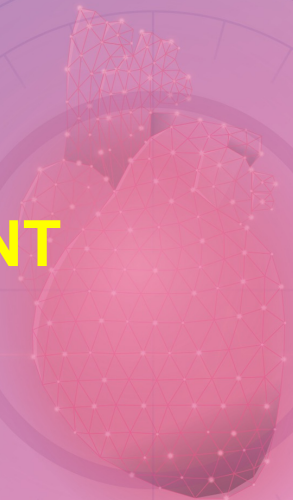




ROLE OF THE FONTAN OPERATION FOR TREATMENT OF SINGLE VENTRICLE HEART DISEASE AT CHO RAY HOSPITAL

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PEDIATRIC CARDIAC SURGERY DEPARTMENT





INTRODUCTION

- Functional single ventricle disease is rare, accounts for 4-8/1000 newborn and 7.7/100 of congenital heart disease.
- Poor prognosis without surgical treatment (75% die within the first 3 years of life.)
- Fontan surgical – the purpose of passively diverting all blood from the systemic vein to the lung helps repairing this pathophysiology for normal achievement.



INTRODUCTION

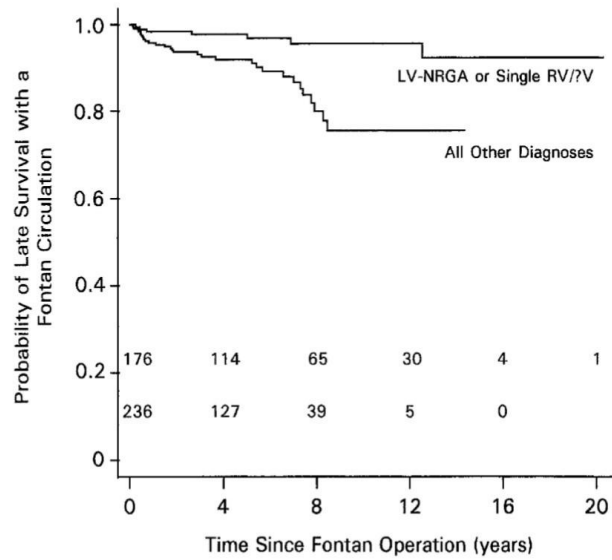


Fig. 5. Kaplan-Meier estimates of the probability of late survival with a Fontan circulation as a function of diagnosis. Time zero is 30 days after the Fontan operation. *LV-NRGA*, Left ventricle with normally related great vessels; *Single RV/?V*, single right ventricle or ventricle with unknown morphology.

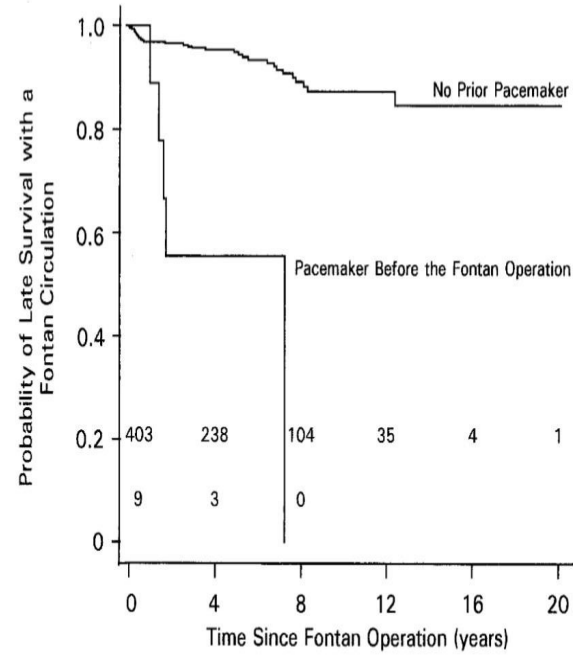


Fig. 6. Kaplan-Meier estimates of the probability of late survival with a Fontan circulation in patients with and without a pacemaker before the Fontan operation. Time zero is 30 days after the Fontan operation.



INTRODUCTION

- Techniques of Fontan operation have many improvements over time, helping increasingly optimize treatment results.
- The Fontan operation by tube graft with fenestration which made in many countries initially has good results at Cho Ray hospital.





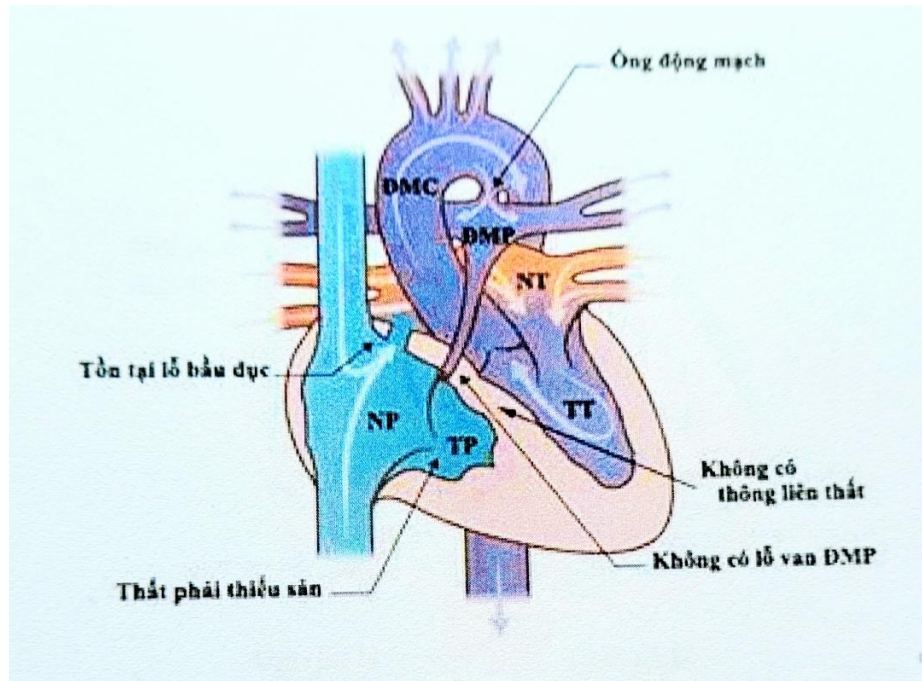
PATHOPHYSIOLOGY OF FUNCTIONAL SINGLE VENTRICLE

Anatomy(1)

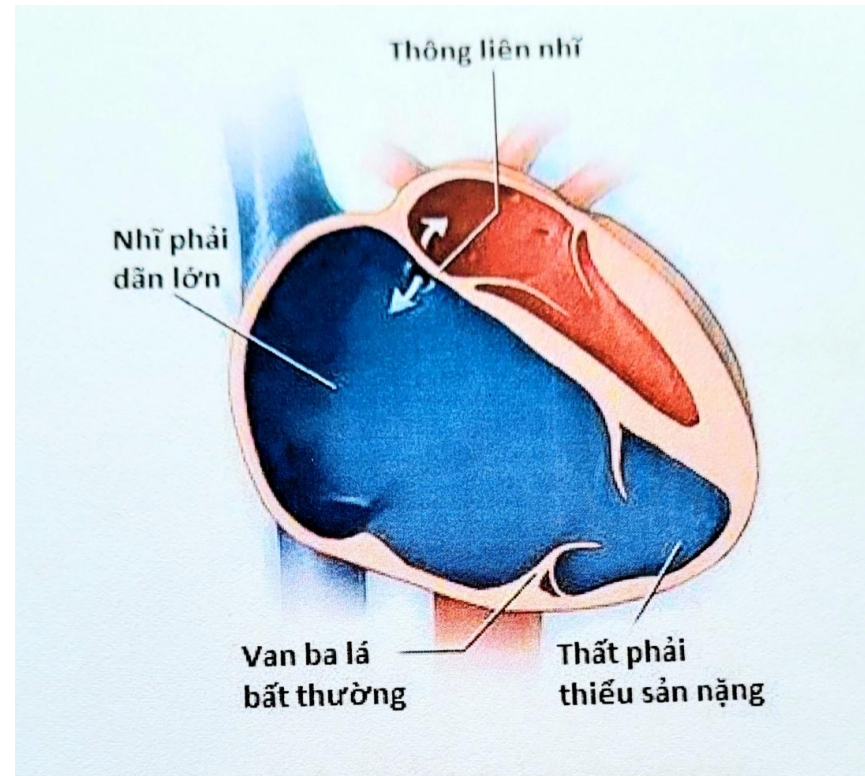
- Jacobs and Anderson : Anatomical characteristic with one or two ventricles chamber but only one ventricle has normal function.
- The remaining ventricle which is non- existent or hypoplastic can not responsible for pulmonary or systemic function.



SINGLE VENTRICLE DISEASES

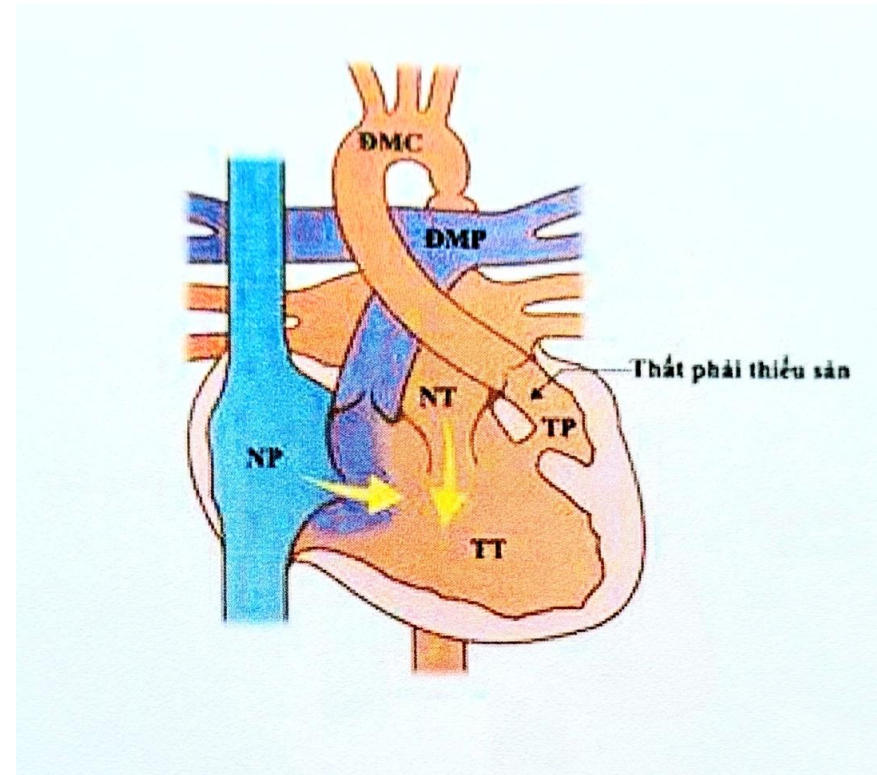
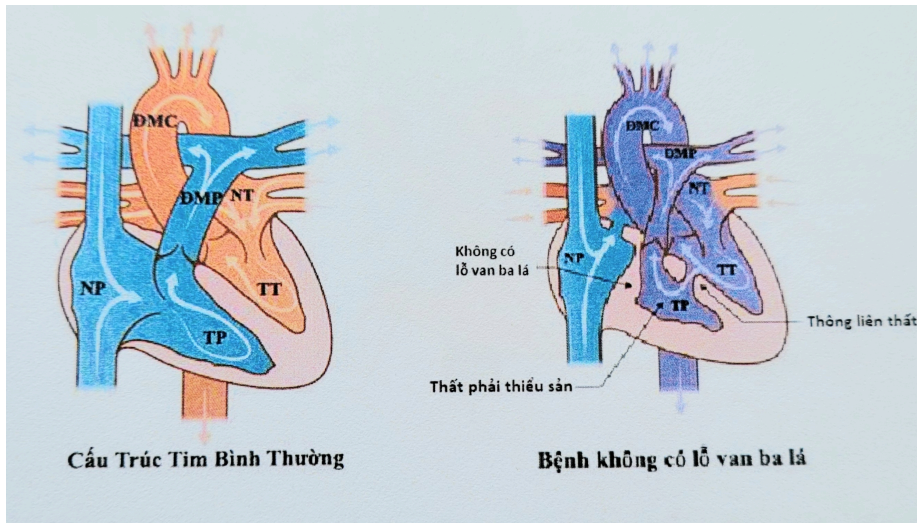


Tricuspid valve atresia, pulmonary valve atresia, intact ventricle septum and hypoplasia in right ventricle



Ebstein (type D);

SINGLE VENTRICLE DISEASE

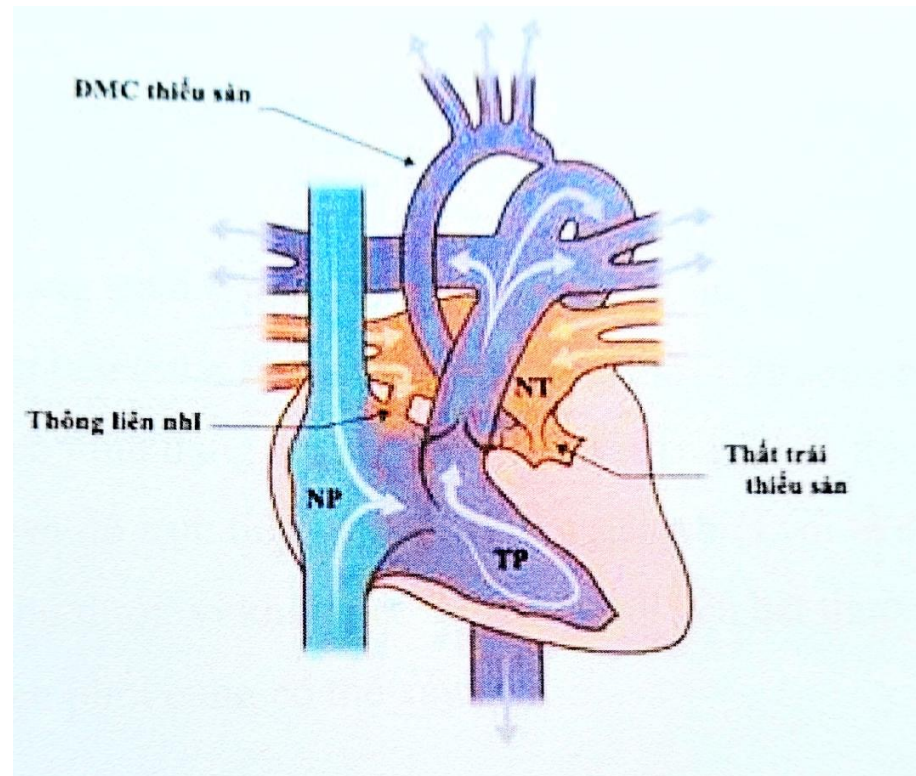


Common double right or left ventricle inlet; mitral valve atresia in HHLS

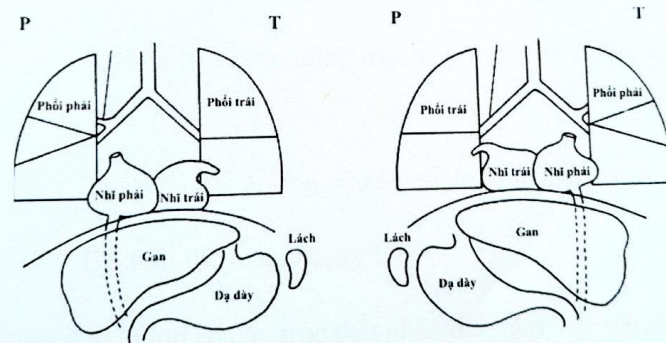
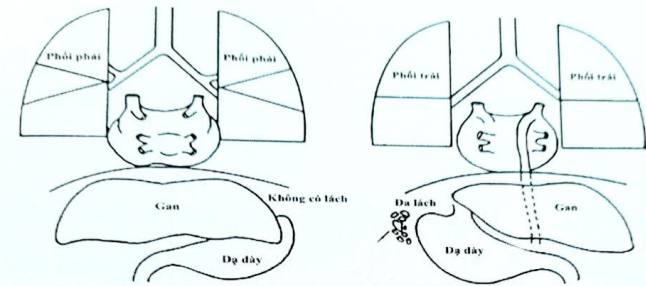
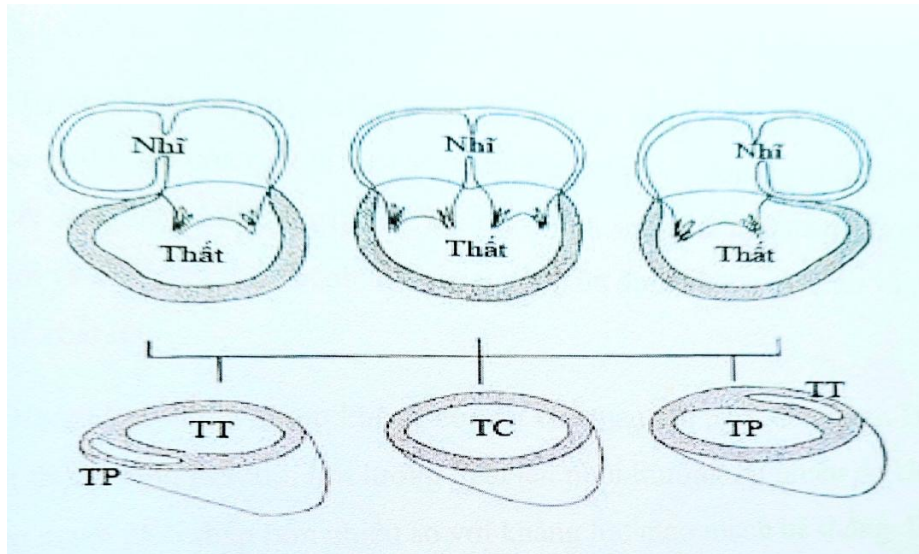
Hypoplasia of RV

SINGLE VENTRICLE DISEASES

Mitral valve atresia in HHLS



SINGLE VENTRICLE DISEASES





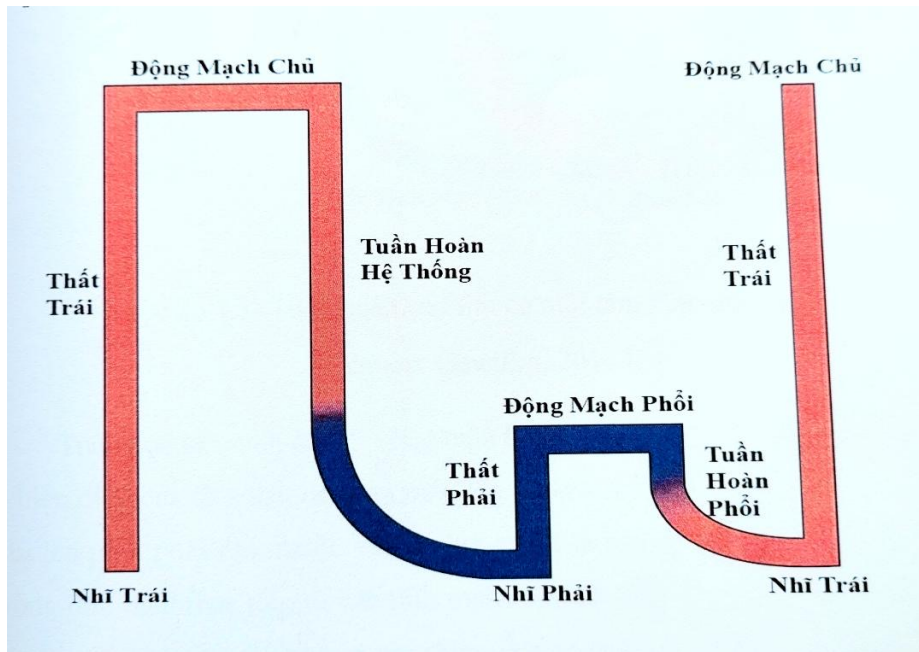
PATHOPHYSIOLOGY OF SINGLE VENTRICLE

The functional classifications:

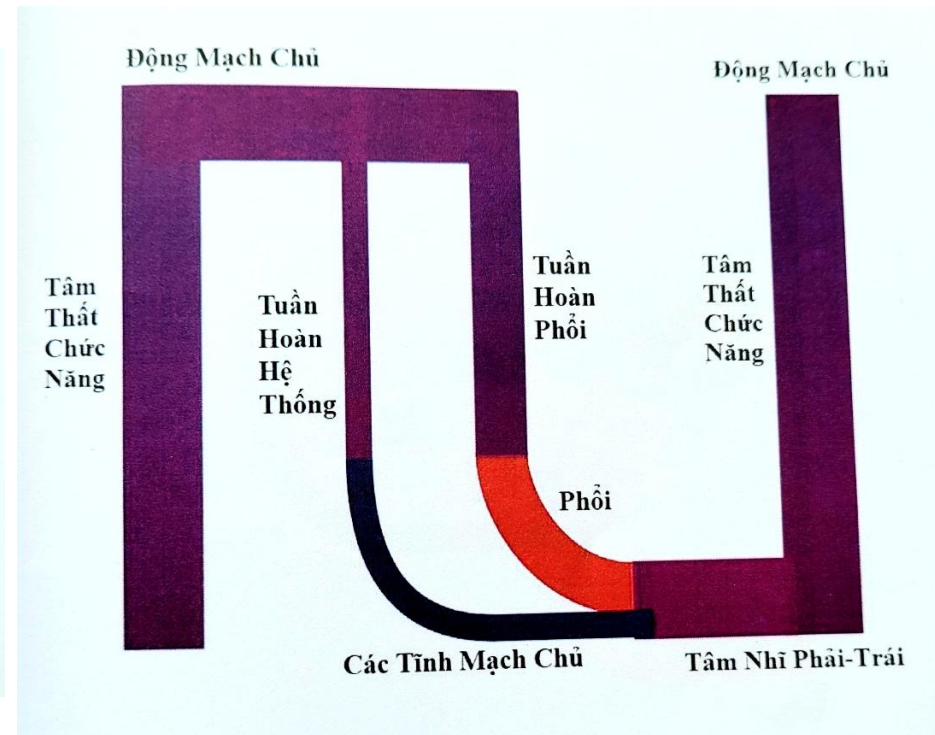
- The dominant ventricle as left ventricle structure + hypoplastic rudimentary right ventricle without function.
- The dominant ventricle as right ventricle structure + hypoplastic rudimentary left ventricle without function.
- The dominant ventricle can not decả hai thất.



PATHOPHYSIOLOGY OF SINGLE VENTRICLE

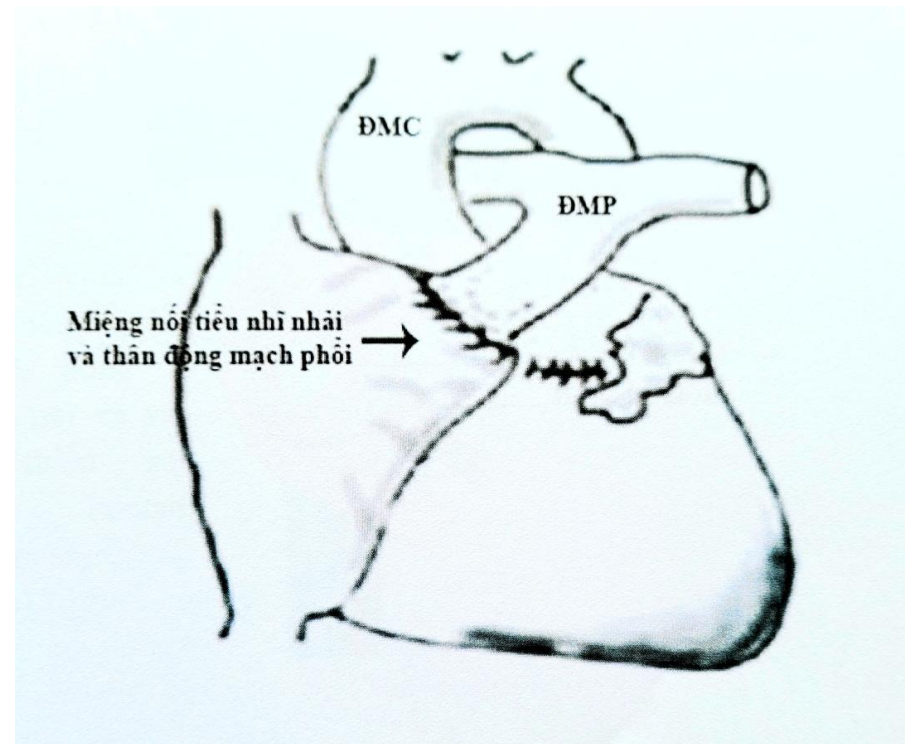
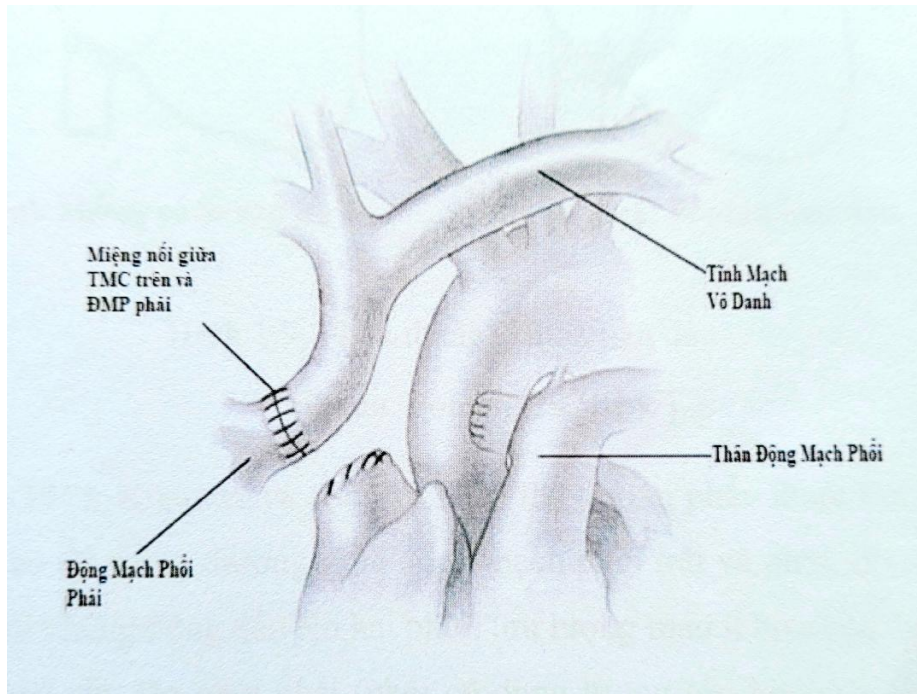


Physiology of normal biventricular circulation



Pathophysiology of single ventricle circulation

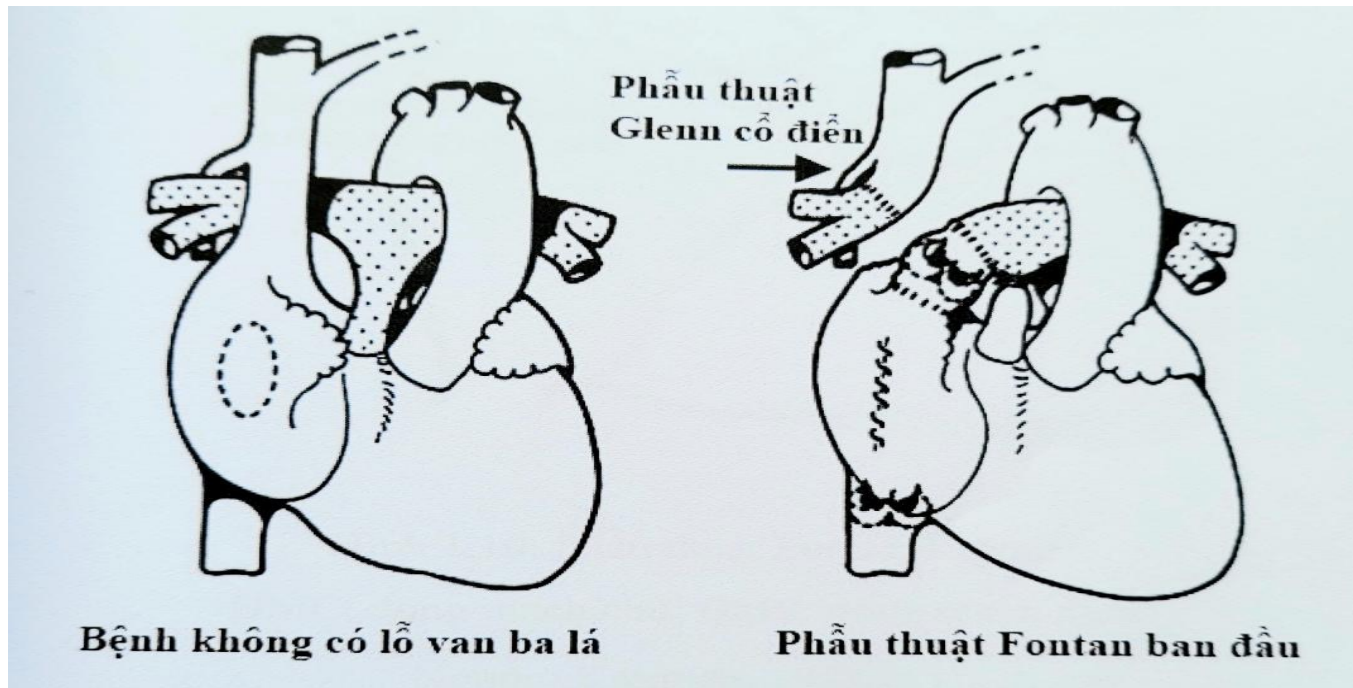
PREPAIR FOR FONTAN OPERATION



Classical Glenn operation



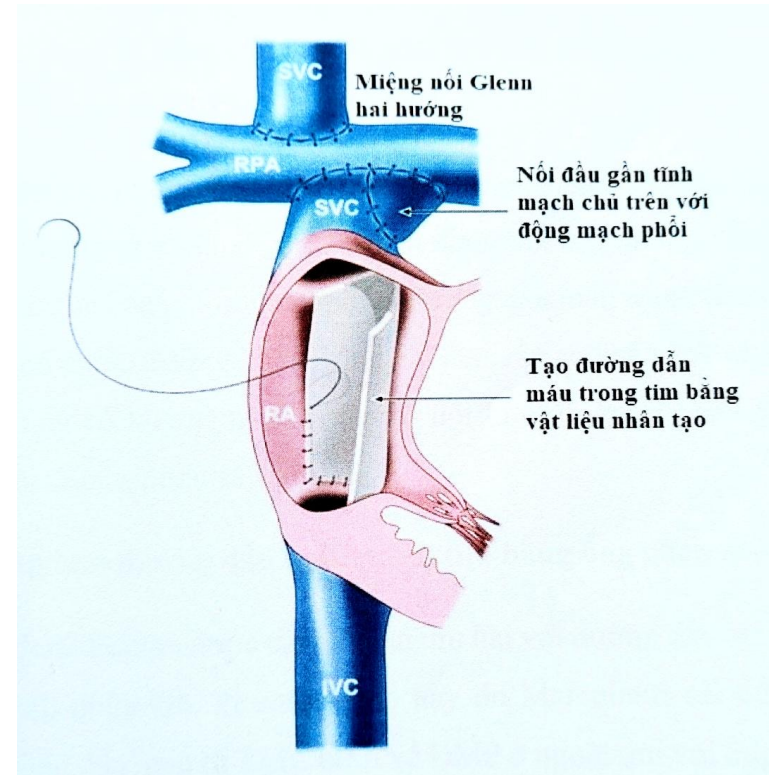
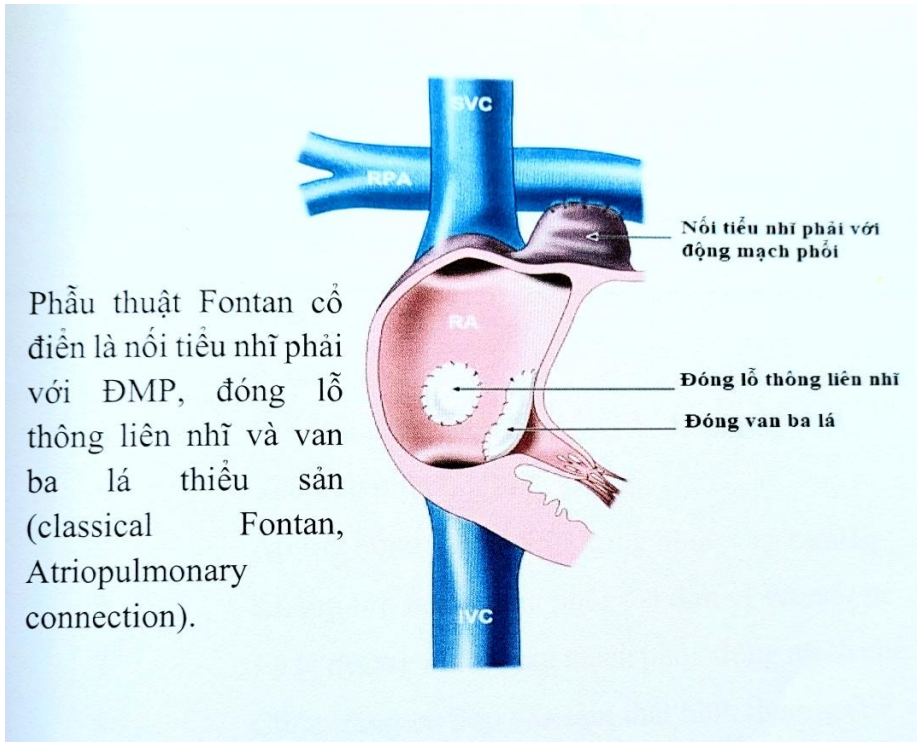
FONTAN OPERATION



Classical Fontan operation



FONTAN OPERATION



FONTAN OPERATION

- Currently, development of techniques and improvement in resuscitation
- Fontan operation applied by extra cardiac with graft tube+ fenestration
- 1990 : Marcelletti and Co, created extra cardiac blood path from the IVC to the PA with Dacron or Gortex tube in patients whose underwent bidirectional Glenn surgery.





FONTAN OPERATION

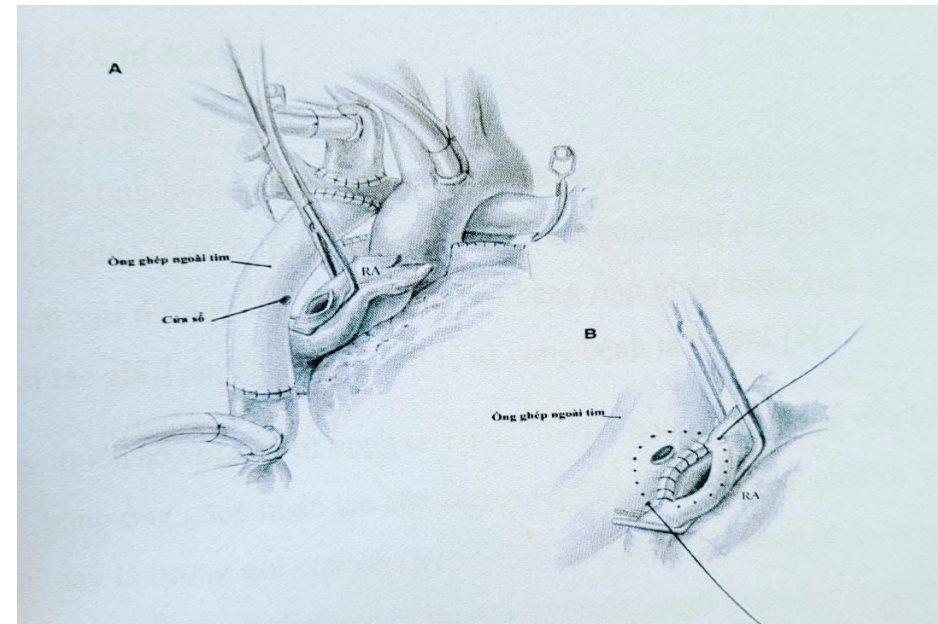
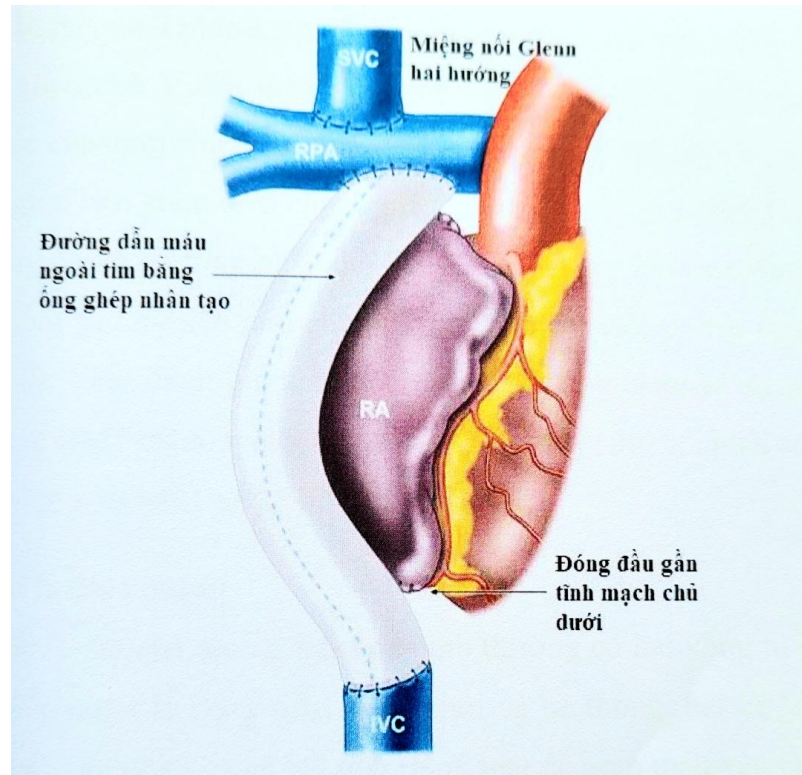
Advantages:

- Feasibly perform in patient with single ventricle anatomy
- Heart beating with CPB (prevent the side effects from CPB and cardioplegia fluid)
- Uniformity in size between the graft and diameter of IVC (prevent narrow the path and good control the blood flow to the lung)
- Reduced risk of arrhythmia due to stress in atrial wall or atrial

sutures.



FONTAN OPERATION



Fontan operation with extra- cardiac artificial graft tube



DIAGNOSIS

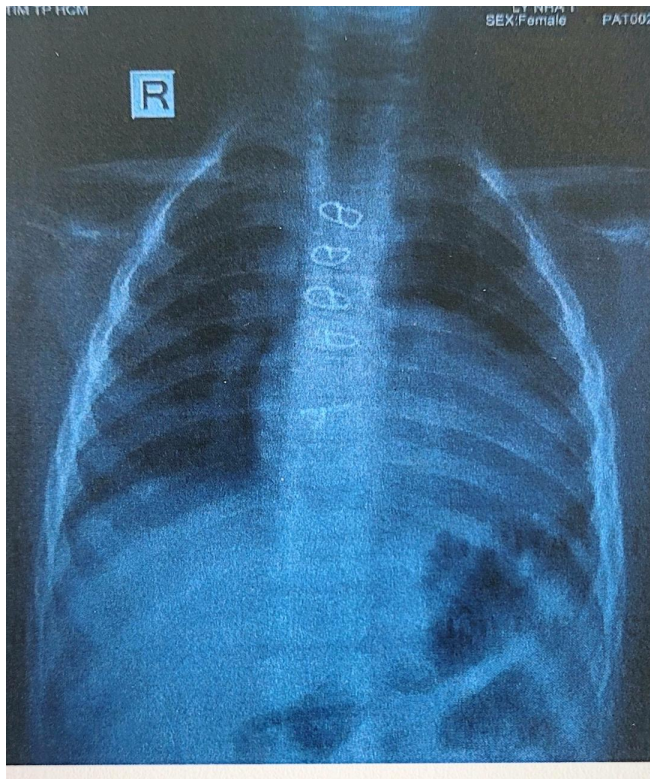
Echocardiology

Thoracic MS CT

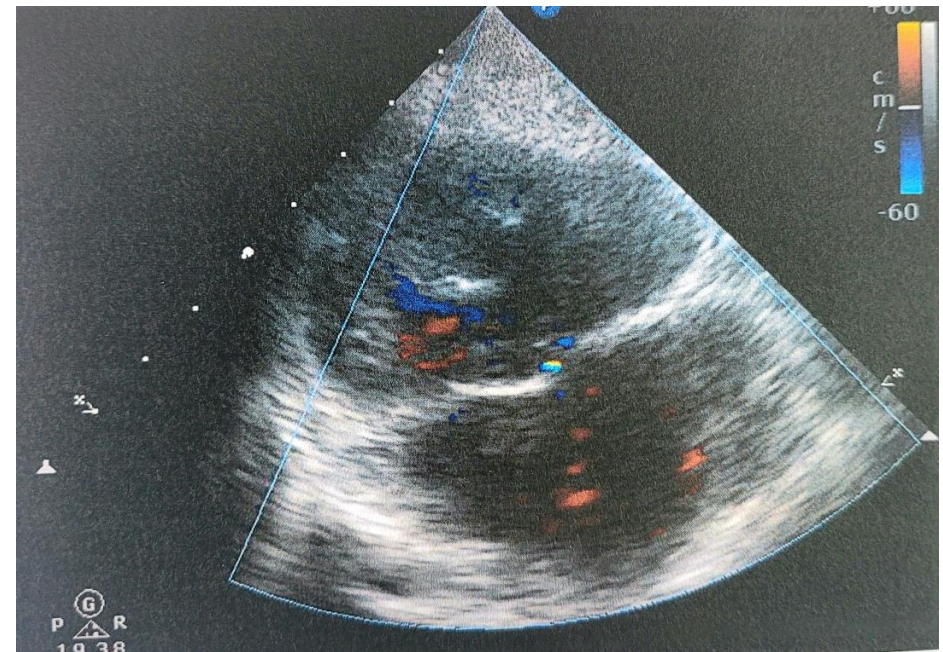
Cath-lab diagnosis



DIAGNOSIS



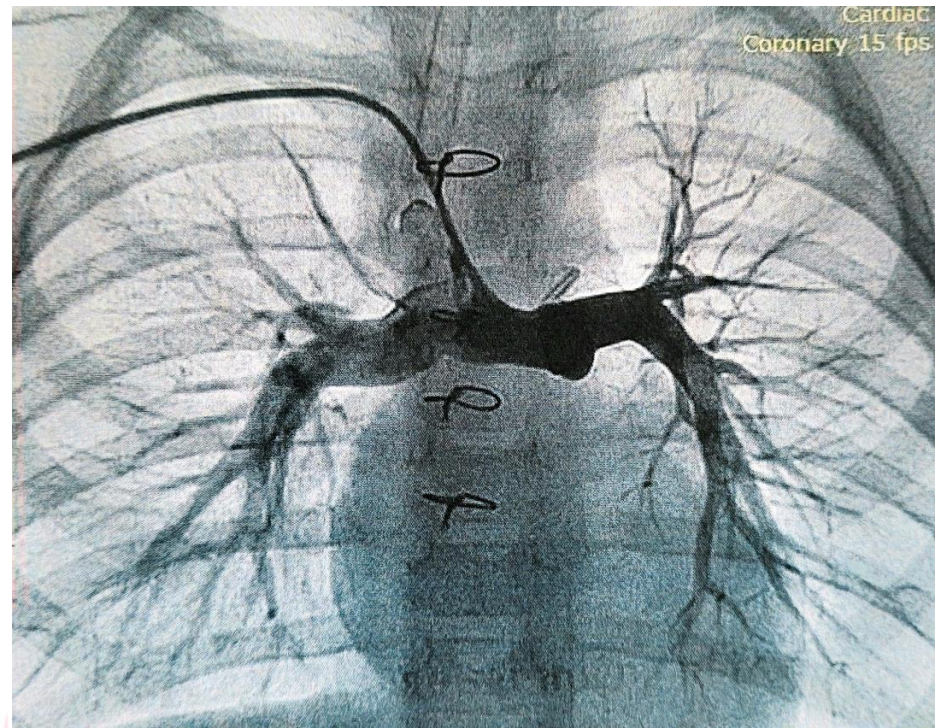
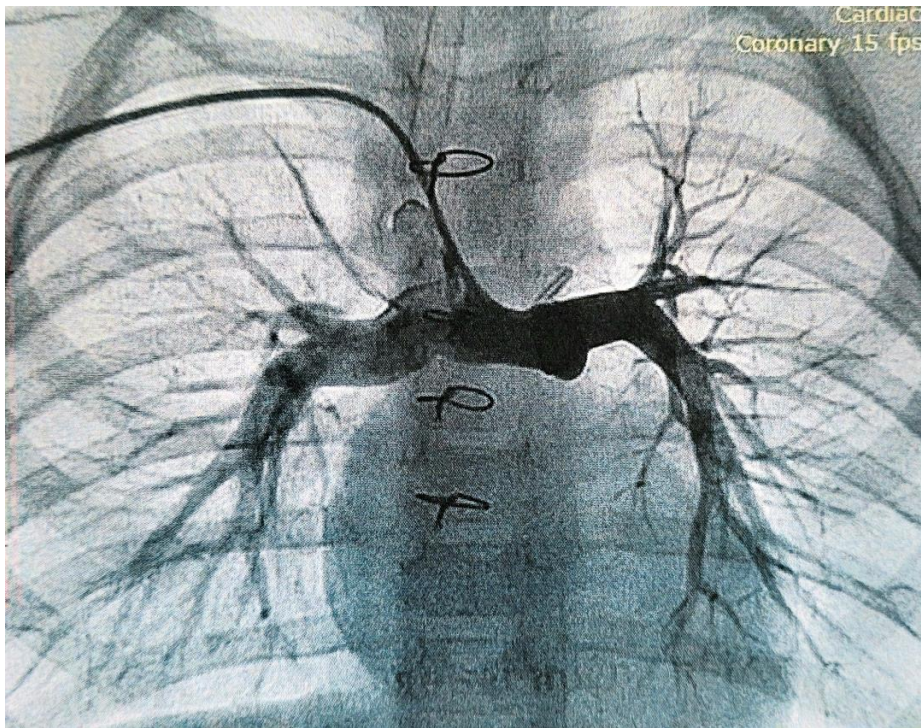
Chest X ray



Echo cardiology preoperation



DIAGNOSIS



Preoperation cath- lab for Fontan operation



OBJECTIVE

Evaluating early results of Fontan operation using the extra cardiac conduit with fenestration in the treatment of functional single ventricle heart disease at Cho Ray hospital





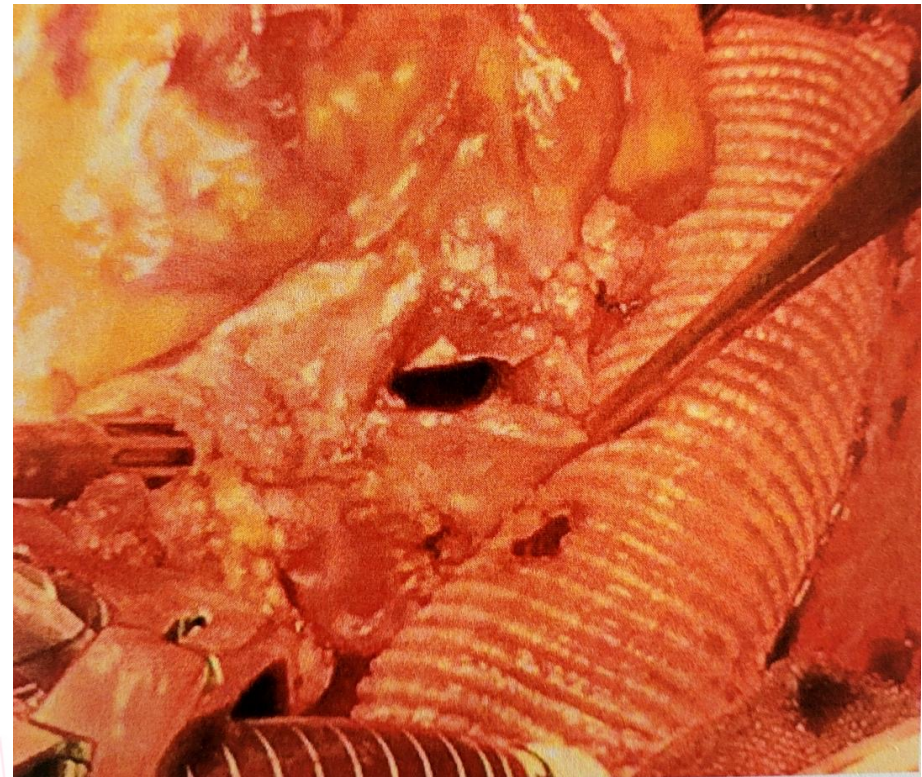
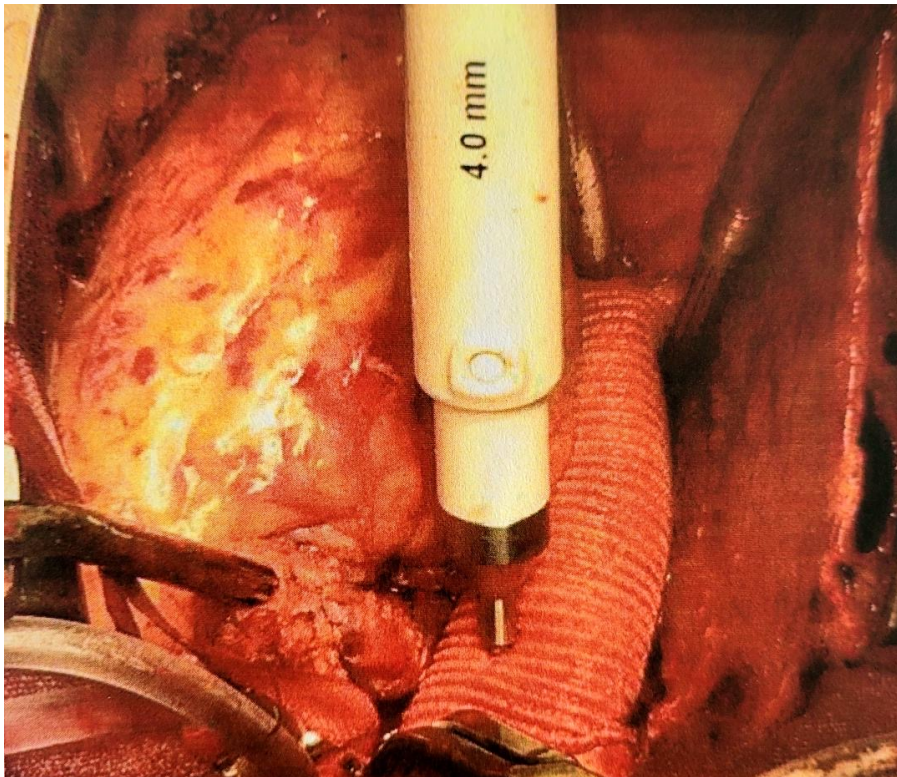
MATERIAL AND METHOS



- Retrospective study
- Duration: from 1/2017 to 12/2021
- Subjects: 31 patients with functional univentricle heart disease who underwent Fontan operation using the extra cardiac conduit with fenestration.

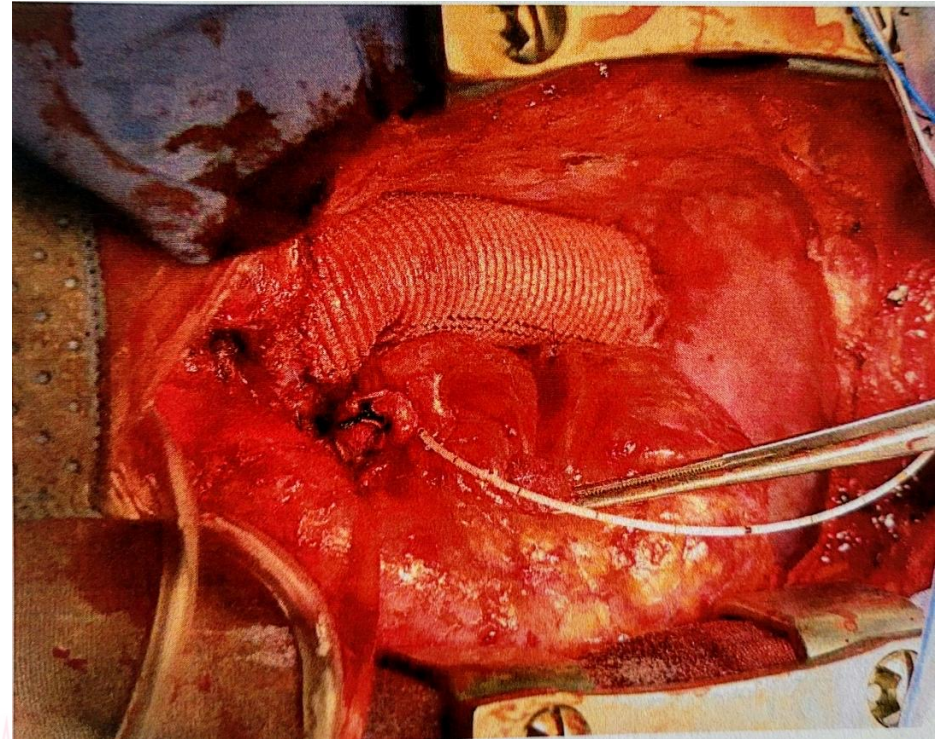
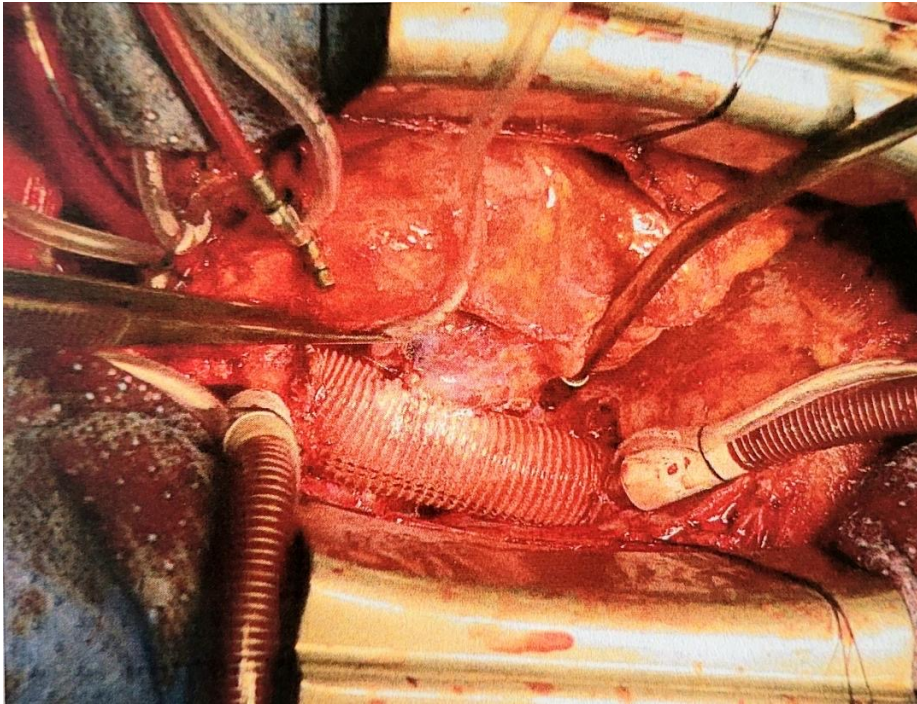


TECHNIQUES



Fontan operation with extra cardiac conduit and fenestration

TECHNIQUES



Fontan operation with extra cardiac conduit and fenestration

RESULTS

Patient characteristic (n=31 pts)

Male: 18 pts (59,2%)

Do Anh Tien et al (2019):

male/ female: 35/26

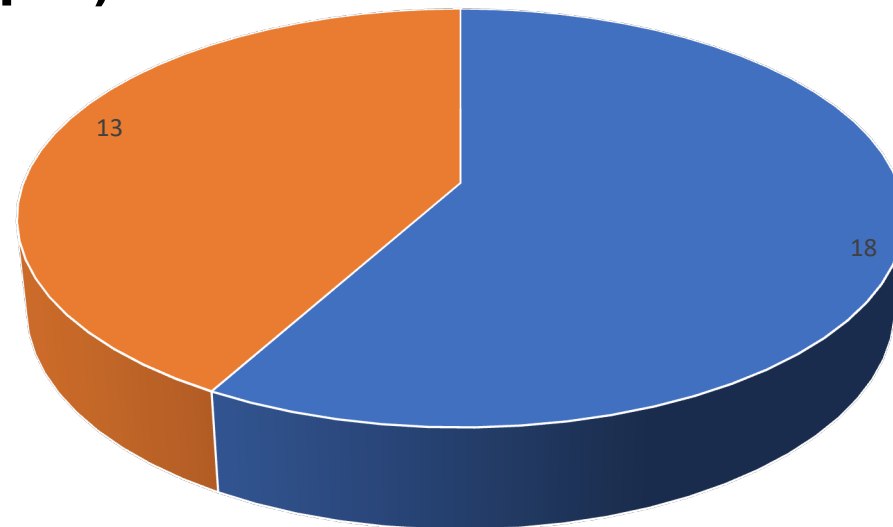
Kotani et al (2018):

303/197 (2/1)

Tacy Downing et al (2017):

484/289 (2/1)

Gendre





Patients characteristics

- Mean age: $66,3 \pm 11,4$ months (19 – 204)
- Ohye et al(2016) : Fontan operation was perform from 18 months to 4 years old
- Masamichi Ono et al. (2019): mean 2,3 (1,8 – 3,8)
- Edward Malec et al (2017): 3,7 (1,1 – 6,3)
- Đỗ Anh Tiến et al (2019): 5,6 (2-14)



Historical treatment

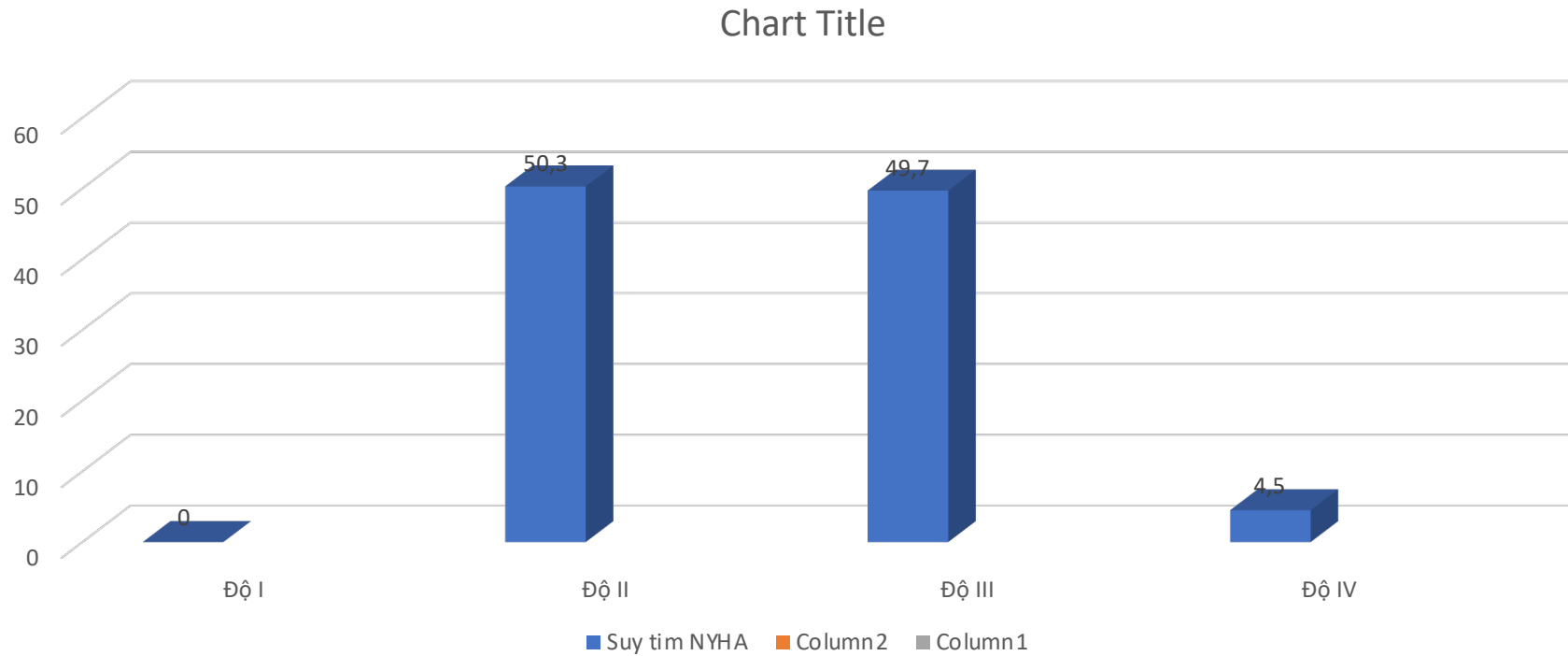
Historical treatment	Number of pts	%
PDA Stent	5	16,1
B-T shunt	8	25,8
PA banding	2	6,45
Bidirectional Glenn procedure	31	100

Mean Glenn operation duration : $15,1 \pm 3,4$ months



Clinical signs

NYHA classification



Most of patients had NYHA grade I : 0%; II: 50,3 (%). Pts 49,7(%) grade III, no patients with grade IV.



Clinical and para clinical signs(n=31)

Value	Mean	Range
SpO2 (%)	80,2 ± 3,4	78-92
Heart rate (beat/minute)	90,3 ± 15,6	76-110
Systolic arterial pressure (mmHg)	95,2 ± 9,8	87-138
Diastolic arterial pressure (mmHg)	59,1 ± 6,3	50-83
Cardio-thoraci ratio	0,56 ± 0,02	0,45- 0,6
Hct (%)	54 ± 7,26	50-67
EF (%)	61,4 ± 7,3	52-78

Most of patients had signs of central cyanosis and sinus rythm. EF > 60% account in 69%pts.



Cath-lab diagnosis

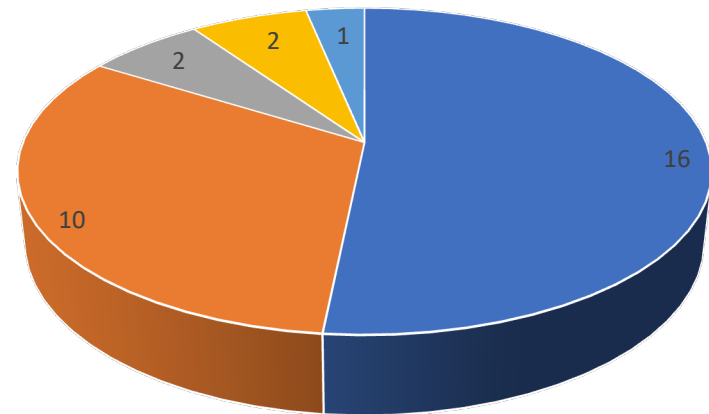
Value	Mean	Range
Nakata index (mm ² /m ²)	245 ± 80,7	220 - 312
Mean PA pressure (mmHg)	11,4 ± 2,3	8 - 15
PVR (wood/m ²)	1,8 ± 0,9	0,9 – 2,2

Most of patients had Nakata index > 150 (mm²/m²) and mean PA pressure <15 mmHg with low PVR pre operation



Morphometric of cardiac

Tricuspid atresia accounts high prevalent as 51,6%; total A-V canal unbalance + PA hypoplastic or atresia



- Không lỗ van ba lá
- Kênh AV - hẹp ĐMP
- DORV - thiếu sản thất T
- PS- thiếu sản thất phải
- DOLV - thiếu sản thất P

Mineto Kamata et al (2017): right side univentricle accounts as 51,4%; left- side :27,8%; indefinite : 20,8%



Surgical characteristics

Characteristic	Number of pts	%
A-V valve repair	2	6,45
Enlarment in PA branches	4	12,9
Conduit fenestration	31	100
Size of Conduit 20mm	22	72
size of conduit 18mm	9	28

Elizabeth H. Stephen et al (2019): AV repair by Alan Carpentier

Yasuharu et al (1997): A-V annular plasty in dilate annulus AV valve





Surgical characteristics

- Koichi Sughimoto et al (2017): the survival rate in patients with Fontan operation after 3 years was 66%.
- Keiichi Itatani et al (2009) the size of graft tube with 16 – 18mm suitable for pts 2 – 3 years old





Surgical features:

- Scott et al (2006): child patients with 15 kg can use the conduit 20mm for good flow as adult patients
- Brakel et al (2014) using the diameter of conduit $< 16\text{mm}$ – high risk of narrow.
- Conduit with size as 18 - 20mm are optimally effective even for children less than 12 kg.





Surgical features

- Alan G. Magee et al(1998): divided helical group of the PA as 4 group in PA plasty with Fontan operation.
- Igor E. Konstantinov et al (2016): using the patch to plasty the PA branches is better than cutting the graft for widen the connetion to the PA





Surgical feature

- Qiang Fan et al (2017): Using the Goretex artificial tube with circle cover make fenestration may difficult in operation
- Pan et al (2016): Should make fenestration in conduits for high risk patient



Surgical features

Value	Mean	Range
CPB time (minutes)	83,9 ± 28,4	67 - 158
Aortic clamp time(minutes) (n=5)	60,3 ± 11,5	45 - 101
PA pressure right after CPB stop (mmHg)	15,3 ± 1,42	10 - 17
SpO2 (%)	90,4 ± 5,16	88. 95
Heart rate (beat /minute)	101,4 ± 4,3	78 - 120
Systolic arterial pressure (mmHg)	99,2 ± 13,8	86 - 132
Diastolic arterial pressure (mmHg)	60,3 ± 4,5	55 - 78

Đỗ Anh Tiến et al (2019) mean CPB time $98 \pm 31,15$ minutes

Sarkar et al (2017): $110,2 \pm 1,3$ minutes; long time in CPB make more side effects in inflamtory or respiration function.



THE RESULTS

Post operative features

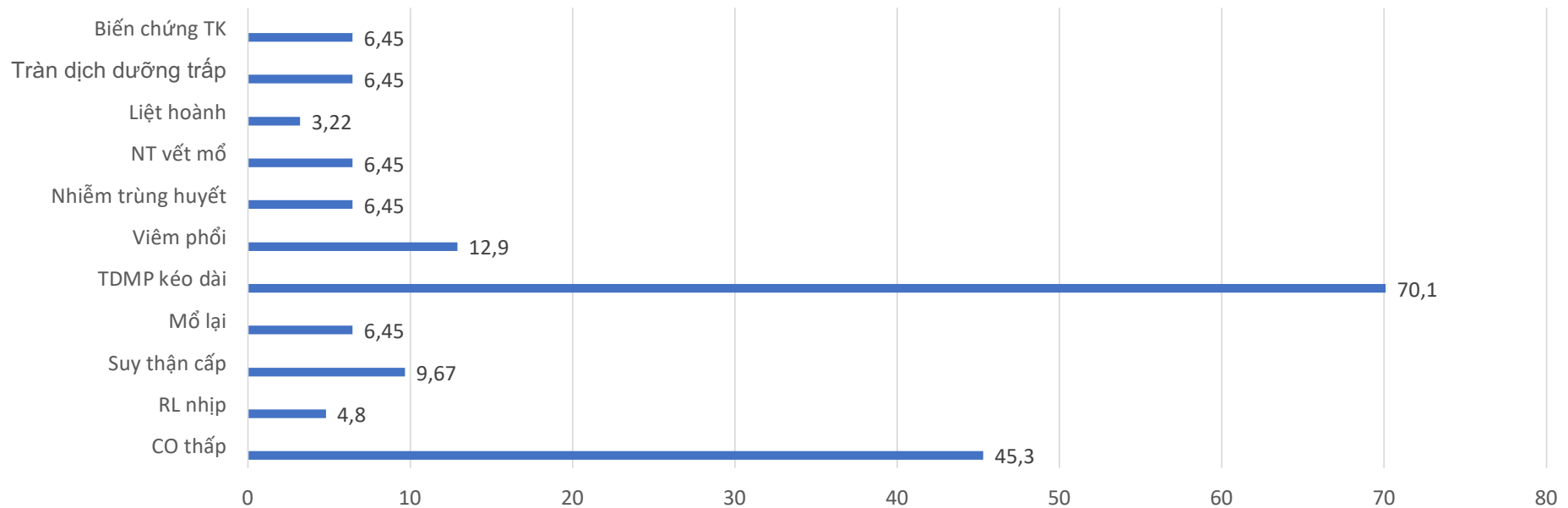
VALUE	MEAN	RANGE
Machanical ventilator mean time(hours)	50,2 ± 103,7	5 - 201
CCU mean time (days)	7,6 ± 9,5	2 - 23
Post operative mean time(days)	20,7 ± 15	10 - 78
Mean Time of pulmonary effusion drain (days)	11 ± 24,3	2 - 54
The fluidd volume per day (ml)	250,6 ± 102	103 - 1305
SpO2 post operation (%)	92 ± 3,55	90 - 96
Mean Hct post. operation(%)	40,1 ± 1,4	38 - 46

Mechanical ventilator time under. 2 days ; Post operative time was quite long. The pulmonary effusion drainage has alot



Post operative complications

Biến chứng sau PT Fontan



Gupta et al: **lung effusion drain after Fontan operation account for 13 – 39%**; Minh Nhật et al found in 39%. High prevalent of heart failure appeared after Fontan operation





Hospital mortality

- Hospital mortality rate : **3 BN (9,67%)**

Etiology: 02 pts with low cardiac output and multi organs failure

01 pt with blood infection and shock sepsis

- Marcelletti et al (1999): hospital mortality rate 10%;
- Trần Đức Đại et al (2020): with 8,97% death rate.



Short term results

mean following time : $17,3 \pm 34,1$ (month)

NYHA classification pre and post operation

NYHA	Pre ope	1 month later	6 months later	1 year later
I	5	8	17	21
II	18	22	12	9
III	8	1	2	1
IV	0	0	0	0

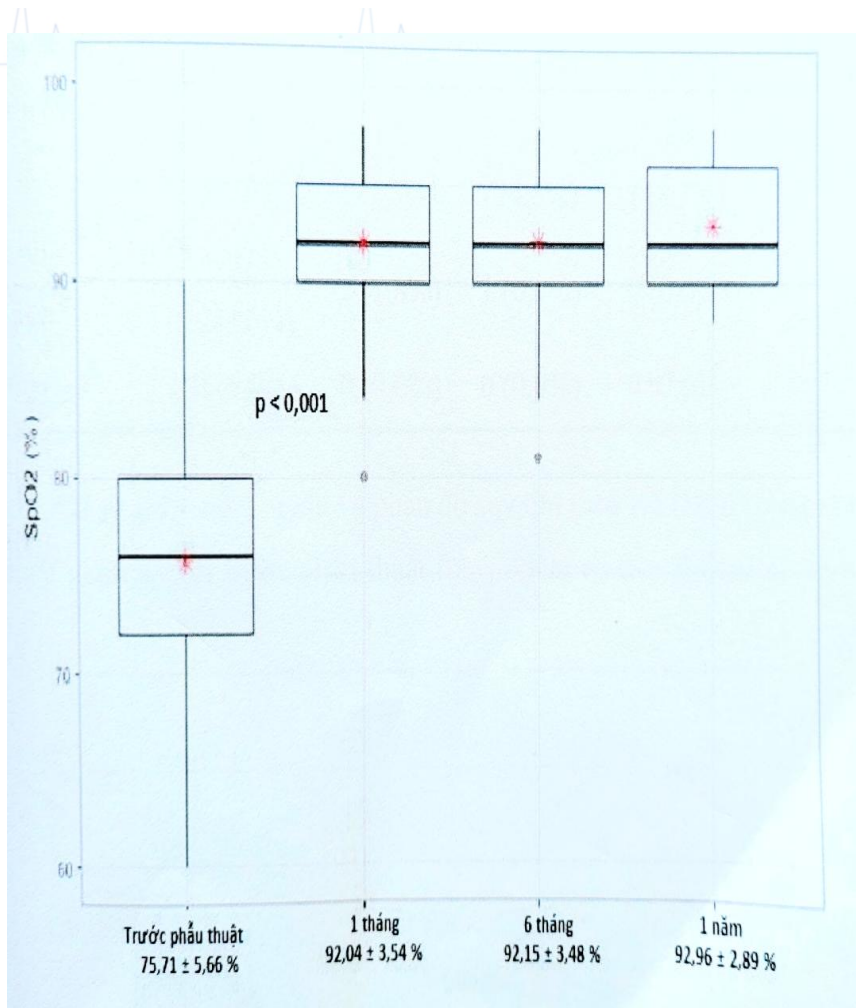


The changes of EF (by Echocardiology))

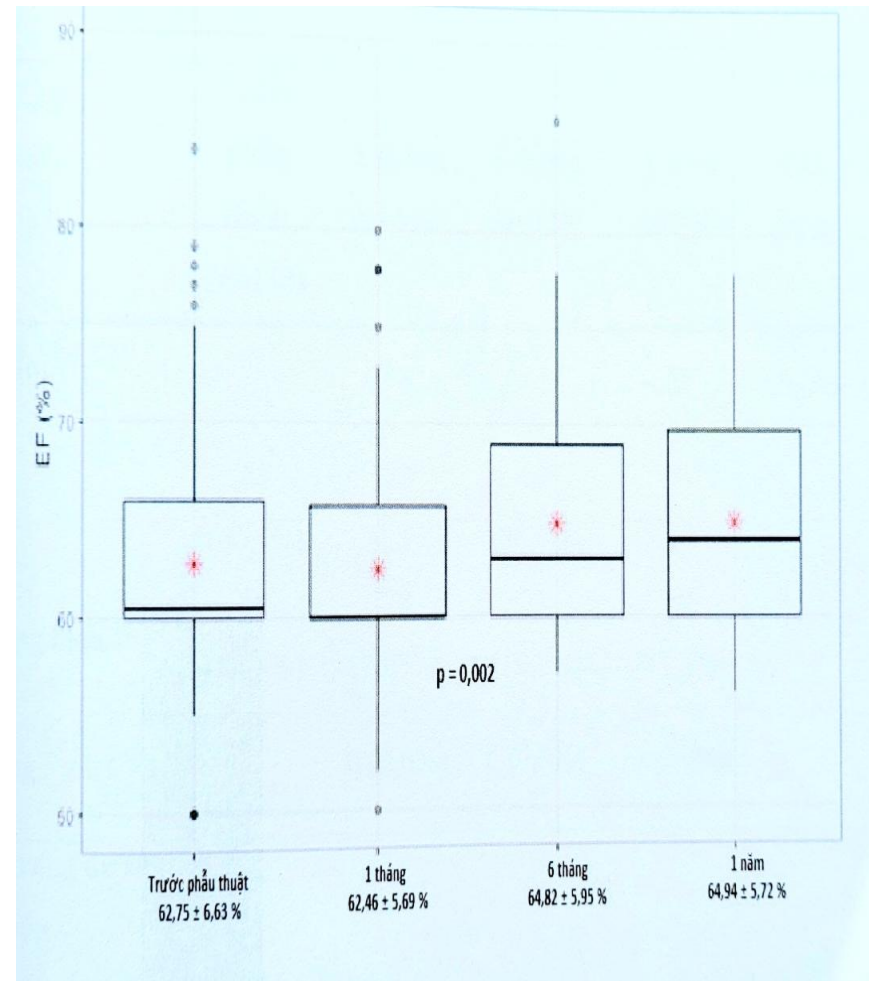
EF (%)	Value
Pre operation	61,5± 3,7
1 month later	62,37 ± 1,02
6 months later	64,8 ± 5,15
1 year later	64,96 ± 5,12

There is an improvement in EF pre and. After Fontan operation at ;1, 6 months and 1 year.





Changes of SpO₂ at pre and post operation



Changes of EF at pre and post operation



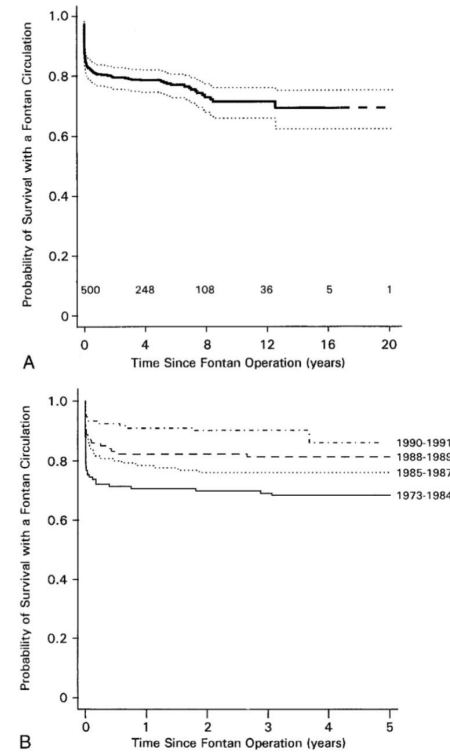
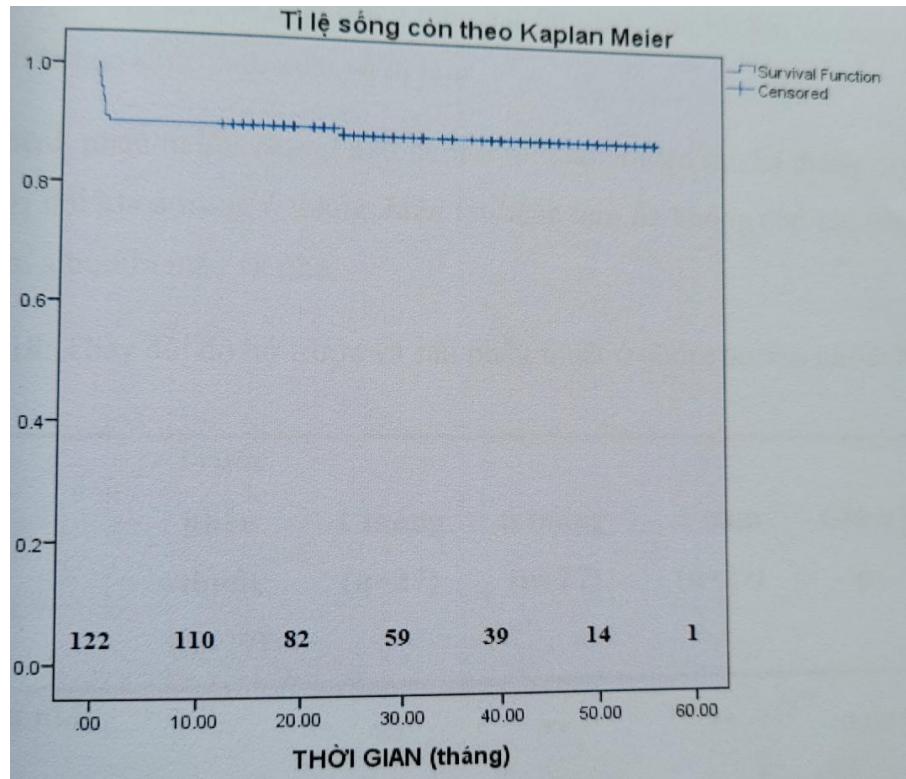
The changes of SpO2 pre vs post operation

SpO2 (%)	Value
Pre operation	76,7 ± 6,3
1 month later	92,3 ± 4,51
6 months later	92,8 ± 3,47
1 year	93 ± 1,02

There is a significant improvement changes in SpO2 pre operation vs 1, 6 months and 1 year.



The survival rate



The survival rate in patients with Fontan operation is : 90,2 % at 1 month; 87,3 % at 6 months



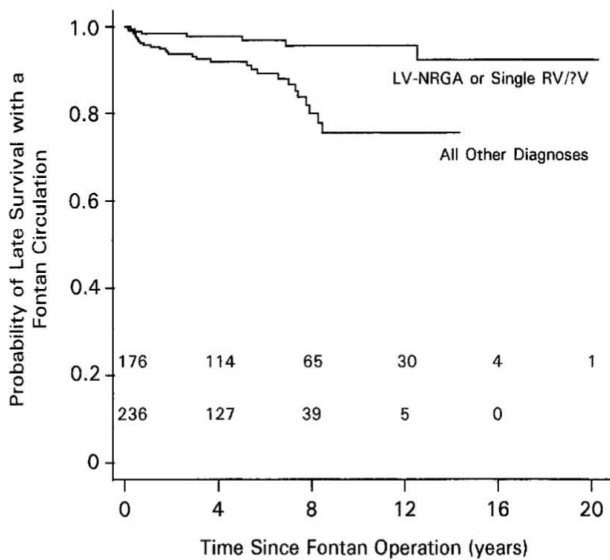


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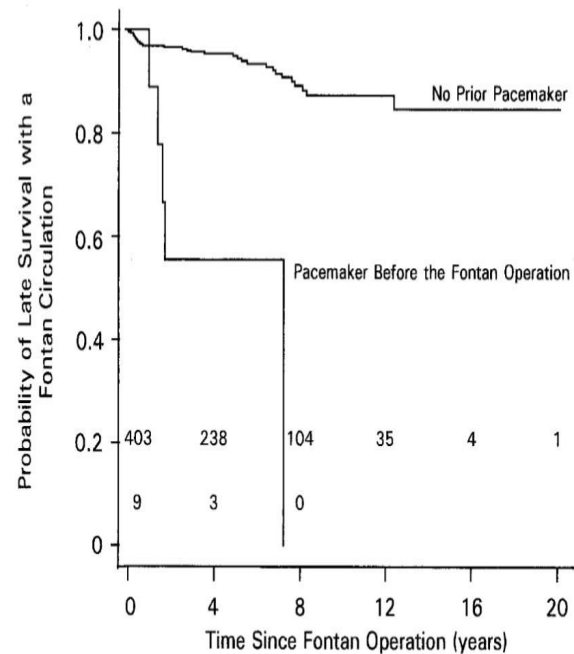






Fig. 6. Kaplan-Meier estimates of the probability of late survival with a Fontan circulation in patients with and without a pacemaker before the Fontan operation. Time zero is 30 days after the Fontan operation.

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- Sainz et al :Fontan operation gets good duration exercise (more than 7METs) according to Bruce criteria
 - Kreutzer et al : female patients with Fontan operation can get pregnant and have a normal baby



- 
- 
- Yves et al : Fontan operation with extra cardiac tube help reduce the arrhythmia
 - Minh Nhật et al : the survival rate after Fontan operation is 90,2 % at 6 months ; Marcelletti et al is 90%. Edward et al found the early survival rate as 100%.



CONCLUSION

- Study in 31 patients with functional single ventricle heart disease were underwent. Extra cardiac Fontan operation with artificial graft tube with fenestration at Cho ray hospital has good results
- There is low in hospital mortality rate; and low prevalent of post operative complications
- The early survival rate after Fontan by that way is good.





CONCLUSION

- There is an improvement in cardiac function after Fontan operation
- Recommendation in Fontan operation with extra cardiac artificial tube plus fenestration in most patients get a good and long life





THANK YOU VERY MUCH

