Research Article

Incidence and Management of Vascular Injuries after Invasive Cardiac Catheterization in Children

Arifa Aqil[1], Shaad Abqari[1], Mohammad Mirza Kamran[1]*, Mohammad Azam Haseen[2], Mohammad Moaaz Kidwai[1]

[1]Interdisciplinary Pediatric Cardiac Centre, Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India, [2]Department of Cardiovascular and Thoracic Surgery, Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

Abstract

Background: Vascular injuries after cardiac catheterization are well documented in adult population. The incidence of vascular injuries after pediatric cardiac catheterization is not as well defined. With the advent of therapeutic cardiac catheterization in pediatric patients, the incidence of vascular complications is likely to increase.

Purpose: The aim of the study was to determine the incidence and management of vascular injuries associated with pediatric cardiac catheterization as an initial experience of in a newly established pediatric center.

Methods: This retrospective and observational study was conducted on 268 children with congenital heart disease who have undergone cardiac catheterization either as diagnostic procedure or a therapeutic intervention between March 2018 and August 2019. Patient records were reviewed to obtain demographic, procedural, and treatment data. Patients were analyzed for the incidence and the type of vascular injury seen and treatment given for the same. The type of vascular injury was divided in to major and minor based on severity of the injury.

Results: Diagnostic cardiac catheterization was performed in 77 patients and interventions in 191 patients. A total of 62 (23.1%) patients developed some vascular injury out of which 60 (22.3%) cases had minor complication and 2 (0.7%) had major a complication. The most common type of vascular complication seen in our study was transient loss of femoral pulse.

Conclusions: Vascular injury is common in children undergoing cardiac catheterization, majority of which are minor complications and can be managed conservatively. They are seen more commonly during therapeutic cardiac catheterization. Further studies with larger sample size are needed to identify the risk factors for vascular injury.

Keywords: Pediatric cardiac catheterization, vascular complication, femoral artery, femoral vein, hematoma, thrombosis

Introduction

Cardiac catheterization has revolutionized the management of congenial heart disease (CHD). Although diagnostic catheterizations play an important role, therapeutic procedures are increasingly being done with the availability of safer devices and balloons. Very few studies have been done regarding the vascular injuries in pediatric patients, and most of the available data are from adult studies. Vascular interventional procedure is a relatively safe compared with analogous surgical procedures, with overall major complication rates of <1%.[1] Some centers routinely acquire femoral access under ultrasound guidance.[2] This has shown to decrease the risk of complications by 49% in one published series.[3] Vascular complications related with cardiac catheterization can be divided into major and minor complications. Major complications include pseudoaneurysm, arteriovenous fistula, hematoma requiring

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Address for Correspondence:
Dr. Mohammad Moaaz Kidwai, Interdisciplinary Pediatric Cardiac Centre, 2nd Floor, OBG and Cardiac Block, Modern Trauma Centre, Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India. E-mail: moaaz06@gmail.com

transfusion, retroperitoneal pseudoaneurysm, while minor complications include minor bleeding, transient pulse loss, ecchymosis, and stable hematoma.[4] Embolic complications after catheterization are uncommon but can lead to tissue ischemia.[3-6] Local thrombosis leading to limb ischemia is rare.[6] Femoral access site complications have been reported to range from 0% to 17% in patients undergoing diagnostic and interventional cardiovascular procedures.[1,2,7] It is important for individuals caring for the patient returning from the cardiac catheterization laboratory to be aware of and recognize the various complications that can occur and how they should be treated. This study is done to describe the vascular access site complications seen at our institution.

Methods

The present study was a retrospective and observational analysis done in 268 children, conducted between the period of March 2018 and August 2019. Clinical characteristic and information regarding procedural data were collected for all consecutive patients who underwent cardiac catheterization through femoral artery (FA), axillary artery, femoral vein (FV), and right internal jugular vein. All the procedures were performed by trained pediatric cardiologists. Informed consents were obtained from the parents of children after completely explaining the adverse events of the procedure. Children were prepared and anesthetized according to the unit protocol. Non-invasive monitoring (body temperature pulse oximetry and blood pressure measurement) was done as per the unit protocol.

Vascular site management protocol after the procedure

- All the vascular sheaths were flushed with normal saline before removing them
- After removal, some amount of bleed back is allowed to remove any clots if present
- Then groin compression is applied till the bleeding stops
- Finally, the puncture site is closed with pressure bandage.

Patients were then shifted to the pediatric intensive care unit. Frequent puncture site and femoral pulse monitoring was done. For those patients who developed transient loss of pulse, heparin infusion was given. The patients were kept under monitoring for 24 h for pulse loss/hematoma or any other significant bleeding. Doppler examination was done if there was loss of pulse and surgical intervention was immediately done if there was any evidence if ischemia. Strict monitoring of the vital parameter was done and if there was return of pulse or resolution of hematoma the child was discharged after 24 h of observation in the ward.

Ethics

The purpose and design of the study were explained to the patients or the consenting family members. The parents or consenting family members were informed that they can ask to withdraw from the study at any time without having reasons for the same. The confidentiality of information obtained was maintained and revealed only to doctor/auditor involved in study and to regulatory authorities. The study was conducted on ethical guidelines for Biomedical Research on human subjects given by Central Ethical Committee on human research, New Delhi, in addition to principles enunciated in the "Declaration of Helsinki."

Statistics

Descriptive statistics for categorical variables were reports as frequency and percentages and continuous variables were reported as mean and standard deviation.

Results

A total of 268 children with CHD underwent cardiac catheterization between the period of March 2018 and August 2019. Among those patients, 77 (28.7%) patients underwent diagnostic study and 191 (71%) patients had a therapeutic procedure. As shown in Table 1, eight different types of interventions were done on these children.

In patients with diagnostic study, both FA and FV accesses were taken. During therapeutic procedures, FV was taken in all except one patient in which coil embolization was done for MAPCA (Major aorto pulmonary collateral artery). FA was punctured in only 43 (16%) cases undergoing intervention as shown in table 2. Arterial access was avoided of the therapeutic procedures as we avoid puncturing FA electively in cases with patent ductus arteriosus (PDA) device closure, atrial septal defect device closure, and also Balloon pulmonary valvotomy as a unit policy. Extra access in the form of the left axillary and right internal jugular vein was taken in 2 (0.7%) cases.

A total of 62 (23.1%) patients developed vascular complications in this study out of which 60 (22.3%) cases had minor complication and 2 (0.7%) had developed major a complication as shown in Table 3. It was seen that the incidence of both major and minor complications was more during therapeutic procedures

Table 1: Type of therapeutic procedure

S. No.	Procedures	Number (%)
1.	PDA device closure	81 (30.2)
2.	VSD device closure	59 (22)
3.	ASD device closure	19 (7)
4.	Balloon pulmonary valvotomy	17 (6.3)
5.	Balloon aortic valvotomy	5 (1.8)
6.	Balloon dilation of coarctation of aorta	4 (1.4)
7.	PDA stenting	3 (1.1)
7.	Balloon mitral valvotomy	2 (0.7)
8.	Coil occlusion of PDA	1 (0.3)
	Total	191 (71)

ASD: Atrial septal defect, VSD: Ventricular septal defect, PDA: Patent ductus arteriosus

Table 2: Type of venous and arterial access taken

Access	No. of patients (268)	Percentage
Femoral vein	267	99.6
Femoral artery	43	16
Left axillary artery	2	0.7
Right internal jugular vein	2	0.7

as compared to diagnostic ones (Table 3). The various types of minor vascular complications seen in this study were-FA stable hematoma, prolonged puncture site bleed, and transient loss of FA pulse which was the most common complication seen.

Out of the 60 (22.3%) minor complicationsm 40 (14.9%) patients experienced a transient loss of femoral pulses which required heparin transfusion for <24 h with complete recovery of pulses within 24 h while 10 (3.7%) patients needed heparin infusion for more than 24 h with a maximum of 96 h in one patient and eventually all these 10 cases also recovered completely. As shown in Table 3, minor complications were more in therapeutic procedures as compared to diagnostic study. In this study, only 2 (0.7%) major complications were seen, both of which occurred during interventional procedure and no major complication was seen during diagnostic study. One patient (0.35%), who was taken for ventricular septal defect (VSD) device closure procedure, suffered from the right FA thrombosis requiring surgical thrombectomy and another (0.35%) patient developed right FV tear during intra atrial stenting procedure and required surgical repair as shown in Table 5.

In this study, a total of 77 patients had cyanotic CHD and underwent diagnostic CC. There was no major vascular complication in these patients. Minor complication in the form of transient loss of FA pulse was seen in 12 cases (15%). Only two patients needed heparin infusion for more than 24 h.

Discussion

Diagnostic cardiac catherization is usually indicated in children when there is need for need additional anatomical or physiological data before surgery.[6] In our study, the indications were anatomical assessment of tetralogy of fallot patients, hemodynamic assessment before univentricular palliation, and oximetry study for operability for the left to right shunt lesions. These children usually tend to be of a younger age group and thus more prone for vascular complications. Therapeutic procedure is usually in the form of device closure procedures and in our study, the most common was PDA device closure done in 81 (30.2%) patients followed by VSD device closure done in 19 (7%) patients as shown in Table 1. Avoiding the cannulation of FA as much as possible reduces the occurrence of vascular complications since the vessels are prone for injury.

The advancement in pediatric cardiac catheterization in the recent years has significantly reduced the incidence of vascular access-related complications during diagnostic and therapeutic procedures in children, but it still remains one of the most common complications seen in routine practice.[5] The incidence of vascular complication varies widely from 2.4%[8] in one study to 33% in another.[5] In our study, the overall incidence of vascular complications was 23.1%. Furthermore, the incidence of vascular complications is seen more during therapeutic procedures as compared to diagnostic ones as shown in Table 3, which is also the case in a study done by Mehta *et al*. in 2008.[5] This can be explained by the fact that therapeutic procedures take longer time, may require a larger size sheath, and lots of catheter manipulations. The most common type of vascular complication seen in our study was transient loss of femoral pulse and it was seen that all patients responded to heparin infusion and none of the patients developed permanent loss of pulse. Loss of FA pulse usually occurs because of usage of a larger size femoral sheath or due to prolonged procedure both of which are more commonly seen during an intervention especially in infants. The previous studies have also shown that early initiation of heparin infusion on suspicion of femoral pulse loss leads to complete recovery.[8] Other minor vascular complications seen in this study were FA stable hematoma and prolonged puncture site bleed. To prevent the formation of hematoma, it is important that we flush the sheath before removal and allow bleed back after removal. Stable hematoma is managed by squeezing out the blood clot and then applying groin compression. Prolonged puncture site bleed occurs because of intravenous heparin given during the procedure and is managed by groin compression. Groin hematoma is common complication that can occur shortly after sheath removal. In a study by Castillo-Sang *et al*., it was seen that the incidence of groin hematoma was 14%.[9] Majority of hematomas can be avoided by pressure across the FA puncture site, but it can progress and lead to retroperitoneal bleed.[10]

Major vascular complication was seen in only 2 (0.7%) patients in this study which is in concordance with other studies

Table 3: Complication rate

Type of diagnostic study	Minor complication (%)	Major complication (%)
Interventions	48 (17.9)	2 (0.7)
Diagnostic study	12 (4.4)	0
Total number	60 (22.3)	2 (0.7)

Table 4: Spectrum of diagnostic studies

Type of diagnostic study	No of patients 77 (28.7%)
TOF cath (pre-ICR)	35 (13)
Oximetry for operability	22 (8.2)
Pre-glenn cath	15 (5.5)
Post-ICR TOF Cath	05 (1.8)
Total number	77 (28.7)

ICR: Intracardiac repair, Cath: Catheterization, TOF: Tetralogy of fallot

Table 5: Details of major complications

S. No.	Age/Sex	Wt kg	HB% MG/DL	Sheath size	Procedure	Complication	Treatment
1.	5Y/M	15	12.5	5F	VSD device closure 6MMX4MM	Thrombus AT RFA	Surgical thrombolec-tomy
2.	3.5Y/M	9	16.7	5F	Intra atrial septum stenting	RFV tear	Surgical repair

VSD: Ventricular septal defect, RFV: Right femoral vein

which show the risk to be <1% (1 and 4). FA thrombectomy was needed in one patient only (0.35%) in our study which is similar to a study done by Lin *et al*. in 2001 where 2% of patients needed thrombectomy.[11] The other major vascular complication seen in our study was right FV tear which needed surgical repair. Both of the major complication were seen during therapeutic procedures as shown in Table 4. Surgical thrombectomy has become a rare phenomenon due to the use of heparin and thrombolytic therapy. Lesser weight, longer procedure time, longer puncture time, and larger sheath size are risk factors for thrombosis.[12] Vascular complications can be reduced by doing pre procedure planning to reduce procedure time, avoiding arterial access, if possible, use of smaller sheath size, and use of ultrasound guidance.[13]

Conclusion

Pediatric cardiac catheterization is not free from vascular complications which is seen more during therapeutic procedures. However, fortunately, the incidence of major complications is rare. The most common vascular complication seen in this study was transient loss of femoral pulse. Pre-procedure planning along with post-procedure monitoring of pulse and puncture site reduces the incidence of vascular complications. Further studies are needed to identify the vulnerable population to reduce the incidence of vascular complications.

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Conflicts of Interest

There are no conflicts of interest.

References

1. Cassidy SC, Schmidt KG, Van Hare GF, Stanger P, Teitel DF. Complications of pediatric cardiac catheterization: A 3-year study. J Am Coll Cardiol 1992;19:1285-93.
2. Vitiello R, McCrindle BW, Nykanen D, Freedom RM, Benson LN. Complications associated with pediatric cardiac catheterization. J Am Coll Cardiol 1998;32:1433-40.
3. Zeevi B, Berant M, Fogelman R, Galit BM, Blieden LC. Acute complications in the current era of therapeutic cardiac catheterization for congenital heart disease. Cardiol Young 1999;9:266-72.
4. De Bono D. Complications of diagnostic cardiac catheterisation: Results from 34,041 patients in the United Kingdom confidential enquiry into cardiac catheter complications. The joint audit committee of the British cardiac society and royal college of physicians of London. Br Heart J 1993;70:297-300.
5. Mehta R, Lee KJ, Chaturvedi R, Benson L. Complications of pediatric cardiac catheterization: A review in the current era. Catheter Cardiovasc Interv 2008;72:278-85.
6. Bennett D, Marcus R, Stokes M. Incidents and complications during pediatric cardiac catheterization. Pediatr Anesth 2005;15:1083-8.
7. Tay CL, Tan GM, Ng SB. Critical incidents in paediatric anaesthesia: An audit of 10 000 anaesthetics in Singapore. Pediatr Anesth 2001;11:711-8.
8. Bergersen L, Gauvreau K, Jenkins KJ, Lock JE. Adverse event rates in congenital cardiac catheterization: A new understanding of risks. Congenit Heart Dis 2008;3:90-105.
9. Castillo-Sang M, Tsang AW, Almaroof B, Cireddu J, Sferra J, Zelenock GB, *et al*. Femoral artery complications after cardiac catheterization: A study of patient profile. Ann Vasc Surg 2010;24:328-35.
10. Morris GM, O'Grady EA, Wynn GJ, Davis GK. Retroperitoneal hematoma after diagnostic coronary angiography caused by collateralization of a chronic common femoral artery occlusion secondary to childhood femoral cannulation. Circ Cardiovasc Interv 2009;2:580-1.
11. Lin PH, Dodson TF, Bush RL, Weiss VJ, Conklin BS, Chen C, *et al*. Surgical intervention for complications caused by femoral artery catheterization in pediatric patients. J Vasc Surg 2001;34:1071-8.
12. Bansal N, Misra A, Forbes TJ, Kobayashi D. Femoral artery thrombosis after pediatric cardiac catheterization. Pediatr Cardiol 2021;42:753-61.
13. Vermilion RP, Snider AR, Bengur AR, Beekman RH. Doppler evaluation of femoral arteries in children after aortic balloon valvuloplasty or coarctation balloon angioplasty. Pediatr Cardiol 1993;14:13-8.

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