boston: Houghton Mifflin; 2003.
7. Klandima S, Kirawittaya T, Pethdumrongsakul A, et al. Preoperative angiographic evaluation of the pulmonary arterial size in tetralogy of Fallot: comparison the McGoon ratio and Nakata index. *Thai Pediatr J*. 2006;13:178.
8. Lebecque P, Shango P, Stijns M, Vliers A, Coates AL. Pulse oximetry versus measured arterial oxygen saturation: a comparison of the Nellcor N100 and the Biox III. *Pediatr pulmonol*. 1991;10(2):132-135.
9. Schmitt HJ, Schuetz WH, Proeschel PA, Jaklin C. Accuracy of pulse oximetry in children with cyanotic congenital heart disease. *J Cardiothorac Vasc Anesth*. 1993;7(1):61-65. doi:10.1016/1053-0770(93)90120-A.
10. Griksaitis MJ, Scrimgeour GE, Pappachan JV, Baldock AJ. Accuracy of the Masimo SET® LNCS neo peripheral pulse oximeter in cyanotic congenital heart disease. *Cardiol Young*. 2016;26(6):1183-1186. doi:10.1017/S1047951115002188.
11. Ramachandran S, Gera A, Gera R, Kataria S, Pratim Roy M. Accuracy of pulse oximetry versus arterial blood gas in screening cyanotic heart. *Int J Contemp Pediatr*. 2016;3(3):983-987.

Original Article/นิพนธ์ต้นฉบับ

ความสัมพันธ์ระหว่างความอิ่มตัวของออกซิเจนในเลือดและขนาดแขนงเส้นเลือดปอดในโรคหัวใจพิการแต่กำเนิดชนิดเขียวที่มีเลือดไปปอดลดลง

บุญชู ศิริจงกลทอง

ภาควิชากุมารเวชศาสตร์ คณะแพทยศาสตร์ มหาวิทยาลัยธรรมศาสตร์

บทคัดย่อ

บทนำ: หนึ่งในข้อกำหนดของการผ่าตัดผู้ป่วยโรคหัวใจพิการแต่กำเนิดชนิดเขียวคือ การมีขนาดเส้นเลือดปอดที่เหมาะสม ผู้ป่วยจำเป็นต้องได้รับการประเมินโดยผู้เชี่ยวชาญและตรวจด้วยเครื่องมือพิเศษ ซึ่งเป็นข้อจำกัดในสถานการณ์ที่มีผู้ป่วยโรคหัวใจรอคิวผ่าตัดจำนวนมาก

วัตถุประสงค์: เพื่อศึกษาหาความสัมพันธ์ระหว่างค่าความอิ่มตัวของออกซิเจนกับค่า McGoon ratio และค่า Nakata index ในผู้ป่วยโรคหัวใจแต่กำเนิดชนิดเขียวที่มีเลือดไปปอดลดลง และหาค่าความอิ่มตัวของออกซิเจนที่เหมาะสมเพื่อช่วยในการวางแผนผ่าตัดหัวใจ

วิธีการศึกษา: การศึกษาย้อนหลังในผู้ป่วยที่เข้ารับการสวนหัวใจ ณ โรงพยาบาลธรรมศาสตร์ ในช่วงปี พ.ศ. 2551 - 2560 โดยศึกษาภาพเอกซเรย์หลอดเลือด (Angiogram) คำนวณค่า McGoon ratio และค่า Nakata index จากนั้นวิเคราะห์ความสัมพันธ์กับค่าความอิ่มตัวของออกซิเจนในเลือดโดยใช้สถิติ Pearson product moment correlation (r) และคำนวณค่าความอิ่มตัวของออกซิเจนที่สัมพันธ์กับค่าเกณฑ์ในการผ่าตัดของค่า McGoon ratio และค่า Nakata index โดยใช้สถิติ Linear regression analysis

ผลการศึกษา: การสวนหัวใจทั้งหมด 100 หัตถการจากผู้ป่วยจำนวน 82 คน พบว่า ค่า McGoon ratio และค่า Nakata index มีความสัมพันธ์กับค่าความอิ่มตัวของออกซิเจนอย่างมีนัยสำคัญ ($r = 0.61$ และ $r = 0.46$ ตามลำดับ) ผู้ป่วยถูกแบ่งเป็น 3 กลุ่ม มีค่าความอิ่มตัวของออกซิเจนที่สอดคล้องกับค่าเกณฑ์ผ่าตัดของค่า McGoon ratio และค่า Nakata index ในแต่ละกลุ่ม ดังนี้ กลุ่ม Biventricular repair (54 หัตถการ) เท่ากับร้อยละ 73.47 (95% CI, 70.34 - 76.62) และร้อยละ 75.87 (95% CI, 72.41 - 79.33) กลุ่ม Univentricular repair ที่ยังไม่ได้รับผ่าตัด Glenn operation เท่ากับร้อยละ 76.23 (95% CI, 73.76 - 78.70) และร้อยละ 76.73 (95% CI, 74.24 - 79.23) และกลุ่ม Univentricular repair ที่ได้รับการผ่าตัด Glenn operation เท่ากับร้อยละ 82.29 (95% CI, 79.87 - 84.70) และร้อยละ 85.03 (95% CI, 81.57 - 88.49) ตามลำดับ

สรุป: การศึกษานี้เลือกค่าความอิ่มตัวออกซิเจนที่น้อยสุดของ 95% CI ในแต่ละกลุ่ม เป็นค่าในการคัดเลือกผู้ป่วยที่ยังไม่พร้อมจะส่งตรวจเพิ่มเติม สำหรับการวางแผนผ่าตัด Total correction หรือ Glenn/Fontan operation ผู้ป่วยกลุ่ม Biventricular repair ที่มีค่าความอิ่มตัวของออกซิเจนน้อยกว่าร้อยละ 70 ยังไม่เหมาะที่จะวางแผนเพื่อการผ่าตัด Total correction ส่วนผู้ป่วยกลุ่ม Univentricular repair ที่ยังไม่ได้รับการผ่าตัด Glenn operation และที่เคยได้รับการผ่าตัด Glenn operation ที่มีค่าความอิ่มตัวของออกซิเจนน้อยกว่าร้อยละ 74 และร้อยละ 80 ตามลำดับ ไม่เหมาะที่จะวางแผนผ่าตัด Glenn/Fontan operation ต่อไปเช่นกัน

คำสำคัญ: โรคหัวใจพิการแต่กำเนิดชนิดเขียว แขนงเส้นเลือดปอด ความอิ่มตัวของออกซิเจน ค่า McGoon ratio ค่า Nakata index

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