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Perioperative cardiovascular complications associated with blunt thoracic trauma

The purpose of this study was to examine the frequency and importance of intraoperative mortality, arrhythmias and hypotension in the presence of thoracic trauma and to determine the effect of myocardial contusion on these perioperative complications. Over a two-year period patients with evidence of blunt thoracic injury who required surgery within 24 hr of admission were studied. The anaesthetist filled in a questionnaire on intraoperative events. Patients were also studied for the presence of myocardial injury with radionuclide angiography (RNA), at autopsy or at thoracotomy. Two hundred and one patients were studied. The intraoperative and overall mortality was 7.9% and 22.9% respectively. Of the operating room survivors the incidence of intraoperative arrhythmias and hypotension was 3.8% and 26.5% respectively. Only 5.9% of patients had a suspected or confirmed myocardial contusion. Patients were divided into two groups, those without myocardial injury were designated Group I, while those with myocardial contusion were designated Group II. The Group II patients had a greater severity of injury and intraoperative mortality (54.4%) than those in Group I (4.6%) $P < 0.05$. Intraoperative deaths were attributed to, with one exception, non-cardiac causes. There were no differences in the incidences of arrhythmias and hypotension between patients with or without myocardial injury surviving the operating room. All patients with blunt thoracic injury may develop intraoperative arrhythmias or hypotension.

Key words

COMPLICATIONS: arrhythmia, hypotension, mortality;
SURGERY: trauma.

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This study was supported by grants through Physicians Services Incorporated and The Sunnybrook Trust for Medical Research.

Presented in part at the annual meeting of the Canadian Anaesthesiologists' Society, Quebec City, June 1991.

Accepted for publication 1st November, 1993.

Cette étude porte sur le taux de mortalité, la fréquence et l'importance des dysrythmies et de l'hypotension peropératoires dans le trauma thoracique et vise à déterminer l'influence de la contusion thoracique sur ces complications périopératoires. Sur une période de deux années, on a étudié, à l'aide d'un questionnaire rempli par l'anesthésiste pendant l'opération, les malades porteurs d'un traumatisme thoracique fermé nécessitant une intervention chirurgicale dans les 24 heures de l'admission. On a recherché aussi chez ces malades les lésions du myocarde soit par angiographie isotopique, soit à l'autopsie soit lors de la thoracotomie. L'étude regroupait deux cents et un patients. La mortalité peropératoire et la mortalité totale se situent à 7,9% et 22,9% respectivement. Pour les survivants de la chirurgie, l'incidence peropératoire des dysrythmies est de 3,8% et de l'hypotension 26,5%. Seulement 5,9% des patients souffraient de contusion myocardique suspecte ou confirmée. Les patients ont été répartis en deux groupes: ceux qui ne présentaient pas de contusion myocardique désignés comme groupe I; ceux qui en présentaient une désignés comme groupe II. Les patients du groupe II étaient plus gravement blessés et avaient un taux de mortalité peropératoire plus élevé (54,4%) que ceux du groupe I (4,6%), $P < 0,05$. A l'exception d'un cas, la mortalité peropératoire est attribuée à des causes non cardiaques. Chez les survivants, on n'a pas trouvé de différence en ce qui regarde l'incidence des dysrythmies et de l'hypotension entre les patients qui présentaient une blessure myocardique et ceux qui n'en présentaient pas. Tous les traumatisés avec des blessures fermées du thorax peuvent développer des dysrythmies ou de l'hypotension.

Myocardial contusion has been described as a consequence of blunt thoracic trauma. Intraoperative arrhythmias and hypotension have been attributed to this injury by some,¹⁻³ while others have reported uneventful intraoperative courses.^{4,5} Differences in study design and diagnostic criteria for myocardial contusion make these investigations difficult to compare. The diagnosis of myocardial contusion remains difficult and its importance is questionable.⁶ Our institution, as a level I trauma unit, admits more than 500 polytraumatized patients annually. More than 90% of these admissions are due to blunt

trauma. This prospective study was undertaken to determine the frequency and importance of cardiovascular complications during anaesthesia and surgery in patients with blunt thoracic trauma requiring surgery within 24 hr of admission and injury.

Methods

The study had the approval of the Institutional Ethics Committee. All patients admitted to Sunnybrook Health Science Centre Regional Trauma Unit between January 1, 1989 and December 31, 1990 were considered for entry into the study. Inclusion criteria were the presence of blunt thoracic trauma as defined by an abbreviated injury score of 2 or greater in the thoracic region (including single rib fractures or chest wall contusions) and the requirement for emergency surgery within 24 hr of admission.⁷ Patients who were pregnant, whose injury occurred more than six hours from admission to our institution or who had a history of ischaemic heart disease, were excluded from the study.

Demographic data collected included age, injury severity score (ISS) and mortality, both intraoperative and postoperative.⁸ The ISS was calculated by a blinded individual unaware of the nature of the study.

The anaesthetists providing anaesthetic care were given a standardized questionnaire (Figure) at the start of the case to be filled out during the anaesthetic. If the completed questionnaire was not handed in by the following morning, the anaesthetist was contacted directly by a research assistant and the questionnaire was filled in at that time. Any missing data were obtained by reviewing the patient's chart. Data requested included type of intraoperative arrhythmias, treatment of arrhythmias, lowest recorded systolic arterial pressure, aetiology and treatment of hypotension, if present. Hypotension was defined as any intraoperative systolic arterial pressure of less than 90 mmHg. Significant arrhythmias were defined as all rhythms other than sinus rhythm or sinus tachycardia.

Radionuclide angiography (RNA) was obtained as soon as possible after admission; anterior and left anterior oblique (45° and 70°) views were obtained. Interpretation of the RNA studies was accomplished independently by a cardiologist and nuclear physician blinded to the patient's condition. If disagreement occurred, the two physicians involved reviewed the study together. In addition, half of the first 100 studies were randomly selected and sent to an external expert in nuclear cardiology, blinded to the nature of the study or the findings of the study physicians for review. Right and left ventricular ejection fractions (EF) and wall motion studies were performed. Any patient with an abnormal RNA study at admission had a follow-up study at six weeks to determine whether

Myocardial contusion anaesthesia report

Date _____

Rhythm on arrival at OR;

Sinus _____ Other _____

Intraoperative arrhythmias;

Sinus _____ Sinus tachycardia _____

Atrial _____ Treatment _____

Ventricular _____ Treatment _____

Other _____ Treatment _____

Haemodynamics

Lowest recorded blood pressure ____/____

Aetiology of hypotension _____

Treatment of hypotension

Fluids _____

Inotropes _____

Other _____

Total fluids

Packed cells _____ ml Crystalloid _____ ml

Fresh frozen plasma _____ ml

Stored plasma _____ ml

Platelets _____ ml

Cryoprecipitate _____ ml

Other _____ ml Total _____ ml

FIGURE Anaesthesia questionnaire

the findings were reversed. A diagnosis of myocardial contusion was suspected if any of the following reversible findings were present: right ventricular EF < 0.4, the left ventricular EF < 0.5 or abnormal wall motion in one or more segments. Myocardial contusion was confirmed if it was observed at thoracotomy or autopsy. An attempt was made to obtain an autopsy on all patients who died in the operating room or in the postoperative period. Pathologists and coroners were alerted to perform a careful examination of the heart.

Patients without evidence of myocardial injury as defined by the absence of reversible RNA abnormalities or contusion at autopsy or thoracotomy were designated Group I. Patients with myocardial injury as defined by the presence of a reversible RNA abnormality or the presence of myocardial contusion at autopsy or thoracotomy were designated Group II. Patients in both groups were compared with respect to age, ISS and mortality while those patients surviving surgery were compared with respect to frequency of arrhythmia and hypotension. Age and ISS were compared using a t test while mortality, frequency of important arrhythmia and hypotension were compared using chi square analysis. A $P < 0.05$ was considered to be statistically significant.

Results

Two hundred and one patients with blunt thoracic trauma required 212 emergency surgical procedures within 24 hr of admission during the study period. Eleven patients required two emergency surgical procedures within 24 hr of admission. General anaesthesia was provided for all patients. The mean age ($\pm$ SD) of all patients enrolled in the study was 35.1 ($\pm$ 17.3) yr while the mean ISS ($\pm$ SD) was 34.0 ($\pm$ 13.0). Sixteen patients died in the operating room. Operating room deaths were attributed to; hypovolaemia (14), cardiac tamponade (1) and head injury/brain death (1). The hearts of 14 of the patients dying intraoperatively were examined, at autopsy in ten and at thoracotomy in four. Six myocardial contusions were seen in patients dying intraoperatively – five at autopsy and one at thoracotomy.

One hundred-eighty-five patients survived the operating room with 30 deaths occurring in the postoperative period. Studies to detect myocardial contusion could not be completed in 14 patients. The reasons for omission included inadequate blood pool labeling (10), death before RNA scan and no autopsy (3), and one patient refused the RNA study. Of the remaining 171 patients, myocardial contusion was confirmed or suspected in five, at autopsy in two and by reversible RNA abnormalities in three. All patients with reversible RNA abnormalities had a left ventricular EF $<$ 0.5. The reduction in left ventricular EF was global in two patients and confined to the anterior and septal walls of the left ventricle in the remaining patient.

Of the 185 patients surviving the operating room, there were seven severe intraoperative arrhythmias (Table I). Forty-nine patients had an intraoperative systolic blood pressure of less than 90 mmHg. Causes of intraoperative hypotension are listed in Table II. Management of intraoperative hypotension included volume administration (42), inotropic agents including calcium (8) and cardiopulmonary resuscitation (3).

Comparisons of age, ISS, mortality, frequency of hypotension and arrhythmias between Groups I and II are presented in Table III. While there was no difference between the two groups with respect to age, frequency of arrhythmia or hypotension, the Group II patients had a higher ISS ($P = 0.0001$) and mortality ($P < 0.0001$).

Discussion

Patients with blunt thoracic trauma presenting for surgery within 24 hr of admission are a high-risk group as evidenced by a high ISS, intraoperative (7.9%) and overall mortality (22.9%). Survivors in this group also had a high incidence of intraoperative complications such as important arrhythmia (3.8%) and hypotension (26.5%). Hypotension was attributed primarily to hypovolaemia.

TABLE I Intraoperative Arrhythmias

<i>Rhythm</i>	<i>n</i>	<i>Therapy</i>
Sinus arrest	3	Pharmacological
Ventricular tachycardia	2	Cardioversion
Ventricular fibrillation	2	Defibrillation

TABLE II Aetiology of intraoperative hypotension

Hypovolaemia	38
Anaesthetic	5
Arrhythmia	3
Brain death	1
No cause listed	2

TABLE III Comparison of patients with and without contusion

	<i>Group 1</i>	<i>Group 2</i>	
<i>n</i>	174	11	
Age	34.9	34.0	NS
ISS	32.8	48.1	$P = 0.0001$
Mortality %	4.6	56.5	$P < 0.0001$
Arrhythmias*	6	1	NS
Hypotension*	39	5	NS

*Patients who survived operating room only.

Myocardial contusion was suspected or confirmed in only 5.9% of this population which is lower than that reported by others.^{1,4} While the intraoperative mortality was higher in the myocardial injury group, this may be accounted for by a more severely injured patient population or because autopsy was used as one of the diagnostic criteria for myocardial contusion. We are unable to account for our low incidence of myocardial dysfunction but validated our RNA studies with a blinded external reviewer. However, this does not account for our low autopsy or thoracotomy incidence of this injury. Most studies claiming a higher frequency of myocardial contusion used indirect methods such as cardiac enzymes or electrocardiographic criteria.^{1,4,9,10} Cardiac enzymes and ECG abnormalities do not correlate with morbidity, mortality or functional abnormalities as demonstrated by RNA studies or autopsies.^{4,6} The importance of RNA abnormalities in blunt thoracic trauma has been called into question as the results of this investigation do not appear to change clinical management or predict morbidity or mortality.^{5,6,11}

The effect of blunt thoracic trauma on intraoperative anaesthetic management and complications is uncertain: some authors report intraoperative hypotension and arrhythmia and others report none.¹⁻⁵ In a study designed to evaluate echocardiography and RNA as diagnostic

tools for myocardial contusion, Fabian *et al.* reported on 73 patients with blunt thoracic injury requiring surgery. However, data acquisition of intraoperative events was not described. Timing of surgery ranged from shortly after admission to one to two weeks after injury. This group reported no intraoperative arrhythmias requiring treatment and no unexplained episodes of hypotension.⁴ Snow *et al.* reported on 27 patients requiring surgery, 19 of these within 24 hr of admission. There were five episodes of intraoperative hypotension treated with volume administration and three episodes of severe arrhythmias. One of these episodes was specifically attributed to cardiac manipulation at thoracotomy.³ The retrospective studies of Norton *et al.* and Healey *et al.* commented on a specific severely injured subset of patients requiring surgery. Both studies reported small numbers of patients and failed to report the timing of surgical procedures with respect to injury.^{2,10}

Eisenach *et al.* in a retrospective study found a marginally significant increase in the incidence of intraoperative hypotension in patients with myocardial dysfunction as assessed by transthoracic echocardiography. The incidence of arrhythmias requiring treatment was the same whether or not myocardial dysfunction was present.¹ The patient population in the two groups of this study may not have been similar as the severity of injury was not directly compared and there was a significantly higher incidence of patients requiring laparotomy in the group with myocardial dysfunction.

Patients with suspected or proved myocardial injury surviving the operating room did not appear to have an increased incidence of intraoperative hypotension or arrhythmias over patients without myocardial injury. However, the greater intraoperative mortality rate of patients with myocardial injury may be attributed to the myocardial injury itself, the diagnostic criteria used for the purposes of the study or a more severely injured patient population. The cause of intraoperative death, in all but one instance, was attributed to a non-cardiac aetiology by the anaesthetists involved. Because of the small number of patients with myocardial contusion in our series, it is difficult to comment further. However, we would like to point out that intraoperative cardiovascular events occurred independent of the presence of myocardial contusion.

Acknowledgements

The authors would like to thank Drs. J. Dubbin and L. Erhlich for help in reviewing the many RNA scans generated by the study and Ms. Rosemary Scanlon for assistance with preparation of the manuscript. We are also indebted to Ms. Dawn Dirkson for data collection and persistently tracking down wayward reporting forms.

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