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COMPLICATIONS IN CARDIAC CATHETERIZATION AND ANGIOCARDIOGRAPHY IN INFANTS AND CHILDREN – PROSPECTIVE STUDY

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Abstract – Prospective study of complications in cardiac catheterization and angiocardiography comprised 411 infants and children consecutively entered into the study protocol in the period from January 1, 1987 to October 30, 1989. The patients were observed for 48 hours after an invasive procedure and complications were recorded for each patient. There were 46 complications noted in 40 patients. Overall complication rate was 11.2%. However, if only diagnostic procedures were examined their overall rate was 7.5% which compared favorably with other studies. Major complications were more frequent in high-risk group than in low-risk group of patients ($P < 0.01$). There were 3 deaths (0.78%), but only one death could be attributed directly to catheterization procedure. The most frequent complications were arrhythmias (58.6% of all complications); these were encountered more often in infants than in older children ($P \geq 0.01$). Each laboratory should keep a continuous record of their activities and complication rates because the introduction of newer procedures, especially in the field of interventional catheterization, might increase the complications and alert the physician to change, improve or even abandon the procedure.

UDC: 616.12-089.819.1-061-053.2

Key words: heart catheterization–adverse effects, angiocardiography–adverse effects, child

Orig sci paper

Radiol Iugosl 1990: 24: 131-5.

Introduction – Retrospective review of the complications in 1074 infants and children catheterized in our hospital from January 1, 1981 to December 31, 1985 revealed the overall complication rate of 5.2% (1). The major drawback of that retrospective study might be inaccurate data collection and even possible loss of some cases.

The aim of the present report is to present data of the cardiac investigation with the advantage of more exact data collection.

Materials and methods – In the period of January 1, 1987 to November 30, 1989 we performed 411 cardiac catheterizations. The infants were sedated with the mixture of chlorpromazine, promethazine, and pethidine. Ketamine was used in older children as reported in a previous paper (1). Percutaneous technique of catheter entry into the femoral vein was used in 315 cases, cut down of great saphenous vein was performed in 66 cases, of femoral vein in 13 cases, and of cubital vein in 4. The umbilical vein was entered in 5 infants. The Femoral artery was punctured in 74 patients, and the axillary artery in 4. The way of entry was chosen by preference of different the investigator, but cut down was also sometimes performed if puncture of the vein failed. 100 U/kg of heparin was administered intravenously immediately after the introduction of sheath or catheter into the artery. All patients received solution of heparin 5 U/ml of of 5% glucose for flushing the catheter.

The modification of classification of the severity of illness described by Stanger and associates was used in the same way as in the retrospective study (2):

A. Asymptomatic patients – without distress, cyanosis, hypoxemia, and congestive heart failure.

B. Slightly ill patients – without distress, noncyanotic, mildly hypoxemic (pO2 > mmHg), or with controlled heart faillure.

C. Moderately ill patients – hypoxemic (pO2 < 25 mmHg), but without acidosis, or with severe congestive heart failure that is only partly controlled with digitalis and diuretics.

D. Critically ill patients – with one or more of the following:

- ventilatory assistance
- acidemia
- poor peripheral perfusion and cardiogenic shock.

Apart from this classification, high and low risk groups were identified prior to catheterization according to previous experience with the rate of

Received: December 20, 1989 – Accepted: February 17, 1990.

complications in the retrospective study (1). Patients were allocated to high-risk group if younger than 4 months and/or moderately or critically ill.

All the infants and children were observed for the complications during the invasive procedure and were routinely examined immediately, 1, 4-6, 24 and 48 hours after the procedure.

Detailed data on each invasive procedure were entered into the patient file. Partiuclar attention was paid to age, clinical status prior to catheterization, medications, site of entry of the catheter, type and size of the catheter, route of the catheter, and volume, rate, and site of injection of contrast medium. Final diagnosis was recorded after reviewing of all the noninvasive and invasive data. The nature, time of appearance, clinical outcome and therapy employed were described for each complication. Table 1 shows age distribution and clinical status of patients prior to catheterization.

was 11.2%. Table 2 shows major and minor complications. Percantage of all complications related to cardiac diagnosis is presented in Table 3.

Interventional procedures were performed in 37 infants and children which represented 9% of all the invasive investigations which represented a major increase in comparison with the retrograde study where only 1.5% of such procedures were performed. It was interesting to note that 32% of all complications occurred during the interventional procedures, and thus their rate was significantly higher than in diagnostic catheterizations ($P < 0.01$). If only complications in diagnostic procedures were examined their rate was e 7.5%.

Almost all complications related to the procedure itself occurred during the invasive investigation and the prolongation of observation to 48 hours did not increase the number of complications.

Table 1 – Age distribution and clinical status of patients

Age groups	Number of patients A	B	C	D	Total
< 1 week	3	10	1	0	14
1 week to 1 month	2 2	8 8	9 9	3 3	22 22
1 month to 2 months	2	4	2	0	8
2 months to 4 months	6	8	2	0	16
4 month to 1 year	75	22	4	3	104
1 year to 4 years	99	10	0	0	109
4 years to 15 years	116	7	0	0	123
> 15 years	14	1	0	0	15
Total	317	70	18	6	411

A = asymptomatic, B = mildly ill, C = moderately ill, D = critically ill

For the sake of comparison, major and minor complications were divided in categories used by Stanger and associates (2), Cohn and associates (3), and in the retrospective study (1).

Chi – square test was used to test the difference between the age groups, high and low risk groups, and diagnostic and interventional catheterizations.

Results – Among 411 patients 40 suffered from 46 complications. Overall complication rate

Major complications – 60.9% of all complications. The rate of major complications was highest in the age group 1 week 1 month (Table 4). It dropped sharply after 4 months of age ($P < 0.01$). They were also more frequent in the high risk group ($P < 0.05$).

Death within 48 hours of catheterization occurred in 3 patients (0.73%). The first patient was an 11-month-old girl with complete form of atrioventricular septal defect and pulmonary hyper-

Table 2 – Major and minor complications

Major complications	Minor complications
1. Death within 48 hours – 3	1. Arrhythmias not requiring treatment or termination of catheterization – 9
2. Arrhythmias: any arrhythmia reguiring treatment or termination of catheterization – 18	a. Supraventricular tachycardia – 4
a. Cardiac standstill – 0	b. Sinus bradycardia – 3
b. Ventricular fibrilation – 1	c. 3 AV block – 2
c. Ventricular tachycardia – 0	2. Burst of Rashkind balloon catheter – 3
d. Supraventricular tachycardia – 4	3. Arterial problems – 1
e. Atrial fibrilation or flutter – 2	4. Allergic urticaria – 1
f. Sinus bradycardia – 7	5. Myocardial staining – 1
g. 2 AV block – 0	6. Bleeding without transfusion – 2
h. 3 AV block – 4	7. Burst of balloon during dilation of aortic recoarctation – 1
3. Profound hypotension – 0	
4. Arterial problems – 1	Total 18
5. Perforation of the heart or vessel – 1	
6. Catheter problems – 0	
7. Serious infection – 0	
8. Serious allergic reaction – 0	
9. Embolism – 0	
10. Cardiac complications	
a. Myocardial infarction – 0	
b. Pulmonary edema – 0	
c. Hypoxic spells requiring morphine, bicarbonate or oxygen – 1	
11. Serious bleeding – 3	
a. Surgical intervention – 1	
b. Transfusion – 2	
12. Pneumothorax – 0	
13. Other – 0	
a. Respiratory arrest – 1	
Total – 30	

2 AV = second degree atrioventricular block; 3 AV = third degree atrioventricular block

Table 3 – Major and minor complications

Age groups	Number of patients	% of major	% of minor
< 1 week	14	21.4	28.5
1 week to 1 month	22	40.9	4.5
1 month to 2 months	8	12.4	37.4
2 months to 4 months	16	18.6	6.3
4 months to 1 year	104	7.7	2.9
1 year to 4 years	109	0.9	2.7
4 years to 15 years	123	2.4	1.6
> 15 years	15	0.0	6.7

tension. At the time of catheterization the right iliac artery was perforated with the wire and dilator. Signs of hypovolemic shock developed due to bleeding which was confirmed by ultrasound examination of the abdomen. Surgical reconstruction of the iliac artery failed and the infant died 10 hours after catheterization. The second death occurred in a 1-month-old infant with transposition of the great arteries and pulmonary stenosis, who was referred to our hospital in critical condition. There were signs of heart failure and he was in severe acidosis prior to catheterization. During the attempt to pass Rashkind atrioseptostomy catheter into the left atrium complete atrioventricular block developed which reverted spontaneously into the sinus rhythm. The atrioseptostomy failed because the catheter could not be introduced into the left atrium. Surgical septectomy was planned but the child died 12 hours after the invasive procedure. This death was considered to be the consequence of the disease itself and of the failure to do Ras-

Table 4 – Percantage of complications and cardiac diagnosis

Diagnosis	Number of patients	%
Ventricular septal defect	70	4.2
Tetralogy of Fallot	53	11.3
Atrial septal defect	27	3.7
Coarctation of the aorta	26	15.3
Transposiltion of the great arteries	49	36.7
Patent ductus arteriosus	15	0.0
Pulmonary stenosis	21	0.9
Aortic stenosis	31	0.6
Univentricular heart	17	0.5
Atrioventricular septal defect	29	10.3
L-tranposition of the great arteries	5	0.0
Tricuspid atresia	10	1.0
Pulmonary atresia	5	0.0
Double outlet right ventrticle	12	0.8
Normal children	1	0.0
Postoperative catheterization	14	0.7
Aortopulmonary window	2	50.0
Total anomalous pulmonary drainage	4	25.0
Miscellaneous	20	0.5

hkind atrioseptostomy. The last death occurred in a 9-month-old infant 48 hours after the invasive procedure. The infant was in heart failure and had severe valvular aortic stenosis and mitral regurgitation. The death and the invasive procedure were probably not directly interconnected.

Perforation of the heart during an attempt of balloon valvuloplasty of critical pulmonary valvular stenosis in a 19-day-old infant was without serious consequence, and valvuloplasty was successfully accomplished a week later (4).

Hypoxic spell in an infant with tetralogy of Fallot resolved after administration of bicarbonate and morphine.

Serious bleeding from the femoral vein when cut down technique was used required blood transfusion in 2 infants with transposition of the great arteries.

A newborn infant 12 days of age with transposition of the great arteries and ventricular septal defect suffered from apnea immediately after intravenous injection of diazepam. He was intubated and ventilated and cardiac catheterization was than performed without further complications.

Arrhythmias were the most common complications (table 5) and they represented 58.6% of all complications. 75% of all arrhythmias occurred in infants, their number being significantly higher than in older children ($P < 0.01$). Therapy was necessary in 63% of arrhythmias and was always successful.

Minor complications – 39.1% – As in major complications, also here arrhythmias were encountered most frequently (table 5).

There was a loss of arterial pulsation for 6 hours in a 11-month-old girl weighing 7 kg after introduction of F5 pig-tail catheter into the right femoral vein.

Rupture of Rashking atrioseptostomy balloon catheter was noticed 3 times without embolization. In a 4-year-old boy with coarctation of the aorta the balloon of dilation catheter burst in a attempt of relieving the coarctation. The event entailed no consequences.

Two minor bleeding episodes from femoral vein cut down occurred not requiring blood transfusion.

Only one allergic reaction to contrast medium in the form of mild urticaria was noted.

Injection of contrast medium into the myocardium of the right ventricle with F6 NIH catheter in

Table 5 – Arrhythmias

Type	Number
Supraventricular tachycardia	8
Sinus bradycardia	10
Atrioventricular block 3 rd degrec	6
Atrial flutter	2
Ventricular fibrillation	1

a child with tetralogy of Fallot occurred and resolved after 5 minutes.

Discussion – At the time of this study the average number of catheterizations per year was f140 cases in comparison to 215 at the time of the retrospective study, which represented 35% reduction. This decrease was a consequence of the introduction of better echocardiographic equipment, and acceptance of some simple cases of congenital heart defects by a surgeon to operate on without prior invasive investigation. The complication rates of major and minor complications int his prospective study was hither than in the retrospective one ($P < 0.01$), but lower than in the report of Stanger and associates (1, 2). However, if only the rate of complications in diagnostic procedures were taken into account, their rates were comparable to the reports of others (2, 3, 5, 6). The reason for higher overall complication rates was thus a higher proportion of interventional procedures in the present study. This inctease could be ascribed the earlier referral of newborns with transposition of the great arteries for Rashkind atrioseptostomy, and the introduction of new techniques such as balloon pulmonary valvuloplasty, dilation of recoarctation of the aorta and Blalock-Taussig anastomosi, closure of Blalock-Taussig anastomosis and major aortopulmonary collateral arteries.

As in the retrospective study, higher rate was noted in high risk group. The arrhythmias again prevailed among the complications and they were more frequent in infants. The arrhythmias were quickly reverted to sinus rhythm by rather simple therapeutic interventions.

Three deaths occurred, but only one death with perforation of the external iliac artery could be attributed to the catheterization procedure itself. Both other infants died because of the severity of cardiac anomaly and the cases could be judged as pseudocomplications (7).

Conclusion – Complication rates of diagnostic catheterization procedures compare favorably with previous reports. However, the introduction of therapeutic procedures has increased the overall rate of complications. Standards for individual cathetrerization laboratory need to be continuously re-evaluated. The new procedures must be taken into account. The evaluation should focus on the type of procedure performed and the age and clinical status of patients.

Acknowledgment – I wish to thank Dr D. Fettich and Dr D. Bartenjev for performing some of the invasive diagnostics.

This study was partly supported by the Research Community of Slovenia.

Izvleček

ZAPLETI SRČNE KATETERIZACIJE IN ANGIOKARDIOGRAFIJE PRI NOVOROJENČKIH, DOJENČKIH IN OTROCIH – PROSPEKTIVNA ŠTUDIJA

Pri 411 bolnikih smo opazovali pojav zapletov pri srčni kateterizaciji in angiokardiografiji s prospektivno študijo v času od 1. 1. 1987 do 30. 11. 1989. Opazovali smo jih 48 ur in zaplete vpisovali za vsakega otroka. Naleteli smo na 46 zapletov pri 40 otrocih. Vseh zapletov je bilo 11.2%. Če smo upoštevali le diagnostične kateterizacije je bilo zapletov 7.5%, kar se dobro sklada z drugimi študijami. Večjih zapletov je bilo več pri visoko rizični kot pri nizko rizični skupini ($P < 0.01$). Trije otroci so umrli (0.78%), vendar bi le eno smrt lahko neposredno pripisali sami kateterizaciji. Najpogostejši zapleti so bile aritmije (58.6% vseh zapletov). Nanje smo naleteli pogosteje pri dojenčkih kot pri večjih otrocih ($P < 0.01$).

Vsak kateterizacijski laboratorij naj bi stalno spremljal število zapletov, ker uvedba novih preiskav posebno še na področju intervencijskih kateterizacij, lahko poveča število zapletov. To lahko opozori zdravnika, da spremeni, izboljša ali celo opusti kakšno preiskavo.

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