

A retrospective analysis of high thoracic epidural anesthesia and analgesia in cardiac surgery over the 1995-2002 period

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Summary

Background: According to many studies, high thoracic epidural anaesthesia (TEA) offers various advantages over general anaesthesia for patients undergoing cardiac surgery. On the other hand, there is a potential risk for development of epidural haematoma with serious neurological consequences. Studies concerning this problem are inhomogeneous and refer to about 6,000 patients in total. Because of more than ten years of experience with TEA, we decided to determine the risk of serious neurological complications associated with TEA. This is the largest single-center series of patients who underwent a cardiac surgical procedure under TEA and general anaesthesia.

Material and methods: A single-center retrospective analysis of the perioperative course of all patients undergoing cardiac surgery from 1995 to 2002 was performed. The primary endpoint was incidence of spinal cord compression such as radicular back pain or progressive neurological deficits in patients who had cardiac surgery under combined general and TEA. A secondary endpoint was a comparison of outcome between the groups of patients with TEA and balanced anaesthesia.

Results: Records of 3,966 patients were analyzed. A group of 1,519 patients underwent cardiac surgery with TEA and 2,447 patients in balanced general anaesthesia. In the TEA group, no patient showed a sign of spinal cord compression until hospital discharge. Patients in the TEA group were extubated earlier (11 hours of mechanical ventilation vs. 13 hours in the GA group, $P < 0.00001$), but there was no difference in the other analyzed variables (mortality, ICU stay, incidence of stroke, atrial

Streszczenie

Wstęp: Wysokie znieczulenie zewnątrzoponowe oferuje wiele korzyści chorym poddawanym zabiegom kardiologicznym. Jednakże jego zastosowanie wiąże się z ryzykiem wystąpienia krwaka nadtworówkowego, a co za tym idzie, z wystąpieniem powikłań neurologicznych. Prace analizujące to zagadnienie są trudne do porównania i dotyczą ok. 6 tys. chorych. Ze względu na 10-letnie doświadczenie w stosowaniu znieczulenia zewnątrzoponowego w kardiologii podjęliśmy się określenia ryzyka wystąpienia powikłań neurologicznych po zastosowaniu znieczulenia zewnątrzoponowego w kardiologii.

Materiał i metody: W pracy przedstawiono analizę retrospektywną przebiegu pooperacyjnego u chorych po zabiegu kardiologicznym, z zastosowaniem znieczulenia zewnątrzoponowego oraz bez jego zastosowania, operowanych w naszym ośrodku w latach 1995–2002. Pierwszoplanowym celem naszej analizy była częstość występowania cech kompresji rdzenia kręgowego, takich jak korzeniowe bóle pleców czy wystąpienie nasilających się ubytków neurologicznych u chorych po zabiegach kardiologicznych, operowanych z zastosowaniem znieczulenia zewnątrzoponowego. Drugoplanowym zadaniem analizy było porównanie wyników leczenia między grupami chorych znieczulanych ogólnie z zastosowaniem znieczulenia zewnątrzoponowego i bez jego zastosowania.

Wyniki: Analizie poddano 3 966 chorych. U 1 519 z nich zastosowano znieczulenie zewnątrzoponowe w połączeniu ze znieczuleniem ogólnym, natomiast u 2 447 jedynie znieczulenie ogólne. U żadnego pacjenta w grupie znieczulenia zewnątrzoponowego

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fibrillation, postoperative myocardial infarction, pulmonary and wound infection).

Conclusion: General anaesthesia combined with TEA is relatively safe and allows earlier extubation than general anaesthesia in cardiac surgery.

Key words: anesthesia, epidural – cardiac surgical procedures - haematoma, epidural, spinal – postoperative complications

Background

As the age of surgical patients and the incidence of associated disease increase, postoperative complications in patients undergoing cardiac surgery (despite increasingly improving surgical and anesthetic procedures) are becoming an important factor affecting the length and quality of life of our patients and, not less so, the utilization of costs in cardiac surgery. Smaller studies published over the past 15 years have identified the following advantages of epidural anesthesia and analgesia in cardiac surgery: improvement of postoperative analgesia [1], improved pulmonary function [2], an increase in hemodynamic stability [3], a decrease in myocardial oxygen consumption [4], reduction in the intraoperative stress response [5-7]. The subsequent large, randomized studies have demonstrated, in a varying measure, a beneficial effect of epidural anesthesia and analgesia, even in the clinical postoperative outcome of patients undergoing direct coronary revascularization: earlier extubation and improved postoperative analgesia compared with techniques based on parenteral opioid administration, prevention of postoperative supraventricular arrhythmias, reduced incidence of respiratory infection, improvement of pulmonary function based on spirometry and oxygenation parameters, but, also, a lower incidence of postoperative type II neurological dysfunction, and of long-term post-traumatic stress and depression [8-10]. Important factors of the postoperative course such as shortened duration of time spent at the ICU, shorter length of in-hospital stay or early mortality, have not been demonstrated, perhaps because of the number of confounding factors involved in small patient groups.

When considering thoracic epidural anesthesia in cardiac surgery, there is inadequate valid evidence of a significant positive effect on outcome in patients undergoing cardiac surgery on the one hand and concerns about a possible neu-

rological effect on the patient on the other (epidural hematoma). Despite the current trend associated with an effort at early extubation, rehabilitation and shortening of hospital stay, it is the risk of CNS involvement during heparinization which is necessary for the safe use of the extracorporeal circuit which will discourage most cardiac anesthesiologists from using the central block in cardiac surgery patients.

Wnioski: Znieczulenie zewnątrzoponowe z połączeniu ze znieczuleniem ogólnym do zabiegów kardiologicznych wydaje się bezpieczne i pozwala w okresie pooperacyjnym na wcześniejsze rozintubowanie chorego.

Słowa kluczowe: znieczulenie, znieczulenie zewnątrzoponowe, zabiegi kardiologiczne, krwaki nadtwardówkowy, powikłania pooperacyjne

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Papers published to date involving a total of approx. 6,000 patients do not report an epidural haematoma or another severe neurological disease [10], a finding presumably related to the anticipated incidence of this complication, believed to be in the range of 1:2,000-1:150,000.

The recently published case report on epidural haematoma as a complication of a cardiac surgical procedure in an 18-year-old patient should be seen in the context of outright failure to abide by recommendations for epidural catheter removal from the epidural space [11]. Given the lack of homogeneity of prospective randomized studies [8, 9], a synthesis of data published to date (a meta analysis) emerging from the above studies is correspondingly appropriate.

Considering the above facts and our more than 10 year-experience with high thoracic epidural anesthesia we decided to perform a retrospective analysis of patients undergoing cardiac surgery in our center with the following aims:

Aim of study

Primary: To determine the incidence of spinal cord compression or another serious neurological spinal cord injury detected by clinical examination in patients who had cardiac surgery under combined general and TEA.

Secondary: To compare the postoperative course (mortality, length of post-op ICU stay) and major postoperative complications (supraventricular arrhythmia, lung infection, post-operative myocardial infarction) between the group of

patients with epidural anesthesia and analgesia and those with balanced anesthesia and post-operative analgesia by parenteral opiates.

Material and methods

Intraoperative data of patients undergoing cardiac surgery at the Department of Cardiovascular Surgery, General University Hospital in the 1995-2002 period were processed retrospectively. The decision to perform the epidural block was fully up to the anesthesiologist performing anesthesia in the patient involved.

Excluded from the follow-up were patients with contraindicated thoracic epidural anesthesia because of:

- a. coagulopathy documented by one of the following (INR>1.5; aPTT>45s, thrombocytopenia<80,000; abnormal thromboelastogram), preoperative use of antiplatelets was not a contraindication of epidural puncture
- b. serious hemodynamic instability (based on the anesthesiologist's discretion)
- c. patients operated on under anesthesia without intubation and artificial lung ventilation
- d. as well as those not inserted the epidural catheter before the postoperative period.

In schedule patients antiplatelets therapy was withdrawn 7 days before the surgical procedure.

All patients were pretreated with oral diazepam at a dose of 0.15 mg/kg in the evening before the procedure, and with oral midazolam at a dose of 0.05-0.2 mg/kg, morphine at a dose of 0.1-0.15 mg/kg i.m., and atropine at a dose of 0.01 mg/kg i.m. 2 hours preoperatively.

Thoracic epidural anesthesia was performed shortly before induction of general anesthesia. In all cases, an epidural 18G needle was used and inserted into the epidural space using hanging drop method in spaces Th2-Th4 with the patient lying on their right side or in the sitting position, at the anesthesiologist's discretion. Epidural blockade was not performed while not deferring surgery in cases with so-called blood puncture. Epidural anesthesia itself was induced by administration of a bolus of bupivacaine 0.25% or ropivacaine 0.5% 8 ml + sufentanil 10ug into the epidural catheter with subsequent infusion of bupivacaine 0.125% or ropivacaine 0.2% along with sufentanil 1ug/ml at a rate of 3-10 ml/h titrated by the ICU nurse according to the standard ICU protocol until 2 to 5 post-op days. Completion of epidural analgesia and catheter removal were indicated by the patient's attending physician with regard to coagulation profile (In patients on intravenous or oral anticoagulants, the catheter was systematically removed before the drug was effective, INR>1.5 and aPTT>45s were contraindication of catheter removal). General anesthesia in patients with epidural anesthesia was induced by thiopental 2-4 mg/kg i.v., midazolam 3-10 mg i.v., sufentanil 10-30 ug or fentanyl 100-300 ug i.v. depending on ve-

nous graft harvesting from the lower limbs, isofluran 0.4-1.2%, N₂O/O₂ 1:1 (except for open-heart procedures); muscle relaxation was induced by an intubation dose of a myorelaxant (atracurium, pancuronium, vecuronium). General anesthesia in patients without epidural anesthesia differed in the dose of intraoperative opiates (sufentanil 0.5-1 ug/kg/hr or fentanyl 5-10 ug/kg/hr i.v.). For postoperative analgesia, these patients received morphine 1-2 mg i.v. at the discretion of the attending nurse, who assessed pain according to the standard ICU protocol, with piritramide 15 mg i.m. at 4-6 hours, oral morphine-sulfate 5-10 mg at 12 hours, and a non-steroid anti-inflammatory drug depending on the patient's associated disease on the ensuing postoperative days.

Intraoperative information was obtained from the nationwide registry of cardiac surgery, with lacking data collected by analysis of individual medical records made by trained personnel (8 physicians/anesthesiologists, 4 nurses from a postoperative intensive care unit) with random quality control of data they had processed (review of a 5% sample of processed data by one of the authors, M.L.).

The following demographic parameters were collected: age, gender, weight and height of patients, as well as NYHA class, ejection fraction (EF), hypertension, diabetes mellitus, chronic obstructive bronchopulmonary disease (COPD), stroke in the patients' history, smoking, alcohol abuse, preoperative infection, preoperative antibiotic use were assessed as associated conditions. The following perioperative parameters were evaluated: extracorporeal circuit use, cardiac valve surgery, off-pump duration, aortic cross clamp time, postoperative revision, absence of antibiotic prophylaxis, low cardiac output, failure of epidural blockade.

The following postoperative data were recorded: neurological spinal complications (see below), total mechanical ventilation time (total intubation-to-extubation time including time of surgery - only available time data from the nationwide registry of cardiac surgery), length of stay at intensive care unit (ICU), neurological complications (stroke confirmed by neurologist), lung infection (clinical and x-ray findings confirmed by microbiology), surgical wound infection (clinical finding confirmed by microbiology), supraventricular arrhythmia (atrial fibrillation including other supraventricular tachycardia confirmed by ECG), postoperative myocardial infarction (a combination of ECG finding and cardiac specific enzyme elevation).

The neurological status of patients was regularly monitored by the attending anesthesiologist at the postoperative intensive care unit (ICU). Peripheral nervous injury was suggested by functional disorder seen in the area distal to a lesion with motor or sensory deficiency depending on the structure of the given nerve. Spinal cord root injury was considered in patients complaining of radiating pain combined with reduced sensitivity consistent with dermatoma.

Sensitivity was determined with respect to the dermatomas involved along with motor function (limb mobility) and was examined every 4-6 hours. In cases with suspected spinal cord root injury close to the site of catheter insertion, the catheter was first slightly retracted or completely removed. Pain remission following catheter removal was considered evidence of spinal root irritation by the epidural catheter. A neurological expert panel was convened in the event of a positive neurological finding (see above). Data on intense back pain associated with sensory or motor deficiency were considered symptoms of expansive process in the spinal channel. In cases of suspected epidural haematoma, examination by nuclear magnetic resonance (NMR) was available within the facility.

Data were processed and analyzed using statistical software R, version 2.0.1 (R Foundation, Austria). Depending on their nature, the data were summarized using mean and standard deviation (SD) or using median and quartile range (in cases of markedly non-symmetrical distribution); dichotomic parameters were summarized by giving the percentage of representation of the selected category. Groups of patients with general and epidural anesthesia were compared within selected parameters using either the Pearson chi-square test (categorical variables) or Wilcoxon two-sample test (continuous variables). A p-value less than or equal to 0.05 was considered statistically significant.

Results

A total of 3,966 patients were included in the analysis; 1,519 patients had an epidural catheter inserted prior to induction into general anesthesia (TEA, thoracic epidural anesthesia). A control group included 2,447 patients with general anesthesia (GA) without TEA. In 81 cases (5% of all TEA patients), TEA was found to be inadequate requiring intraoperative opioid administration. As a result, these patients were included in the group of general anesthesia in the analysis. No difference was seen between the groups in the selected medical history parameters except for smoking. The TEA group showed a significant, yet very small difference in patients age; in addition, TEA was performed in 3.6% more men compared with GA. As regards intraoperative parameters, the groups differed in terms of length of extracorporeal circulation, and the percentage of procedures on cardiac valves (tab. I).

Primary aim: Clinical symptoms of serious spinal cord injury were not documented during hospitalization in any patient.

Secondary aims: Mortality (within 3 post-operative days), length of stay in the postoperative ward, the postoperative incidence of supraventricular arrhythmia, neurologic complications, myocardial infarction, lung infection, or infection at the surgical wound site was very similar in both groups. A significant difference was seen only in the length

Tab. I. Perioperative and intraoperative data expressed as mean with SD, as * median with a quartile range, or as the percentage of cases where appropriate

	TEA	GA	p-value #
Age	62.3 (8.9)	63.0 (9.1)	0.0150
Gender – males, %	79.2	75.6	0.0120
Weight, kg	81.2 (12.3)	80.8 (12.6)	NS
NYHA *	0 (2)	0 (2)	NS
EF, ejection fraction < 40%, %	9.5	10.3	NS
Stroke, %	5.8	5.8	NS
COPD, %	9.9	10.2	NS
Smoking, %	64.8	60.3	0.0051
Pump time, min *	72 (33)	75 (32)	<0.0001
Clamp time, min *	35 (21)	37 (20)	NS
Valvular procedure, %	7.9	12.7	<0.0001

*median (quartile range)

p-value based on Pearson chi-square test (categorical variables) or Wilcoxon two-sample test (continuous variables)

NS = non-significant

Tab. II. Values of postoperative parameters

	TEA	GA	p-value #
30-day mortality, %	1.8	2.4	NS
Mechanical ventilation, hrs*	11 (7)	13 (8)	<0.00001
Length of stay ICU, hrs*	43 (29)	44 (34)	NS
Stroke, %	5.0	4.4	NS
Arrhythmia, %	31.1	31.8	NS
Postoperative MI, %	1.8	1.8	NS
Lung infection, %	3.4	4.1	NS
Sternal infection, %	0.9	1.3	NS

of mechanical ventilation with medians of 11 and 13 hours in the TEA and GA groups respectively (tab. II).

Discussion

Thoracic epidural anesthesia and analgesia are an integral part of our center. As part of combined anesthesia, TEA was introduced into the practice of cardiac anesthesiology in the early 1990s, to be performed systemically from 1995. It is precisely this long-term commitment which makes us,

in our view, qualified to present our experience with the risks and any benefits of the technique.

The main reason for this retrospective analysis has been the recently often-vented concern of epidural hematoma related to epidural space puncture combined with catheter insertion and heparinization during the cardiac surgical procedure. It is specifically this concern of severe spinal cord injury which is one of the main arguments of TEA adversaries. As shown by the above results, no such complication was seen in our group of patients. However, it should be remembered that a complete coagulation profile is available to us before performing TEA, and a thromboelastographic examination is undertaken in the case of any doubt. Epidural space puncture is performed only by physicians with adequate experience with epidural anesthesia induced in other surgical branches. Although the puncture is performed shortly before surgery, subsequent central venous catheter cannulation and other necessary arrangements for surgery provide sufficient time for any physiological arrest of bleeding from an artificially injured epidural vessel. Needless to say, we always assess coagulation postoperatively prior to catheter removal in patients whose history or pharmacotherapy lead to concern about coagulation disorders.

A secondary aim of our study was to evaluate any advantages of combined anesthesia versus traditional balanced anesthesia. We are well aware that a retrospective analysis, the lack of homogeneity of anesthetic procedures, and many other contributing factors reduce the validity of our results. The greater number of smokers in the TEA group probably reflects an effort of anesthesiologists to use TEA for these patients with a higher risk of postoperative pulmonary dysfunction. The shorter mechanical ventilation time in the TEA group may reflect not only earlier extubation but also shorter time of surgery, but the latter is not very likely according to the similar characteristics of both groups. No significant differences were noted between the groups in the other study parameters, a finding inconsistent with some published papers. The reasons for differences are numerous, beginning with varying methods of TEA and going on to multifarious postoperative cardiac surgery care standards. Scott et al. [8], demonstrating a beneficial effect of TEA on the incidence of supraventricular arrhythmia, used a different method for TEA (96 hours postoperatively, additive effect of epidural clonidine); however, another possible reason for the results reported by such authors was the low rate of beta-blocker use in the early postoperative period. Seen from this point of view, epidural anesthesia taking the form of temporary thoracic sympathectomy rather takes the form of systemic beta-blocker administration, with the synergy of both approaches (beta-blockers and TEA) seeming to be insecure. It is for this reason that we see the advantage of TEA in patients contraindicated to receive

beta-blockers due to left ventricle dysfunction or spastic COPD form. Although the results presented by us do not show a positive effect of TEA on the incidence of lung infection, earlier extubation and the potential for more intense breathing rehabilitation in the group of at risk patients (COPD) may reduce the incidence of infectious and non-infectious pulmonary complications and hence cut hospitalization time. We are well aware that these hypotheses must be confirmed by a prospective randomized trial which we are currently performing in our center and which includes patients with risk factors for individual postoperative complications [12]. On the other hand, there is enough evidence for routine safe TEA use, and a clearly beneficial effect on postoperative pain relief, earlier extubation and, perhaps, the decrease in postoperative stress and depression should be a clear argument for all anesthesiologists when considering whether or not to include TEA into their cardiac anesthesiologic arsenal [8, 9, 10].

In conclusion, general anaesthesia combined with TEA is relatively safe and allows earlier extubation than general anaesthesia in cardiac surgery.

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