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Cardiac arrest in the early stage of cardiosurgical procedure

Unfortunately the wonderful advance observed in cardiac surgery over the last few years, especially in low-invasive techniques, has not excluded potential risks connected with surgical treatment of various cardiac diseases. Modern cardiac surgery and cardioanesthesiology can offer therapeutic possibilities for very advanced cardiac pathologies decreasing ejection fraction, and for patients with severe concomitant diseases such as obstructive pulmonary disease, renal insufficiency, generalized arteriopathy or neurological risks. Age of cardiac surgical patients increases as well as mean age of population.

Every stage of procedure performed with extra-corporeal circulation (ECC) can be complicated by rhythm disturbances which sometimes induce to intraoperative cardiac arrest (ICA). Our intention was to evaluate the possible risk factors of pre-ECC ICA and estimate if pre-ECC ICA increases postoperative complications rate.

MATERIAL AND METHODS

Between July 1998 and December 2001 the total number of 1,288 patients underwent cardiac surgical procedure with ECC in our institution. Pre-ECC intraoperative cardiac arrest (ICA) has occurred in 28 (2.2%) of them. The mean age of patients was 54.7 (34–79 years), 21 of them were male and seven female.

Retrospective analysis of records of these cases included main and concomitant diseases, kind of surgery with its course and further postoperative complications with statistical analysis performed with Statistica 5.0 software.

RESULTS

In 20 patients (71%) CABG was a planned procedure and in the remaining ones eight heart valve procedures had been planned (Table 1). In the subgroup with coronary artery disease (CAD) eight patients (35%) had left main stenosis. Thirteen patients (46.4%) suffered from myocardial infarction in the past, one underwent gastrectomy, in seven cases arterial hypertension, in five severe arteriosclerosis in lower extremities, in two chronic renal failure and in one diabetes, were concomitant diseases. A year earlier one patient underwent PTCA procedure of three vessels and still previously CABG, after which three venous grafts had closed with the remaining patent LIMA-LAD graft.

In all the 28 cases ventricular fibrillation was a cause of pre-ECC ICA and all the patients required indirect and/or direct cardiac massage to the moment of ECC start. ICA was the most frequent during sternotomy (eight cases), pericardium opening (seven cases) and harvesting of left internal mammary

Table 1. Indications for surgical treatment

Indication	n	(%)
Coronary disease:	20	
stable CCS II	4	(20 %)
stable CCS III	5	(25 %)
unstable	10	(50 %)
acute myocardial infarction	1	(5 %)
Valve disease:	8	
aortic	1	(12.5 %)
mitral	1	(12.5 %)
mitro-aortic	3	(37.5 %)
mitro-tricuspid	1	(12.5 %)
mitro-aorto-tricuspid	1	(12.5 %)
aortic + coronary disease	1	(12.5 %)
Heart failure:		
NYHA II	3	(37.5 %)
NYHA III	3	(37.5 %)
NYHA III / IV	1	(12.5 %)
NYHA IV	1	(12.5 %)

artery (LIMA). In three cases pre ECC ICA occurred during patient draping, in three – during skin opening, in one – during manipulations around superior cava vein and in one very early during jugular vein cannulation at the beginning of anesthesia.

Trials of reinstatement of hemodynamically effective heart rhythm have failed and in all cases chest opening and/or cannulation and ECC institution have been achieved during heart massage. Surgical procedures performed during ECC are presented in Table 2.

Table 2. Performed surgical procedures

Procedure	n
CABG (no of grafts):	20
1	1
2	2
3	8
4	6
5	3
Valve procedure:	8
aortic	1
mitral	2
mitro-aortic	3
mitral + tricuspid reconstruction	1
aortic + CABG (one graft)	1

In 16 cases (57.1%) prolonged reperfusion was necessary after declamping of the aorta, and in two (7.2%) of these cases ECC re-entry was needed. Eight patients (28.6%) have died, including one (3.6%) intraoperative death. In 14 cases (50%) low output syndrome has been developed requiring in intra-aortic balloon pump (IABP) implementation in seven (25%) cases (Table 3). In two cases IABP introduction was impossible for severe arteriosclerosis of iliac and femoral arteries. Perioperative deaths and other severe complications are presented in Table 3.

Table 3. Perioperative complications

Complication	n (%)
Death	4 (28.6%)
intraoperative	1
in the first post-op day	6
between 1 st -30 th post-op day	1
Low output syndrome	14 (50%)
IABP	7
Prolonged mechanical ventilation (> 48 h)	4 (14.8%)
Perioperative myocardial infarction	5 (18.5%)
Neurological complications:	9 (33.3%)
hemiparesis	3
psychosis	4
other	2
Resternotomy for:	5 (18.5%)
bleeding	2
unstable sternum	3

Mortality in the investigated group was significantly higher than in the total group of 1,288 patients (28.6% vs. 7.4%, $p < 0.01$) as well as the rate of severe complications such as perioperative myocardial infarction, low output syndrome or neurological complications (18.5% vs. 4.3%; 50% vs. 16.7%; 33.3% vs. 20.1% respectively; $p < 0.01$). Resternotomy, performed in five patients was also more frequent than in the whole group of patients (18% vs. 4.6%, $p < 0.05$) – Table 3.

DISCUSSION

The last decade of the 20th century gave an impressive development of modern cardiac diagnostic and therapeutic methods. Surgical treatment remains, however, a very important part of heart diseases therapy. Cardiac surgeons are operating on patients who are older and in worse condition than in the past. Mean age of cardiac surgical patients is higher than 65 and patients older than 80 are operated on.

Nowadays even advanced stage of heart or concomitant diseases (low left ventricle ejection fraction, severe arteriosclerosis, previous myocardial infarctions, pulmonary, renal or metabolic diseases) are not direct contraindication for surgical treatment. Many preoperative risk scales are being used around the world, descriptive such as CARE or multifactor such as, used also in Poland, EuroSCORE, Parsonnet or Tuman scales (1, 2, 4, 6, 7).

The Task Force commission has also proposed risk assessment objectification (3). All these 'universal' scales can be affected by regional factors so we think that the local version of these scales should be processed in Poland just as it was in the United Kingdom (5).

Our effort to find risk factors of pre-ECC ICA were stimulated by the absence of this problem in current literature. Unfortunately, we have not found any certain risk factor of pre-ECC ICA. In our patients ICA was occurring in either non-stable or stable angina, single or multiple valve disease, NYHA-II and NYHA IV patients.

Ventricular fibrillation contributing to ICA was occurring in any moment of the procedure, however most frequently during sternal or pericardial opening suggesting possible reflex etiology. We have found that pre-ECC ICA increases, in comparison with our whole population of patients, postoperative mortality and complication risk. Low output syndrome, which developed in 50% of patients forced us to IABP implementation in half of them. High perioperative mortality reaching 29%, prolonged mechanical ventilation, neurological complications and perioperative myocardial infarction rates (Table 3) also seem to be connected with ICA.

CONCLUSIONS

We conclude that pre-ECC ICA is a severe intraoperative complication and contributes to noticeable postoperative complications rate after cardiac surgical procedures. Sternotomy and opening of pericardium are the most frequent moments when pre-ECC ICA appears, however it may happen in any moment of pre-ECC period.

We have not found any significant preoperative risk factor for pre-ECC ICA.

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SUMMARY

Cardiosurgical operations remain one of the most demanding and complicated surgical procedures. Cardiac arrest before extra corporeal circulation (ECC) is one of severe intraoperative complications which can occur in any moment of operation. We have tried to evaluate possible risk factors of intraoperative, pre-ECC cardiac arrest in cardiac surgical patients and also have tried to estimate, if such an incident itself can be a risk factor for further post-operative complications. Pre-ECC intraoperative cardiac arrest (ICA) has occurred in 28 (aged 34–9) of 1,288 cardiac surgical patients operated on in our institution between July 1998 and December 2001. In 20 of these patients (71%) CABG was a planned procedure and in the remaining eight heart valve prostheses implantation were planned. In all 28 cases ventricular fibrillation was a cause of ICA and all patients required indirect and/or direct cardiac massage up to the moment of ECC start. In the subgroup with coronary artery disease (CAD) eight patients (35%) had left main stenosis, 13 (46.4%) had myocardial infarction in medical history. In the group of valve patients mitro-aortic valve disease was diagnosed in three cases and mitro-aorto-tricuspid valve disease with CAD or mitral valve disease or aortic valve disease in single patients.

ICA was the most frequent during sternotomy (eight cases), pericardium opening (seven cases) and harvesting of left internal mammary artery (LIMA). In 16 cases prolonged reperfusion was necessary after declamping of the aorta, and in two of these cases ECC re-entry was needed. Eight patients (28.6%) have died, in 14 cases (50%) low output syndrome has been diagnosed, in five cases (18%) myocardial infarction has occurred and, in nine cases (32%) different neurological complications have been found postoperatively and five patients required resternotomy. All these complications were

significantly more frequent in the investigated group than in the whole population of patients. We conclude that pre-ECC ICA contributes to noticeable post-operative complications rate increase. Sternotomy and opening of pericardium are the most frequent moments when pre-ECC ICA appears. We have not found any significant preoperative risk factors for pre-ECC ICA.

Zatrzymanie krążenia we wstępnej fazie zabiegu operacyjnego w krążeniu pozaustrojowym

Zabiegi kardiochirurgiczne z użyciem krążenia pozaustrojowego łączą się z ryzykiem wystąpienia powikłań pooperacyjnych, ze zgonem włącznie. Celem pracy była próba ustalenia czynników ryzyka wystąpienia nagłego zatrzymania krążenia we wstępnej fazie zabiegu kardiochirurgicznego z użyciem krążenia pozaustrojowego. Postanowiliśmy również ocenić, czy epizod zatrzymania krążenia we wstępnej fazie zabiegu sam w sobie jest czynnikiem ryzyka wystąpienia powikłań pooperacyjnych. W okresie od lipca 1998 do grudnia 2001 r. 1288 chorych operowano w Klinice z użyciem krążenia pozaustrojowego. Badaniami objęto 28 pacjentów w wieku od 34 do 79 lat zakwalifikowanych do leczenia operacyjnego z powodu choroby wieńcowej lub nabytej wady zastawkowej serca (odpowiednio 20 i 8 pacjentów), u których doszło do zatrzymania krążenia w mechanizmie, migotania komór we wstępnej fazie zabiegu operacyjnego, z koniecznością prowadzenia akcji reanimacyjnej do momentu podłączenia krążenia pozaustrojowego. Najczęściej do zatrzymania krążenia doszło w czasie otwierania mostka, worka osierdziowego i preparowania lewej tętnicy piersiowej wewnętrznej (odpowiednio 8, 7 i 5 pacjentów). Szesnastu spośród 28 operowanych pacjentów (57,1%) wymagało przedłużonej reperfuzy, przy czym w dwóch przypadkach zachodziła konieczność ponownego wejścia w krążenie. Zmarło 8 pacjentów (28,6%), u 14 wystąpił zespół małego rzutu (50%), u 5 pacjentów wystąpił zawał mięśnia serca, u 9 powikłania neurologiczne, a u 5 konieczna była rewizja śródpiersia. Wszystkie powyższe powikłania występowały znamienne częściej w grupie badanej w porównaniu z całą grupą 1288 chorych. Zatrzymanie krążenia we wstępnej fazie zabiegu operacyjnego z użyciem krążenia pozaustrojowego jest jednym z powikłań śródoperacyjnych chirurgicznego leczenia chorób serca, zwiększającym ryzyko wystąpienia powikłań pooperacyjnych. Do zatrzymania krążenia w mechanizmie migotania komór dochodziło najczęściej w trakcie otwierania mostka i worka osierdziowego. Nie udało nam się określić czynników sprzyjających wystąpieniu zatrzymania krążenia we wstępnej fazie zabiegu kardiochirurgicznego.