

**RESEARCH ARTICLE**

Closure of Isolated Doubly Committed Sub arterial Ventricular Septal Defect through Pulmonary Artery versus Trans ventricular Closure

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Abstract

Background: Doubly committed sub-arterial ventricular septal defects is a type of ventricular septal defects located beneath the aortic and pulmonary valve and represent approximately 5 % of all ventricular septal defects. This type of ventricular septal defect has a low tendency for spontaneous closure and associated with aortic valve leaflets prolapse as well as insufficiency. Trans pulmonary arterial approach is standard approach for repair this type of ventricular septal defects. **Objective:** To review the results of transpulmonary arterial approach in repair isolated doubly committed subarterial ventricular septal defects and compare it with that of transventricular approach. **Methods:** this is a retrospective comparative study applied for 23 patients underwent open heart surgery for repair their isolated doubly committed subarterial ventricular septal defects at Ibn -Alnafees teaching cardiothoracic hospital in Baghdad, Iraq from 1st of January 2012 to 1st of January 2022. Those patient divided to two groups ,group 1 (9 patients) trans pulmonary arterial approach applied ,group 2 (14 patients) trans ventricular approach used .Their collected data studied and compared between group 1 and group 2 according to aortic cross clamp time , cardiopulmonary bypass time , intensive care unit stay , prolong mechanical ventilation , need of inotropic support , residual shunt , postoperative tachyarrhythmia , postoperative right ventricular systolic function and mortality. **Results:** age group of (6 to 10 years) was the common age group in this study , 12 patients of 23 patients belong to this age group (53.83%) , female (14 patients) was common gender (61.54%) , female : male ratio was 1.5:1. The mean aortic cross clamp was 45 minutes in group 1 and 54.71 minutes in group 2, mean cardiopulmonary bypass time was 63 minutes in group 1 and 73.61 minutes in group 2. The mean intensive care unit stay was 2 days in group 1 , while was 3.11 days in group 2. Prolong mechanical ventilation (more than 10 hours) seen in 6 patients belong to group 2 (44.45%) and 2 patients belong to group 2 need reintubation (11.11%) . All patients in group 2 needed inotropic support (100%) and 5 patients of them need full support (33.34%) . postoperative tachyarrhythmia noted in 10 patients of 14 patients belong to group 2 (77.78%) , residual shunt also seen in 3 patients belong to group 2 (22.22%). Postoperative depress right ventricular systolic function founded in all patients of group 2 (100%) and classified as mild abnormal (3 patients) , moderate abnormal (8 patients) and severe abnormal (3 patients). Mortality was (11.11%) in group 2 , while in group 1 Reintubation and mechanical ventilation were not found beside no need for inotropic support , there were 0% for tachyarrhythmia , serious complications and mortality. **Conclusion:** transpulmonary arterial approach safe and feasible to repair isolated doubly committed sub arterial ventricular septal defects and its results were superior to that of transventricular approach. **Keyword:** Subarterial ventricular septal defects, Transpulmonary approach for subarterial VSD, transventricular approach for subarterial VSD.

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1 | INTRODUCTION

Conoventricular, doubly committed subarterial (DCSA), Supracristal, subpulmonary ventricular septal defect can be imagined as imperfection in the place of the ventricular septum that occurs just underneath the pulmonary and aortic valves (1,2). Among different subtypes of ventricular septal defects, doubly committed subarterial (DCSA) type is of vital significance. It has high predominance in Asian populace (30%) when contrasted with Western populace (5-10%). Its significance Due to its relationship with aortic valve prolapse and aortic incompetence (AI) which is evaluated to surpass 40 % (1,2).

DCSA represents around 32% of all surgically treated ventricular septal defects (VSD) in Asian population (3). While spontaneous closure of different kinds of VSDs is roughly between 25 to 50%, Eugene and partners found that exclusive 1 out of 128 patients with DCSA experienced spontaneous closure (4,6,7). Subarterial VSD is related with association of aortic valve pathology prior in life (8). Aortic cusp prolapse and aortic valve incompetence connected with DCSA is certainly not an intrinsic lesion (9, 10). It is acquired condition (11). Prolapse of right coronary cusp is more typical than non-coronary cusp while left cusp is once in a while involved (12).

The hidden pathology is nonappearance of strong help which is given by connection of sinus of Valsalva to the ventricular septum prompting prolapse of influenced cusp and regurgitation (13, 14). Most normally acknowledged system is Venturi impact (15, 16, 17). The outright planning for DCSA closure isn't sure. In created nations, where consistence of patients is great, some propose that if level of aortic valve prolapse is more than gentle or advancing, at that point it ought to be operated (18,19,20).

Other indications to close a ventricular septal defect include pulmonary-systemic flow ratio (Q_p/Q_s) is > 1.5 with left ventricle (LV) systolic or diastolic dysfunction causing clinical heart failure, increase in pulmonary pressures or evidence of volume overload of the LV. And endocarditis on the VSD (7,14,16).

Careful administration of the conal ventricular septal

defects contrasts from that of the perimembranous ventricular septal defects in two basic aspects (3,9). The agent approach predominantly through the pulmonary artery. This permits the best introduction of the rest of the conal septum and the pulmonary and aortic valve leaflets, encouraging repair of the imperfections without damage to the valves or conduction system (1,6,17). Conal ventricular septal defects ought to experience early closure, paying little respect to shunt volume, to counteract dynamic aortic insufficiency (2,8,15). Agent introduction accomplish through the pulmonary artery, aorta, right ventricle, or right atrium (4,6,17). Concurrent aortic valve repair can be done (6,7).

The conventional approach for the closure of a ventricular septal defects had experienced the privilege right ventricle (1,7,9). Periodic issues can happen in any case, for example, discouraged right ventricular capacity, postoperative conduction unsettling influences, the advancement of myocardial corruption in connection to the scar and late aneurysm development at the site of the scar (3, 8, 14). These contemplations have driven progressively to trans atrial repair of such imperfections, yet in this approach the infundibular (supracristal) septal defects are more hard to visualize (5,8). To stay away from ventriculotomy in these cases, the trans pulmonary arterial approach has been advocated (1,4,8,13).

Tran's pulmonary arterial approach is the strategy for decision for treating a supracristal VSD, as this method leaves no postoperative right ventricular scars (3, 8, 21). In any case, the conceivable unfavorable impact on the pulmonary valve by this system has been seen (15).

The trans pulmonary supply route approach uncovered the imperfections through a vertical entry point in the pulmonary artery. The bypass and myocardial conservation procedures are the same as

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with other approaches. Utilizing a patch is especially essential in conal VSD repair on the grounds that the patch helps bolster the prolapsing aortic valve and forestalls proceeded with descending weight on the leaflets. Finish closure of the shunt through the VSD disposes of the Venturi impact that pulls the aortic valve cusp into the deformity (11,25). The prolapsing aortic valve leaflet may somewhat impede the deformity with the goal that the VSD opening seems little and manageable to direct suture. It is imperative to perceive this trap and maintain a strategic distance from damage to the aortic valve leaflet by utilizing a proper measured patch and by setting the sutures around the genuine border of the ventricular septal imperfections, as opposed to around the little false opening (7, 16, 22).

A joined trans aortic- trans pulmonary course approach for attending careful repair of aortic deficiency additionally has been supported (4, 17). The patch ought not meddle with pulmonary valve work and ought to offer help to the already prolapsed aortic valve (23). The pulmonary artery primary closed no stenosis occur due to preoperative dilatation which usually present (19, 21).

Trans pulmonary arterial approach is standard approach for repair this type of ventricular septal defects. This kind of VSD is as yet a contraindication for trans catheter devise closure because of trouble in conveyance track working and adjusting the position of eccentric device during deployment. As of late, insignificantly hybrid perventricular devise closure has been presented as an elective treatment for chosen patients with doubly committed sub-arterial VSD (6).

The aim of this study to review the role of trans pulmonary arterial approach in repair isolated doubly committed sub-arterial ventricular septal defect and compare its outcomes with that of trans ventricular approach were classically an incision should be made in the muscles of right ventricle.

2 | PATIENTS AND METHODS

This a retrospective randomized comparative study which was done at Ibn- AL nafees teaching hospital for cardiothoracic surgery in Baghdad, Iraq from 1

January 2012 to 1 January 2022. This study involved 23 patients underwent open heart surgery for repair subarterial ventricular septal defects.

We classified patients into two groups G1 (9 patients) closure of DCSA done through pulmonary artery, G2 (14 patients) closure of DCSA by trans ventricular approach. ECG, CXR, transthoracic echocardiography applied for all patient to aid in diagnosis. All cases referred from pediatric cardiology unit to cardiac surgery unit due to volume overload on LV and some had mild aortic valve regurgitation also. of 23 patents, 18 patients had prolapsed aortic valve, 5 patients had mild aortic valve regurgitation.

We compare between the two groups according to age, sex, aortic cross clamp, cardiopulmonary bypass time, myocardial protection, intensive care unit (ICU) stay, prolong ventilation, need inotropic support, postoperative right ventricle (RV) function, tachyarrhythmia, heart block, residual shunt, trauma to aortic valve, effect on pulmonary valve and mortality in two groups.

3 | RESULTS

Age group (6-10 years) was common age groups (53.85%) in our study, 7 patients belong to this group (Table 1). Of 13 patients, 8 patients were females (61.54%) and 5 patients were males (38.46%). The female gender was common one in this study, female: male ratio was 1.6:1 (table 1).

No different in myocardial protection in both groups, all patients underwent open heart surgery through median sternotomy, classical total cardiopulmonary bypass with moderate hypothermia, antgrade cardioplegia and LV vent. Subarterial ventricular septal defects repaired by patches in all patients either Dacron patches in 7 patients (53.84%) or pericardial patches in 6 patients (46.16%). All G1 patients (4 patients) closure of DCSA by pericardial patches. Cross clamp time little lower in G1 where median time in G1 was 45 minute while in G2 54.71 minute (table 2). Median cardiopulmonary bypass time in G1 was 63 minute and little more in G2 73.6 minute (table 2).

Post-operative heart block, injury to aortic valve or pulmonary valve were not seen in both groups (table 3). ICU stay was longer in 5 patients in G2 (55.55%) median time was 4 days while other 4 patients (44.45%) in same group was 2 days . All patients in G1 ICU stay time was 2 days (table 2). Of 9 patients belong to G2 4 patients (44.45%) had prolong mechanical ventilation, the median time was 3days , this finding not seen in G1 ,all patients belong to this group extubate after few hours post operatively, one patient belong to G2 needed re intubation(11.11%) (table 3) .All patients belong to G2 needed inotropic support in early days (100%) , 3 patients of them (33.33%) needed full inotropic support and other just minimum support, the patients belong to G1 no such need founded (0%) (Table 3).

Post-operative tachyarrhythmia seen in 7 patients of 9 patients of G2 (77.78%) which management smoothly in most patient except in one patient was refractory to treatment (11.11%), no such complications seen in patients belong to G1 (0%) (table 3).

Residual shunt seen in 2 patients belong to G2 (22.22%) and assessed as mild shunt, no any leak in patches of all patients belong to G1 (0%) (Table 3). Postoperative RV systolic function as assessment by tricuspid annular plane excursion (TAPSE) and classified as mild, moderate or severe depress, was depressed in all patients of G2 (100%) as mild in 2patients , moderate in 5 patients , severe in 2 patients while RV systolic function not depress in all patient of G1(0%) (Table 4).

Mortality in G2 (11.11%) while in G1(0%) (table 3) .

Table 1: Age and sex distribution of patients.

Age (years)	Male	Female	Total
1-5	2(15.39%)	2(15.39%)	4(30.76%)
6-10	1(7.69%)	6(46.15%)	7(53.85%)
11-15	2(15.39%)	0(0%)	2(15.39%)
Total	5(38.46%)	8(61.54%)	13(100%)

Table 2: A comparison between G1 and G2 according to mean time of an aortic cross time, cardiopulmonary bypass, ICU stay.

Mean time	G1(9 patients)	G2(14 patients)
Aortic cross clamp (minutes)	45	54.71
Cardiopulmonary bypass time(minutes)	63	73.6
ICU stay (days)	2	3.11

Table 3: Comparative variables between G1 (9 patients)and G2(14 patients) .

Variable	G1 (4 patients)	G2 (9 patients)
Need of prolong mechanical ventilation	0 (0%)	6 (44.45%)
Re intubation	0 (0%)	2 (11.11%)
Minimum inotropic support	0 (0%)	14 (100%)
Full inotropic support	0 (0%)	5 (33.34%)
Residual shunt	0 (0%)	3 (22.22%)
Postoperative tachyarrhythmia	0 (0%)	10 (77.78%)
Refractory postoperative arrhythmia	0 (0%)	2 (11.11%)
Mortality	0 (0%)	2 (11.11%)

Table 4: Post-operative RV systolic function in two groups (G1 and G2) as assessed by tricuspid annular plane excursion (TAPSE).

Post-operative TAPSE value(cm)	G1 (9 patients)	G2(14 patients)
1.5 -2.0 (normal value)	9 (100%)	0 (0%)
1.3- 1.5 (mild abnormal)	0 (0%)	3 (22.23%)
1.0- 1.2 (moderate abnormal)	0 (0%)	8 (55.56%)
>1.0(severe abnormal)	0 (0%)	3 (22.23%)

4 | DISCUSSION

Doubly committed sub arterial VSD usually surgically treated to prevent aortic valve regurgitation (4,8) . Closure of this type of VSD by usage patch either pericardial or synthetic one to maintain normal function of nearby valves (7,18)

Main surgical approach for repair this type of VSD is trans pulmonary arterial and trans ventricular approach (1,8,23). In this study common age group was (6-10 years) 7patients of 13 patients belong to this group(53.85%) and common gender was female 8 patients of 13patients were females (61.54%), which is comparable to Roos-Hesselink JW were age range between 5-13 years , and male-female ratio was (0.9-1.1) (22).

The patients belong to G1 (4patients) underwent trans pulmonary arterial approach had short mean aortic cross clamp time and mean cardiopulmonary bypass time than patients of G2(9patient) underwent trans ventricular approach which so important in outcome of surgery which is again comparable to other study (9). In present study the mean ICU stay time longer in G2 patients than G1patients , mean time 3.11 days in G2 and 2days in G2 reflect the stability of G1 patients and need of more care in G2 patients, this difference reflect the damaging effect of right ventricular incision.

Prolong mechanical ventilation seen in 4 patients belong to G2 (44.455%) due to hemodynamic instability, tachyarrhythmia and need inotropic support which preclude early extubation ,the mean time was 3 days .Single patient belong to G2 require reintubation due to progressive hemodynamic deterioration while all patient belong to G1 extubation underwent sooner after surgery reflect hemodynamic stability, this is very close result to what is seen in Sim EK, Grignani RT study (25) were prolong ventilation and tachyarrhythmia seen in 48.6% of cases.

Need of inotropic support was minimum in all patients belong to G2(100%) and full in 3 patients of them (33.34%) reflect instability of hemodynamic state of them caused by right ventricular incision while no patient belong to G1 require that support (0%) due to their conditions were hemodynamic stable . The post-operative tachyarrhythmia seen in 7patients of 9 patients belong to G2 (77.78%) usually due to arrhythmogenic RV incision, while this arrhythmia not seen in patients belong to G1(0%) due to RV incision not used. most of this arrhythmia managed successively except in one patient was refractory to treated because of big right ventricular incision.

Postoperative RV systolic function as assessed and classified by TAPSE values was depressed in all patients of G2 (100%), 2patients had severe depress RV systolic function , 5patients had moderate depress RV systolic function and 2patients had mild depress RV systolic function .Usage RV incision may cause this abnormality .While RV systolic function was normal in all patients belong to G1 whom underwent transpulmonary arterial approach and that is main advantage of this approach along with absence of tachyarrhythmia due to RV incision not applied .Residual shunt seen in 2patient belong to G2 (22.23%)due to inadequate visualization of the defect while all patches belong to patients of G1 were intact reflected feasibility of transpulmonary arterial approach to repair this defects.

No finding of pulmonary valve incompetence , injury to aortic valve or heart block in G 1 or in G 2 .Mortality was 11.11% in G2 and 0% in G1 .This study show advantage of trans pulmonary arterial approach over transventricular one which resolve problems of RV incision usage (postoperative depress RV systolic function ,postoperative tachyarrhythmia) which may lead to prolong mechanical ventilation, need inotropic support , increase ICU stay time or even mortality .No advantage of trans ventricular approach over trans pulmonary arterial one in isolated DCSA which seen if the defect associated with subpulmonary stenosis where resection more feasible and make the rims of defect clearly identified (21) .

Despite the advantage of transpulmonary approach it is still used less than transventricular approach because low experience in our country in transpulmonary approach and no local papers talk about it.

5 | CONCLUSION

Trans pulmonary arterial approach is superior to trans ventricular approach in repair of isolated double committed sub arterial VSD. Where it safe and feasible approach in management of this type of VSD

REFERENCES

1. Devlin PJ, Russell HM, Mongé MC, Patel A, Costello JM, Spicer DE, et al. Doubly committed and juxtaarterial ventricular septal defect: outcome -s of the aortic and pulmonary valves. *Ann Thorac Surg.* 2014;97(6):2134–2141. doi:10.1016/j.athoracsur.2014.01.059.
2. Lin K, Zhu D, Tao K, Gan C, Tang H, Feng Y, et al. Hybrid per ventricular device closure of doubly committed subarterial ventricular septal defects: mid-term results. *Catheter Cardiovasc Interv.* 2013;82:E225–32. doi: 10.1002/ccd.24869.
3. Tweddell JS, Pelech AN, Frommelt PC. Ventricular septal defect and aortic valve regurgitation: pathophysiology and indications for surgery. *Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu.* 2006;147–152.
4. Mavroudis C, Baker CL, Idriss FS. Ventricular septal defect. In: Mavroudis C, Baker CL, editors. *Pediatric cardiac surgery*. 3. Philadelphia, PA: Mosby; 2003. pp. 298–320.
5. Lun K, Li H, Leung MP, Chau AK, Yung T, Chiu CS, et al. Analysis of indications for surgical closure of subarterial ventricular septal defect without associated aortic cusp prolapse and aortic regurgitation. *Am J Cardiol.* 2001;87:1266–70. doi: 10.1016/S0002-9149(01)01517-X.
6. Zhu D, Lin K, Tang ML, Feng Y, An Q. Midterm results of hybrid perventricular closure of doubly committed subarterial ventricular septal defects in pediatric patients. *J Cardiac Surg.* 2014;29:546–53. doi: 10.1111/jocs.12361.
7. Liu L, Zhao TL, Yang YF, Wang X, Ying N, Wu Q, et al. Intraoperative device closure of subaortic ventricular septal defects. *J Cardiac Surg.* 2013;28:456–60. doi: 10.1111/jocs.12134.
8. Chiu SN, Wang JK, Lin MT, Wu ET, Lu FL, Chang CI, et al. Aortic valve prolapse associated with outlet-type ventricular septal defect. *Ann Thorac Surg.* 2005;79(4):1366–1371. doi:10.1016/j.athoracsur.2004.10.012.
9. Cheung YF, Chiu CS, Yung TC, Chau AK. Impact of preoperative aortic cusp prolapse on long-term outcome after surgical closure of subarterial ventricular septal defect. *Ann Thorac Surg.* 2002;73(2):622–627. doi:10.1016/S0003-4975(01)03393-8.
10. Anderson BR, Stevens KN, Nicolson SC, Gruber SB, Spray TL, Wernovsky G, et al. Contemporary outcomes of surgical ventricular septal defect closure. *J Thorac Cardiovasc Surg.* 2013;145:641–7.
11. Mavroudis C, Backer CL, Jacobs JP. In: *Ventricular septal defect. Pediatric Cardiac Surgery*. 3rd ed. Mavroudis C, Backer CL, editors. Philadelphia, Pennsylvania: Mosby Inc; 2003. pp. 316–7.
12. Fukuda T, Suzuki T, Kashima I, Sato M, Morikawa Y. Shallow stitching close to the rim of the ventricular septal defect eliminates injury to the right bundle branch. *Ann Thorac Surg.* 2002;74:550–5.
13. Demirag MK, Keceligil HT, Kolbakir F. Primary surgical repair of ventricular septal defect. *Asian Cardiovasc Thorac Ann.* 2003;11:213–6. doi:10.1177/021849230301100307.
14. Chen Q, Chen LW, Wang QM, Cao H, Zhang GC, Chen DZ. Intraoperative device closure of doubly committed subarterial ventricular septal defects: initial experience. *Ann Thorac Surg.* 2010;90:869–73. doi: 10.1016/j.athoracsur.2010.06.022.
15. Pan S, Xing Q, Cao Q, Wang P, Duan S, Wu Q, et al. Perventricular device closure of doubly committed subarterial ventral septal defect through left anterior minithoracotomy on beating hearts. *Ann Thorac Surg.* 2012;94:2070–5. doi: 10.1016/j.athoracsur.2012.05.070.
16. Scully BB, Morales DL, Zafar F, McKenzie ED, Fraser CD, Jr, Heinle JS. Current expectations for surgical repair of isolated ventricular septal defects. *Ann Thorac Surg.* 2010;89(2):544–549. doi: 10.1016/j.athoracsur.2009.10.057.
17. Anderson BR, Stevens KN, Nicolson SC, et al. Contemporary outcomes of surgical ventricular septal defect closure. *J Thorac Cardiovasc Surg.* 2013;145(3):641–647. doi: 10.1016/j.jtcvs.2012.11.032.
18. Kogon B, Butler H, Kirshbom P, Kanter K, McConnell M. Closure of symptomatic

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ventricular septal defects: how early is too early? *Pediatr Cardiol.* 2008;29(1):36–39. doi: 10.1007/s00246-007-9016-z.

19. Jacobs ML, O'Brien SM, Jacobs JP, et al. An empirically based tool for analyzing morbidity associated with operations for congenital heart disease. *J Thorac Cardiovasc Surg.* 2013;145(4):1046–1057. doi: 10.1016/j.jtcvs.2012.06.029.

20. Aydemir NA, Harmandar B, Karaci AR, et al. Results for surgical closure of isolated ventricular septal defects in patients under one year of age. *J Card Surg.* 2013;28(2):174–179. doi: 10.1111/jocs.12073.

21. Bol Raap G, Meijboom FJ, Kappetein AP, Galema TW, Yap SC, Bogers AJ. Long-term follow-up and quality of life after closure of ventricular septal defect in adults. *Eur J Cardiothorac Surg.* 2007;32(2):215–219. doi: 10.1016/j.ejcts.2007.04.023.

22. Roos-Hesselink JW, Meijboom FJ, Spitaels SE, et al. Outcome of patients after surgical closure of ventricular septal defect at young age: longitudinal follow-up of 22–34 years. *Eur Heart J.* 2004;25(12):1057–1062. doi: 10.1016/j.ehj.2004.04.012.

23. Menting ME, Cuypers JAAE, Opić P, et al. The unnatural history of the ventricular septal defect. Outcome up to 40 years after surgical closure. *JACC.* 2015;65(18):1941–1951. doi: 10.1016/j.jacc.2015.02.055.

24. Yip WC, Ho TF, Chan KY, Lee CN, Ong KK, Koh BC. Comparison of spontaneous closure rate in children with different types of ventricular septal defects. *J Paed Child Health.* 1997;33(suppl 1):S41.

25. Sim EK, Grignani RT, Wong ML, Quek SC, Wong JC, Yip WC, et al. Outcome of surgical closure of doubly committed subarterial ventricular septal defect. *Ann Thorac Surg.* 1999;67(3):736–738. doi:10.1016/S0003-4975(98)01256-9.

26. Wei XZ, Kang SZ, Xiang DW. Surgical repair of ventricular septal defect in 2085 pediatric patients. *Asian Cardiovasc Thorac Ann.* 1997;5(2):83–86.

27. Sands AJ, Casey FA, Craig BG, Dornan JC, Rogers J, Mulholland HC. Incidence and risk factors for ventricular septal defect in “low risk” neonates. *Arch Dis Child Fetal Neonatal Ed.* 1999;81(1):F61–F63. doi: 10.1136/fn.81.1.F61.

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