A COMPARATIVE STUDY OF PEDIATRIC CARDIAC CATHETERIZATION PROCEDURE UNDER GENERAL ANESTHESIA WITH OR WITHOUT FEMORAL NERVE BLOCK

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ABSTRACT

OBJECTIVE

Anesthetic management for interventional cardiac procedures/cardiac catheterization in pediatric patients is challenging. Cardiac anomalies vary from simple to complex congenital cardiac anomalies, shunts may be present at multiple levels and patients may be profoundly cyanotic, may be with ventricular dysfunction. They usually require sedation and analgesia to maintain steady stable state. In adults, such type of procedures can be well managed with local anesthesia.

METHODS

Fifty patients were included in the study. They were randomly divided into two groups- Group A (n=25) patients received femoral N. block along with IV sedation and analgesia while group B (n=25) patients received only IV sedation and analgesia. Both groups were compared for hemodynamics, pain score and requirement of IV anesthetic agents and any complications if come up.

RESULTS

Group A patients required IV ketamine 3.24mg/kg (±0.31SD) as compared to 5.58mg/kg (±1.6SD) in group B, which suggests significantly reduced requirement of IV anesthetic agents in group where femoral nerve block has been given. Hemodynamic parameters remained stable and comparable (no statistically significant variation) Pain score was less in group A patients than group B.

CONCLUSION

It has been observed that Group A patients required less dosages of IV anesthetic agents, with stable hemodynamics and less pain score and sedation score as compared to group B patients.

KEYWORDS

Congenital heart disease, Cardiac catheterization, Sedation, Femoral nerve block.

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INTRODUCTION: The use of cardiac catheterization and angiography as a diagnostic tool was first described in adult human by Cournand[(1)] and in children with congenital heart disease by Bing et al, 1947.[(2)]

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Interventional catheterization was first performed in 1953 by Rubio-Alvaroz to treat pulmonary stenosis.[(3)] In 1958 Smith et al.[(4)] Reported anaesthetic experience with a sedative (lytic) cocktail, widely used and traditional DPT mixture of Demerol (Meperidine), Phenergan (Promethazine) and Thorazine (Chlorpromazine).

The paediatric patients posted for diagnostic or therapeutic cardiac catheterization procedure, range in age from premature neonates to upper limits of paediatric age group. Cardiac anomalies vary from simple to complex congenital cardiac anomalies, shunts may be present at multiple levels, and patients may be profoundly cyanotic and may be with ventricular dysfunction. They usually require

sedation and analgesia to general anaesthesia to maintain steady stable state.

Now a days medications administered for sedation and analgesia include benzodiazepines, propofol, ketamine, opioids, dexemedetomidine etc.[5] Close monitoring of these patients is required. Since in neonates deterioration can be rapid. These patients may be highly sensitive to anaesthetic; hemodynamic instability may ensue. In adults such type of procedure can be well managed with local anaesthesia.[6] Considering all these facts, the present study has been conducted to evaluate the usefulness of femoral nerve block along with IV sedation and analgesics in paediatric cardiac catheterization procedures, to compare requirement of dosage of IV drugs, to compare post procedure sedation, analgesia, and haemodynamics and to observe the safety of femoral nerve block in this age group patients.

MATERIAL AND METHOD: This study was a prospective, observational clinical study for the use of femoral nerve block in paediatric patients undergoing diagnostic or interventional cardiac catheterization in the cath lab at our Institute. The institutional ethics committee approved study protocol and enrolled patient's parents gave written informed consent. Study included a total number of patients-50, aged between 2-10 years and weighed between 6-25 kg. They were randomly divided into two groups- group A (n=25) and group B (n-25), Group A patients received femoral nerve block along with IV sedation and analgesia, while group B patients received only IV sedation and analgesia. Procedures included in the study were diagnostic procedure and interventional cardiac procedures (Table-1).

A	**Diagnostic catheterization**
B	**Interventional catheterization**
	• Pulmonary artery angioplasty
	• Aortic coarctation of aorta
	• Patent ductus arteriosus (PDA) occlusion or stenting
	• Ventricular septal defect closure
	• Atrial septal defect closure
	• Atrial septal defect dilation
	• Balloon atrial septostomy
	• Aortic valve dilation
	• Pulmonary valve dilation
	• Mitral valve dilation
	• Stent in pulmonary vein

Table 1: Common procedures in catheterization laboratory

All patients were monitored for heart rate, respiratory rate, SpO_2, temperature with multipara monitor and Ramsay sedation score Table 2[5] and Wong-Baker FACES Pain Rating Scale (Figure 1).

Score	Ramsay Score
0	Awake, Oriented
1	Agitated, Anxious
2	Awake, Co-operative
3	Sleeping but co-operative
4	Deep sedation, quick reaction to pain stimulation
5	Deep sedation, slow reaction to pain stimulation
6	Deep sedation, no reaction to pain stimuli

Table 2: Ramsay Score

Fig. 1

All children were given O_2 supplementation with 5 litres O_2 via ventimask. Premedication was given in both the groups in the form of inj. glcopyrollate 0.004 mg/kg with inj. midazolam 0.1 mg/kg IV on arrival in the cath lab. In both the groups, patients received sedation and analgesia in the form of inj. ketamine 2 mg/kg IV along with inj. propofol 0.5 mg/kg IV and inj. ketamine 1 mg/kg IV repeated as and when required. The goal was to obtain a Ramsay Score of 6 in spontaneously breathing patients during procedure[7,8] (Table 2). In group A, patients received femoral nerve block in addition to sedative and analgesics. In group B in all patients puncture site was infiltrated with a local anaesthetic by the cardiologist.

Technique of Femoral Nerve Block: After induction of anaesthesia, femoral nerve block was performed with patients in supine position; and the skin was prepared with aseptic solution. The femoral artery was palpated one cm below the inguinal ligament with the nondominant hand placed firmly on the artery, a 1.25 cm, 23 G needle, attached to an extension tube set-up and a 20 ml syringe, was inserted 1 cm lateral to the artery at a 90º angle to the skin and underlying vessel. The needle was advanced and two definite "pops" were felt. When the needle penetrates first the fascia lata and then the iliac fascia, the needle pulsates laterally or paraesthesia elicited, and then it was withdrawn a few millimetres. After aspiration, to reduce the risk of intravascular injection, the measured amount of local anaesthetic agent was injected. The anaesthetic will diffuse around and into the nerve bundle to achieve analgesic effect. The agents used for femoral nerve block were, inj. xylocaine (2%) with adrenalin 4 mg/kg with inj. Sensorcaine (0.5%) 1 mg/kg.[9]

RESULTS: The data from all 50 patients were included in statistical analysis. The two groups were comparable with respect to demographic data and duration of procedure (Table 3).

Parameter	Group A	Group B
Age (Mean±SD)	7.82±4.97	5.98±3.89
Height (Mean±SD)	109.29±25.37	108.53±35.37
Weight (Mean±SD)	19.75±10.69	13.71±6.86
Time of Procedure	39.58±16.34	37.25±12.65

Table 3: Demographic data

Wong-Baker Faces Pain Rating Scale was measured for all the patients in both the groups at various time interval.

At different time period	Group A	Group B	P value
After femoral puncture	1.23±1.06	3.20±1.22	<0.001
10 min	0.36±0.58	3.04±1.39	<0.001
20 min	0.45±0.75	2.76±1.39	<0.001
30 min	0.11±0.33	2.67±1.58	<0.001
60 min	0.25±0.5	4±0	<0.001

Table 4: Pain score during Procedure

Table 4 shows the comparison of pain scores-immediately after femoral puncture, 10 min, 20 min, 30 min, & 60 min after onset of procedure in both the groups. It is observed that, there was significant decrease in pain score in group A patients as compared to group B patients at all-time intervals.

At different time period	Group A	Group B	P value
After Shifting (Mean ±SD)	0.46±0.658	1.48±1.04	<0.001
15 min (Mean±SD)	0.50±0.59	1.56±1.22	<0.001
30 min (Mean±SD)	0.21±0.41	2.60±1.19	<0.001
60 min (Mean±SD)	0.08±0.408	3.20±1.19	<0.001
4 hrs (Mean±SD)	0	2.20±1.47	<0.001

Table 5: Pain score after Procedure

Table 5 shows the pain scores in post-procedure periods-immediately after shifting, 15 min, 30 min, 60 min and 4 hours post-procedure. It was observed that there was significant reduction in pain score in group A patients as compare to group B patients.

At different time period	Group A	Group B	P value
After Shifting (Mean ±SD)	3.16±0.81	4.64±0.63	<0.001
15 min. (Mean ±SD)	2.62±0.92	4.08±0.57	<0.001
30 min. (Mean ±SD)	2.25±0.607	3.40±0.95	<0.001
60 min. (Mean ±SD)	1.91±0.28	2.00±0.91	0.667
4 hrs. (Mean ±SD)	2.00±0.00	1.92±0.57	0.49

Table 6: Sedation

Ramsay sedation score was recorded in all the patients after shifting in paediatric ICU (PICU) (Table 6), It is observed that, there was significant differences in sedation score after shifting, 15 min & 30 min post procedure in group A & group B while at 60 min and 4 hours after procedure, there was no significant differences in sedation score was observed in both the groups.

Procedure			
Variable	**Start Procedure**	**End procedure**	**p value**
HR (Mean±SD)	124.8±27.38	115.71±20.15	0.002
SpO2(Mean±SD)	90.75±2.54	94.45±9.06	<0.001
RR (Mean±SD)	24.08±6.19	23.30±5.98	0.156
Post Procedure			
HR (Mean±SD)	111.79±20.37	105.38±17.47	0.004
SpO2 (Mean±SD)	95.29±8.85	95.42±7.90	0.757
RR (Mean±SD)	24.08±6.19	23.21±6.05	0.152

Table 7 (a): Group A

Table 7 a shows the hemodynamic parameters during procedure & after shifting the patients in PICU in group A. There is significant reduction in HR at the end of procedure as compare to beginning of procedure. Similarly, HR also decreased at the time of arrival of patients in PICU as compared to the end of 4 hour. Spo2 increased significantly at the end of the procedure than start of procedure, while it remained almost unchanged in PICU course. There was no significant change in respiratory rate during procedure or post procedure.

Procedure			
Variables	Start Procedure	End procedure	p-Value
HR (Mean±SD)	127.12±25.79	127.59±17.36	0.862
SpO2 (Mean±SD)	89.64±7.43	94.48±6.00	<0.001
RR (Mean±SD)	23.48±0.22	29.30±0.28	<0.001
Post Procedure			
HR (Mean±SD)	121.44±23.74	119.11±20.14	0.246
SpO2 (Mean±SD)	94.64±7.25	95.44±6.57	0.02
RR (Mean±SD)	27.20±8.45	28.54±9.33	0.032

Table 7 (b): Group B

Table 7b shows hemodynamic parameters during procedure & post-procedure in group-B. There was no significant change in HR at the start of procedure, end of procedure & post procedure period. Spo2 increased significantly during procedure period.

	Group A (Mean±SD)	Group B (Mean±SD)	Significance
Duration of procedure	39.58±16.34	37.25±12.65	0.575
Total requirement of Ketamine (mg/kg)	3.24±0.31	5.58±1.6	<0.001

Average pain score during procedure	0.59±0.8623	3.00±1.3475	<0.001
Average pain score post-procedure	0.30±0.5591	2.208±1.3754	<0.001

Table 8: shows comparison of requirement of Ketamine, duration of procedure & mean pain score during procedure & mean pain score post-procedure in both the groups

Respiratory rate increased significantly in post-procedure period. (Table 8)

DISCUSSION: Placement of trans venous and trans arterial catheters into the heart and great vessels (cardiac catheterization) in paediatric patients allows determination of cardiac anatomy, Ventricular function, valvular anatomy and pulmonary vascular anatomy, pressure measurements in cardiac chambers and vascular structure determine location of shunts by taking blood samples at various areas. Although much of this information can be obtained with echocardiography, cardiac catheterization remains the gold standard for detailed diagnosis of complex cardiac anatomic anomalies. In order to the hemodynamic and shunt calculations to be valid, a relatively constant cardiovascular and respiratory state is necessary.[10,11] The significant advance in trans catheter technology, and favourable late results of devices, make it increasing use of catheter closure and become the treatment of choice for many intervention cardiac catheterization in paediatric patients. Anaesthetic technique routinely used in these cases range from sedation and analgesia to general anaesthesia and "steady stable state" must be maintained. Although drugs used for sedation, analgesia and anaesthesia are known to be vasoactive themselves at various doses each can have unwanted side effects.

The use of regional anaesthesia is increasingly common in paediatric practice.[12] The femoral nerve block is a basic nerve block, easy to master, carries a low risk of complications and has a significant clinical applicability for surgical anaesthesia of the entire anterior thigh and most of the femur and knee joint. The block also confers anaesthesia of the skin on the medial aspects of the leg below the knee joints. Femoral nerve arises from 2nd, 3rd and 4th lumber nerve and supplies-muscular branches of the iliacus and pectineus and the muscles of anterior thigh, cutaneous filaments to the front and inner side of the thigh, leg and foot, articular branches to hip and knee joint. This block is well suited for surgery on anterior thigh, knee, and quadriceps tendon repairs, post-operative pain management after femur and knee surgery, the success rate of the block for surgery is very high, nearing 95%.[13]

In cath lab, interventional cardiac procedures in paediatric patients require conventional sedation and analgesia to keep patients steady stable and often demands higher dosage of sedative and analgesic which may lead to respiratory depression, extended post procedural sedation. Considering these facts, femoral nerve block has been used along with G/A.

Analgesic Efficacy: group A patients require IV ketamine 3.24mg/kg (±0.31SD) as compared to 5.58 mg/kg (±1.655 D) in group B which suggest significant reduction in requirement of IV anaesthetic agents in group A while Wong-Baker faces pain rating scale, was significantly less in group A as compared to group B at all-time interval during procedure and up to 4 hours post procedures.

Post-procedure Ramsay sedation score was between 2 to 3 in group A patients while in group B it is between 1.5 to 4.5 (Ramsay score 2 & 3 are best for post-op period)

There is significant reduction in HR at the end of procedure & the post procedure period, but within physiological limits, as compared to beginning of procedure. This can be explained due to effect of sedation & analgesics, otherwise haemodynamics remained stable in both the groups. There is no significant change in respiratory rate during procedure or post-procedure in group A, while group B there is significant increase in respiratory rate during procedure and post procedure period, which indirectly suggests the some amounts of pain in group B patients, explained by higher pain score in group B patients.

At the end of procedures, the femoral sheaths are removed which requires compression of puncture site for prolong period of time (due to effect of heparinization during procedure). Patients may not require extra sedation, analgesia in post-procedure paediatric intensive care unit for removal of femoral sheaths in group A where femoral nerve block has been given.

CONCLUSION: Femoral nerve block is safe and effective as an adjuvant to sedative and analgesics in paediatric patients undergoing diagnostic or interventional cardiac catheterization procedures. The success rate is very high with minimal or no complications if performed properly. Some older paediatric patients may not require any intravenous sedation or analgesia, and can be managed with only femoral nerve block.

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