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DIAGNOSTIC CARDIAC CATHETERIZATION IN PATIENTS OF TETRALOGY OF FALLOT - PROGRADE VS. RETROGRADE APPROACH

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All the authors contributed significantly to the research that resulted in the submitted manuscript.

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ABSTRACT

Objective: Diagnostic cardiac catheterization for Tetralogy of Fallot (TOF) is still commonly practiced in our country. Aim of this study was to compare results and complications of prograde/antegrade and retrograde approach in diagnostic catheterizations of TOF.

Methodology: This prospective comparative study was conducted at AFIC/NIHD Rawalpindi from December 2010 to June 2012. 269 consecutive patients who underwent diagnostic cardiac catheterization for TOF were included and divided in three groups. Group A: Prograde study planned, Group B: both venous and arterial accesses were electively obtained at the start and group C, where retrograde study was planned. Group A & C were subdivided: Group Aa, study completed in prograde manner and group Ab where arterial line was subsequently placed for completion of study. Group Ca, study completed in retrograde approach and group Cb where venous line was subsequently placed. Data analysis was computer based using SPSS 17 version.

Results: Total 269 patients with mean age of 7.7 years and including 169 males. Group A included 200 cases (Aa 129 & Ab 71), group B: 45 cases and group C included 24 cases (Ca18 & Cb 6). Systemic complications included 9 episodes of hyper-cyanotic spells (Gp Aa 3, Ab 4, B2), transient Arrhythmias (Aa 1, 2 Ab, 2B) and a transient cardiac arrest (Gp B). The group percentage of local vascular complication in group B as 22.2%, group C 12.5%, group Ab 8.4% and none in group Aa.

Conclusion: Prograde cardiac catheterization for TOF is safe and preferable option in most cases.

Key Words: Congenital heart defects,Tetralogy of Fallot, Cardiac catheterization.

INTRODUCTION

Tetralogy of Fallot (TOF) with right ventricular outflow tract obstruction (RVOTO) is one of the most common cyanotic congenital heart disease (CHD) 1-3, easily diagnosed with 2D-echocardiography with further invasive tests in selected cases 4. Though, in developed countries, the diagnostic cardiac catheterizations for classic TOF with pulmonary stenosis is increasingly becoming rare, attributed primarily to the surgical correction at early age including neonates 5 as well as availability of newer non invasive diagnostic modalities including CT angiography and MRI 6. However, in most developing countries including Pakistan, delay in surgical correction not only leads to increased operative morbidity and mortality but also accounts for significant number of diagnostic caths as diagnostic modalities like 2D-echocardiography is sometimes insufficient in complete delineation of surgical anatomy especially of origin & course of coronary arteries, aortopulmonary shunts and major aortopulmonary collateral arteries (MAPCAs). Though, diagnostic cardiac catheterization for TOF carries low risk of systemic complications 4 but local vascular complications are one of the most common complications especially with larger arterial sheaths, prolonged procedural times and in small children. Though, both venous (prograde) and arterial (retrograde) approaches are used in diagnostic cardiac catheterization for TOF, but there is no data from Pakistan to specifically address this issue with respect to complications, feasibility and outcomes. This prospective study was specifically undertaken to assess the two approaches and to compare the result and complications in patients undergoing diagnostic cardiac cath at our setup (AFIC/NIHD Pakistan) over 18 month of time period.

METHODOLOGY

This study was prospectively conducted at department of paediatric cardiology, armed forces institute of cardiology/National institute of heart diseases (AFIC/NIHD), Pakistan from 01 Dec 2010 to 20 June 2012 after approval of hospital ethical committee. 269 consecutive patients who underwent diagnostic cardiac catheterization for TOF with RVOTO or TOF with absent pulmonary valve syndrome (APVS) were included. Pre-cath assessment included detailed history, physical examination, blood complete picture, chest X-ray and 2-D echocardiography. Basic demographic variables were recorded. All patients were admitted on the same day of cath and written consent was taken. All patients were kept nil per orally for 4-6 hours before cath depending upon age. Small sized children were given general anesthesia for procedure while older children or adults were managed with local anesthesia and conscious sedation. Vascular access was established as per pre procedural decision, either femoral artery or femoral vein or both at the start and the reason for such approach was also recorded. Based upon the vascular access at the start, the patient population was divided into three groups. Group A consisted of cases where only venous access was planned for prograde catheterization, group B consisted of patients where both venous or arterial access (both prograde & retrograde catheterization) were obtained at the start and group C, where only arterial access was chosen for catheterization at the start (Retrograde). Group A & C were subdivided into two sub groups: Group Aa, study completed from venous line only and group Ab where arterial line was subsequently placed for completion of study. Group Ca, study completed from arterial line and group Cb where venous line was subsequently placed for completion of study. In most cases, 5F radial sheaths for femoral artery and 6F for femoral vein were used. Intra-arterial heparin at dose of 25 units per kg given in some cases. In majority of cases the right heart cath was done with National Institutes of Health (NIH) catheter and left heart with pigtail catheter. Complete anatomical assessments included right ventricular (RV) angiogram, RVOT injection, Branch Pulmonary arteries anatomy, left ventricle (LV) angiogram, aortogram and complete delineation of coronary and systemic venous anatomy (Fig 1& 2).

Figure 1: Angiography of pulmonary arteries, aorta, LV & aorta prograde approach

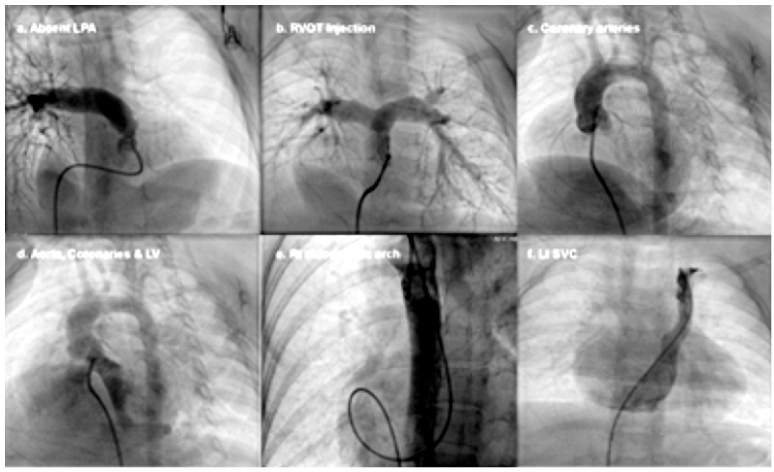
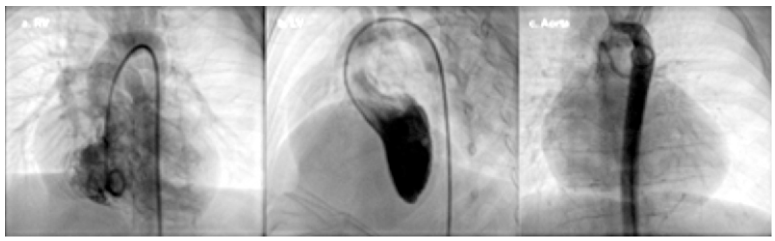


Figure 2: Angiography of RV, LV and aorta from retrograde approach



At the completion of procedure, additional parameters recorded including Flouro time, procedural time, amount of contrast used, reason for changing vascular access plans and status of local vascular access area and pulse noted. Routine care was provided for next 18-24 hours in post cath wards in majority of cases. Cases with absent limb pulse after two hours of procedure were treated with IV heparin 25-50units per kg per hour till recovery. Selected cases of cold limb with Doppler evidence of ischemia were carefully treated with intravenous infusion of streptokinase. Patients were discharged next morning, if no complications occurred and advised follow up after 02 weeks. Data was entered in SPSS 17 and descriptive analysis done along with qualitative tests to compare various variables.

RESULTS

Total 269 patients underwent diagnostic cardiac for TOF with RVOTO/APVS over study period with mean age of 7.7 yrs +/- 7 (range: 10 months- 44 yrs), mean weight of 19.6 +/- 13.5 Kgs, mean height of 107 +/-30 cms and male to female ratio was 1.7:1. The mean procedure time was 29.9 minutes (12-80), mean fluoroscopy time was 8.6 +/- 5.9 minutes and mean amount of contrast used was 77 ml. 179 patients (66%) were given general anesthesia and 127 patients (51%) were younger than 05 years. In 245 patients the underlying anatomy was classic TOF with RVOTO, 22 had TOF with previous palliative aorto-pulmonary shunts while two were TOF with APVS. Additional abnormalities included: 3 cases each of additional patent ductus arteriosus, atrioventricular septal defects variant, dextrocardia, interrupted inferior vena cava (IVC) and one case had situs inversus-dextrocardia. Age distribution in the study population according to vascular access groups is shown in table 1.

Group A: Total 200 cases included as only femoral venous sheaths were inserted at start.

- Sub group Aa: In 129 cases, complete catheterization was satisfactorily performed through venous sheath with no local vascular complications (Fig 1).
- Sub group Ab: In 71 cases, arterial line was subsequently required due to inability to access LV (18) and/or aorta (53) from venous side and in this group transient pulse loss (less than 12 hrs & treated with IV heparin) developed in 06 cases (8.4% of this sub group).

Group B: Total 45 cases included as both venous and arterial sheaths were inserted at the start and procedure completed in all cases satisfactorily. Local vascular complications (22.2%) in this group were: 05 (11%) cases of transient pulse loss of less than 12 hrs needing IV heparin, 01 case of 12-18 hrs pulse loss, 01 case of 24 hrs pulse loss and 03 cases of cold limb needed IV streptokinase to restore circulation.

Group C: total 24 cases included as only femoral arterial sheaths were inserted at start. Local vascular complications in this group were encountered in 12.5% of cases and included: 01 case of transient pulse loss of less than 12 hrs needing IV heparin, 01 case of 12-18 hrs pulse loss and 01 case of 24 hrs pulse loss. However, no systemic

Table 1: Distribution of age in three groups

Age group	Group A		Group B	Group C		Total
	Gp Aa, vein only	Gp Ab: initially vein than artery for completion	Gp B: Both vein & artery electively	Gp Ca: Only artery	Gp Cb: initially artery than vein for completion	
< 2 years	30	12	07	01	00	50
2-5 years	45	21	12	08	02	88
5-18 years	48	23	24	09	04	108
>18 years	06	15	02	00	00	23
Total	129	71	45	18	06	269

Table 2: Comparison of procedural and fluoroscopy time in three groups

	Group A		Group B	Group C	
	Gp Aa, vein only	Gp Ab: initially vein than artery for completion	Gp B: Both vein & artery electively	Gp Ca: Only artery	Gp Cb: initially artery than vein for completion
Mean +/- Sd Fluoroscopic time in minutes	8.0 +/-5.5	11 +/-7.0	6.8+/-3	5.5 +/-4.6	14.5 +/-0.7
Mean +/- Sd amount of contrast used in ml	91+/28	107 +/-41	96 +/-39	89 +/-25	130 +/-99

complications occurred in this group.

- Sub group Ca: In 18 cases, complete catheterization was satisfactorily performed through arterial line (Fig 2).
- Sub group Cb: In 06 cases, venous line were subsequently established due to inability to properly access RVOT and branch Pulmonary arteries anatomy from retrograde RV injection.

In total, 251 cases had venous access with right femoral vein in 96% cases and in 97% cases venous line established in one or two attempts. On the other side, 134 cases required arterial line alone or in addition to venous line and right femoral artery was accessed in 90% cases and no more than two attempts needed in establishing arterial access in 90.7% cases. Table 2 is depicting results of comparison of procedural and fluoroscopy time in three groups.

Systemic complications as associated in study population were: 9 episodes of hyper cyanotic spells during or after cath {Gp Aa 3, Ab 4, B2}, SVT (02 in Gp B), transient Arrhythmias (03 in Gp A) and one patient had cardiac arrest (Gp B) presumably due to air embolism and fortunately recovered with no residua in few minutes. Among local vascular complications, 11 cases with transient pulse loss requiring intravenous heparin for less than 12 hours, 05 cases with transient pulse loss requiring intravenous heparin for 12-24 hours and 04 patients requiring intravenous streptokinase for cold limb and Doppler evidence of ischemia. All these complications encountered in patients younger than six years of age.

DISCUSSION

Unlike developing countries, the diagnostic cardiac cath for classical TOF is still commonly performed in developing country like Pakistan, principally because of age for total correction is beyond infancy in majority of the cases along with availability of more sophisticated noninvasive diagnostic modalities like MRI [6]. The mean age in our study population was 7.7 years and ranging from 9 months to 44 years with male to female ratio of 1.7: 1. This age bracket in itself is quite alarming as this much delay in surgical correction can lead to large number of diagnostic cardiac catheterizations, progressive RV dysfunctions as well as increased morbidity and mortality, at least in comparison to surgery at younger age 7. The diagnosis of TOF is straight forward with echocardiography but accurate assessment of surgical anatomy may mandate invasive tests like cardiac catheterizations in some cases especially in older children primarily to clearly delineate the anatomy of branch pulmonary arteries, coronaries and presence of MAPCAs, with inherent risks of complications, radiation and contrast exposure. Though CT Angiography is superior to Echocardiography in defining anatomy of pulmonary arteries and collaterals 8, but without aid of hemodynamic data. Both prograde (from venous side and through right heart) as well as retrograde (from aorta to both ventricles through aortic over-ride) approaches are used during diagnostic catheterizations of TOF, with their own merits and demerits. Prograde approach carries risk of cyanotic spells with manipulation of the catheter in RVOT and subaortic area while vascular complications are major issue of retrograde approach. In our study, prograde cardiac catheterization accounted for 47.9%, retrograde for 6.7% and remaining 45.3% cases required both retrograde as well as prograde cardiac catheterization to completely delineate the surgical anatomy of TOF. Major systemic complications encountered in 5.6% of cases and included cyanotic spells (9), rhythm problems (5) and brief cardiac arrest (1). A recent report from UK, reported serious complication rate of 23% in their report of 72 cases underwent catheterization for TOF with similar type as of our study 4. The risk of major complications was 3.1% in group Aa, 8.5% in group Ab, 11.1% in group B and none in group C in our patients.

However, the commonest complications of cardiac catheterization are undoubtedly the local vascular assess site complications particularly with prolonged time of arterial sheaths in small children. Patients with TOF had a variety of

hematological problems with tendency to bleed and further compound the local vascular complication after catheterization studies. The group percentage of local vascular complication in our study was highest in group B as 22.2%, in group C 12.5%, in group Ab 8.4% and no local vascular complication occurred in group Aa.

To avoids or at least minimize theses arterial complications, we started cardiac catheterization from venous side (prograde) in 200/269 patients (mean age 7.6 years) and achieved desired results in 64.5% cases, by clear delineation of anatomy and functional status of RV, RVOT, PAs, SVC & IVC, LV, aorta and coronaries (Fig 1). In 129 patients (mean age 6.5 years), study was completed from venous lines only as LV angiograms were performed either by directly crossing from RV or from PFO or in few cases follow through of pulmonary angiogram in levo-phase, satisfactorily visualized LV in smaller children. Aorta was crossed either from RV or LV or in two cases from PDA from venous side. In three cases, aortogram and LV angiogram was abandoned as pulmonary arteries were too small for total correction and was advised modified BT shunts. In 71 cases from group A, arterial access was established to complete the study and reason was inability to go to LV or aorta. The mean age in this subgroup was considerably more than group Aa as 9.5 vs 6.5 years, which may be a factor of failure to access aorta from RV. Group B included 45 patients (mean age 9 years) and study was electively started with both lines for reasons including operator choice, patients with BT shunts, interrupted IVC, dextrocardia, AVSD variant TOF and where MAPCAs were strongly suspected. Obviously study was complete, but its worth mentioning that these patients were having slightly complex anatomy than other two Group, that may have contributed to increase number of complications and procedural time. Group C included 24 patients (mean age 6.1 years) and in 18 cases (75%), study completed from arterial line only along with injection for Left SVC was given from left brachial vein (Fig 2). In six cases, anatomy of RVOT and branch PAs could not be cleared from RV angiogram so venous line was also needed as to clearly visualize RVOT and branch Pulmonary arteries is the fundamental objective of diagnostic catheterization in TOF cases. There were differences in procedural and fluoroscopic times in various groups as maximum in group Cb and minimum in Ca for obvious reasons.

Issue of complete delineation of TOF surgical anatomy before total correction is quite complex especially in older children or adults. The vascular access remains a critical point for starting a successful catheterization. We feel that the venous line should be inserted at the start of cardiac catheterization and after finishing right side, attention should be focused on LV and aorta. PFO to be searched first than aorta should be attempted to cross from RV (anatomy would already be cleared in RV angiogram). If aorta is crossed than on the way down, catheter should be attempted to dip into LV through override. In few cases aortogram from LV injection in AP view can be sufficient especially in small children.

CONCLUSION

In view of no local vascular complication of prograde approach, we recommend that venous vascular access to be established as a first option especially in small children. Retrograde approach to employ, if surgical anatomy is not completely delineated by prograde cardiac catheterization and that to in a very swift manner.

Conflict of Interest

We declare no potential conflict of interest and no financial support for the study.

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