Pronounced unexplained preoperative tachycardia heralding serious cardiac events: a series of three cases

[Tachycardie préopératoire prononcée, inexpliquée, prodrome d'événements cardiaques sérieux : une série de trois cas]

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Purpose: Pronounced, unexplained preoperative tachycardia can be a formidable challenge for the anesthesiologist. Whereas the relationship between persistent intraoperative tachycardia and perioperative morbidity is indisputable, there is a lack of available data on unexplained preoperative tachycardia. The main objective of this case series is to stimulate research and discussion on this topic, so that guidelines can be developed to aid in management.

Clinical features: We present three patients with pronounced (≥ 130 beats·min^{-1}) unexplained preoperative tachycardia who suffered adverse perioperative events that were garnered from quality improvement records at two teaching hospitals. In the first case, a 38-yr-old woman with a lumbar spinal tumour went into ventricular fibrillation after induction of anesthesia and was found on subsequent evaluation to have an abnormal cardiac re-entrant pathway. In the second case, an otherwise healthy middle-aged man developed a wide complex tachycardia with hypotension during foot surgery, with the subsequent cardiac evaluation being negative. In the third case, a young, healthy woman scheduled for a melanoma incision developed crushing, substernal chest pain accompanied by nausea and shortness of breath prior to incision. An echocardiogram revealed mitral valve prolapse with regurgitation. Before rescheduling the procedures, therapeutic interventions were undertaken that facilitated successful completion of the surgeries.

Conclusions: There are currently no data regarding the prevalence of unexplained preoperative tachycardia, and no guidelines to direct management. More research is needed on this important topic, including epidemiological data and management algorithm(s).

Objectif : *Une tachycardie préopératoire prononcée et inexpliquée peut être tout un défi pour l'anesthésiologiste. La relation entre la tachycardie peropératoire persistante et la morbidité périopératoire est incontestable, mais les données sont incomplètes pour expliquer la tachycardie préopératoire. L'objectif principal de la série de cas est de stimuler la recherche et la discussion sur le sujet de sorte que des lignes directrices soient élaborées pour guider la conduite à tenir.*

Éléments cliniques : *Nous présentons trois patients atteints de tachycardie préopératoire prononcée (≥ 130 battements·min^{-1}) et inexpliquée qui ont souffert de réactions indésirables documentées dans les dossiers d'amélioration de la qualité de deux hôpitaux universitaires. Dans le premier cas, on a observé une fibrillation ventriculaire après l'induction de l'anesthésie et un mécanisme réentrant anormal, lors d'une évaluation ultérieure, chez une femme de 38 ans atteinte d'une tumeur de la moelle lombaire. Dans le second cas, une tachycardie à larges complexes s'est développée avec de l'hypotension pendant une opération du pied chez un homme d'âge moyen, par ailleurs en bonne santé. L'évaluation cardiaque ultérieure s'est révélée négative. Dans le troisième cas, une jeune femme en santé, devant être opérée pour un mélanome, a souffert de douleurs thoraciques rétrosternales constrictives, accompagnées de nausées et d'essoufflement, avant l'incision. Un échocardiogramme a révélé un prolapsus valvulaire mitral avec régurgitation. Avant de replanifier les opérations, des interventions thérapeutiques ont été entreprises pour faciliter l'exécution réussie de l'intervention chirurgicale.*

Conclusion : *Actuellement, il n'y a pas de données sur la prévalence de tachycardie préopératoire inexpliquée et pas de normes de prise en charge directe du problème. Il faut d'autres recherches, y compris sur les données épidémiologiques et les algorithmes décisionnels.*

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STANDARD medical dictionaries define 'tachycardia' as a "rapid heart beat, exceeding 100 beats·min^{-1}". In the absence of any readily identifiable cause such as medications or physical and/or emotional stress, tachycardia usually indicates some type of pathology. For most pathological conditions or laboratory abnormalities, specific cutoff values exist above or below which published guidelines recommend postponing elective surgery. Examples of these numbers include systolic blood pressure (BP) ≤ 180 mmHg, diastolic BP ≤ 110 mmHg, potassium ≤ 5.9 mEq·L^{-1} or < 2.9 mEq·L^{-1}, prothrombin time international normalized ratio ≤ 1.5 for performing neuraxial blocks or removing epidural catheters, and waiting six months for elective surgery following a myocardial infarction.[1–3] Although some of these numbers have been designated arbitrarily, the setting of standards for proceeding with elective operations is justified based on the enormous stress to which the body is subjected during anesthesia and surgery, and the inherent uncertainty of outcomes. Scientific evidence supports some, but not all of these recommendations.[4,5]

Although data are lacking on this subject, it is widely recognized that preoperative tachycardia is a common finding in surgical patients. A recent MEDLINE search revealed no studies documenting the prevalence of preoperative tachycardia. In most cases, preoperative tachycardia can be attributed to a limited number of treatable causes, the most common of which are anxiety, acute pain, dehydration and medication side effects. When promptly identified and appropriately treated, these conditions have little effect on perioperative morbidity. In rare cases, preoperative tachycardia may herald a more serious medical condition warranting immediate medical attention, such as hyperthyroidism or pheochromocytoma. If not recognized and adequately treated, these disorders greatly increase the risk of anesthesia.[6,7]

Unexplained preoperative tachycardia is a dilemma commonly faced by anesthesiologists. Yet despite its frequency, there is a paucity of literature on the subject and no guidelines to aid in management. In this article, we present three cases taken from the quality assurance records at two large teaching hospitals in which pronounced, unexplained preoperative tachycardia was the only harbinger of a life-threatening, perioperative cardiac event. Two cases were aborted prior to surgical incision. Subsequent testing revealed an undiagnosed cardiac condition in these patients, which was appropriately treated before the successful completion of surgery. The purpose of this article is to stimulate research on this important subject, and to provide a preliminary framework to assist in its management.

Case reports

Case 1

The patient was a 38-yr-old female with no significant past medical or surgical history, who was scheduled for resection of a lumbar extradural spinal tumour. Four weeks earlier, she began to notice bilateral lower extremity weakness, which had rapidly progressed to the point where she was able to ambulate only with the aid of a walker. She had no other neurologic symptoms. The patient was also found to have limited mouth opening on her preanesthetic assessment, with the plan being to proceed with an awake, fibreoptic intubation.

The evening before surgery the patient was noted to be in sinus tachycardia with a heart rate (HR) of 120 beats·min^{-1}, devoid of any symptoms. The BP at this time was 130/80 mmHg. Her electrolytes, glucose and complete blood count were all within normal limits. When the tachycardia persisted on the morning of surgery, a 12-lead electrocardiogram (ECG) was obtained which revealed sinus tachycardia at 127 beats·min^{-1}. A cardiologist was called to evaluate the patient. After a detailed history and physical examination revealed no symptoms or additional physical findings, the decision was made to proceed with the case.

Upon entry into the operating room (OR), the patient was found to be in sinus tachycardia with a HR in the mid- 130's, which persisted after midazolam 2.5 mg *iv* and fentanyl 100 µg *iv* were administered. However, she appeared, and stated that she was completely relaxed. Her BP was 163/80 mmHg and her respiratory rate 18 breaths·min^{-1}. Bilateral superior laryngeal nerve and transtracheal blocks were performed to facilitate fibreoptic intubation. Glycopyrrolate was not administered because of the tachycardia. The attempt at fibreoptic intubation was quickly aborted because of impaired visualization due to copious secretions. However during this brief attempt with sedation, it was determined that the patient could open her mouth enough to enable direct laryngoscopy. She received Ringer's lactate 1 L during the unsuccessful attempt at fibreoptic intubation. Her vital signs immediately before induction were: sinus tachycardia at 144 beats·min^{-1}, BP 172/82 mmHg and a respiratory rate of 18 breaths·min^{-1}.

After pre-oxygenation, anesthesia was induced with propofol 140 mg *iv*, fentanyl 200 µg *iv* and succinylcholine 100 mg *iv*. The patient was intubated without difficulty, and correct placement of the endotracheal tube was confirmed by auscultation and capnometry. Within 30 sec, before any additional anesthetic was

administered, she was noted to be in supraventricular tachycardia at a rate of 160 beats·min^{-1}, with a BP of 60/29 mmHg. The rhythm quickly deteriorated to ventricular fibrillation, at which point chest compressions were initiated. Almost immediately, the patient was successfully defibrillated with 200 joules. An arterial blood gas drawn several minutes after resuscitation revealed a pH of 7.32, $PaCO_2$ of 45 mmHg, PaO_2 of 608 mmHg, and a potassium of 4.3 mEq·L^{-1}.

Two hours after the episode of ventricular fibrillation the trachea was extubated. The patient's neurological status was unchanged from baseline. Two days later, electrophysiologic studies revealed an atypical, fast-slow atrioventricular nodal re-entrant tachycardia conducted with right bundle branch block aberrancy. Radiofrequency ablation of the posterior inputs (slow pathway) to the atrioventricular node was performed, with no inducible postablation arrhythmias. Two days after radiofrequency ablation, the spinal tumour was successfully removed, and the patient made an uneventful recovery.

Case 2

The patient was a 53-yr-old male with no significant medical history, who was scheduled for open reduction internal fixation of bilateral calcaneal fractures in a two-stage operation. The resting ECG was normal, and a routine preoperative internal medicine consultation concluded the patient was at low risk for a perioperative cardiac event. On arrival into the OR, the patient was noted to be in sinus tachycardia at a rate of 130 beats·min^{-1}, which was attributed to anxiety. His BP was 151/92 mmHg, with a respiratory rate of 20 breaths·min^{-1}. An *iv* catheter was placed and the patient was given 500 mL of Ringer's lactate, midazolam 2 mg *iv*, fentanyl 100 µg *iv* and metoprolol 5 mg *iv*, in divided doses over five minutes. This lowered his HR to 100 beats·min^{-1} and his BP to 140/86 mmHg.

General anesthesia was induced with sodium thiopental 350 mg *iv*, an additional 100 µg *iv* dose of fentanyl and rocuronium 50 mg *iv*, and maintained with isoflurane, fentanyl, nitrous oxide and oxygen. Aside from a brief recurrence of sinus tachycardia to a rate of 140 beats·min^{-1} following laryngoscopy, the 5 ½ hour case was uneventful. During the course of the operation, the patient received a total of 1200 µg of fentanyl and an additional 7 mg of metoprolol, which were titrated to maintain a HR in the low 80's. After the incision was closed, the patient was ventilated with an FIO_2 of 1.0 in an attempt to extubate the trachea. The patient developed a narrow complex tachycardia without visible 'P' waves at a rate of 160 beats·min^{-1}; BP with this rhythm was 155/90 mmHg. Carotid massage was performed, which resulted in a decrease in HR to 140 beats·min^{-1}. Adenosine 6 mg *iv* and metoprolol 1 mg *iv* were administered, with no significant change in HR; however, within 30 sec the QRS complex widened. This wide-complex tachycardia persisted for about one minute, and was accompanied by a drop in BP to 70/40 mmHg. Fluid and phenylephrine were administered, the ECG reverted to sinus rhythm at a rate of 80 beats·min^{-1}, and the patient was transferred to the recovery room intubated and sedated. Six hours later the trachea was extubated and the patient was neurologically intact. Postoperative evaluation included spiral computed tomography to rule out a pulmonary embolus, serial ECGs with cardiac isoenzymes, echocardiography, and cardiac catheterization, all of which were normal. One week later the patient underwent an uneventful general anesthetic to complete surgery on the other foot. Modifications in the anesthetic technique included placement of an arterial line, aggressive beta blockade to a HR < 80 beats·min^{-1}, and extubation under deep anesthesia. There were no further episodes of tachycardia.

Case 3

The patient was a healthy 27-yr-old female with no previous surgical history who was scheduled for excision of a right leg melanoma. During the preanesthetic evaluation the morning of surgery, the patient appeared slightly anxious but requested that the case be done under local anesthesia with sedation. She was taking no medications and denied any cardiac symptoms. Auscultation of her heart revealed a HR of 118 beats·min^{-1} with no extraneous cardiac sounds.

Upon arrival in the OR, the patient was noted to be in sinus tachycardia at a rate of 138 beats·min^{-1}, with a BP of 149/90 mmHg. Intravenous access was obtained and the patient was given midazolam 3.5 mg *iv* and fentanyl 200 µg *iv* in divided doses. This resulted in a decrease in HR to 129 beats·min^{-1} and BP to 140/81 mmHg. At this juncture the patient was responsive to loud verbal stimuli, but was not spontaneously conversant. There was no discussion of cancelling the case, and the patient's leg was prepped and draped for surgery. Just prior to incision, the patient complained of "crushing" substernal chest pain, accompanied by nausea and shortness of breath. She denied ever having had a similar experience. Her vital signs at this point were: HR 146 beats·min^{-1}, BP 150/86 mmHg, and a respiratory rate 22 breaths·min^{-1}.

The case was cancelled and the patient referred for cardiac evaluation. This revealed no evidence of a myocardial infarction and a normal stress thallium

test. An echocardiogram showed mitral valve prolapse with mild regurgitation. Ten days later the patient was rescheduled to have her melanoma removed under general anesthesia. The patient was premedicated with lorazepam 1 mg *per os* before coming to the hospital, and given prophylactic ampicillin 2 g *iv* in the holding area. The HR upon arrival in the OR was 124 beats·min^{-1}, which decreased to 90 beats·min^{-1} after midazolam 3 mg *iv*, fentanyl 150 µg *iv* and metoprolol 3 mg *iv* were administered. Following anesthetic induction with propofol, the case was completed uneventfully using intermittent fentanyl boluses, and isoflurane and oxygen administered through a laryngeal mask airway.

Discussion

In this series, we present three patients with no prior past medical history in whom pronounced, unexplained preoperative tachycardia presaged an adverse, perioperative cardiac event. In two of the cases, the planned procedure was either cancelled or aborted. Prior to rescheduling the surgeries, preemptive interventions were undertaken which facilitated successful completion of the operations.

In and of themselves, these cases are of academic interest. Case #1 describes the first report whereby fast-slow atrioventricular nodal re-entrant tachycardia presented as ventricular fibrillation after anesthesia induction. To our knowledge, case #3 describes the first report in which mitral valve prolapse presented as severe chest pain perioperatively. However, the primary significance of these cases lies not in their uniqueness, but in the common theme they share: in all three patients, pronounced, unexplained preoperative tachycardia was the only indicator of a preexisting, potentially fatal cardiac condition.

Little information exists regarding the incidence of preoperative sinus tachycardia, its effect on perioperative morbidity, or guidelines for management. A recent MEDLINE search revealed no articles on any of these subjects. In response to this paucity of data, we reviewed the preoperative HRs of 60 ASA I or II patients undergoing non-emergent surgery in whom the information was made available during a quality improvement review (mean age 31.4, SD 8.5). In eight patients (13%), the first recorded HR was ≥ 100 beats·min^{-1}. In two of these patients (3%), the initial HR was > 130 beats·min^{-1}. The anesthetic plan did not appear to be altered in any of these cases, and there were no reported complications.

There are two main reasons why pronounced, unexplained preoperative tachycardia can negatively impact outcomes. The first is that it may be a portent for some undiagnosed medical condition. These conditions include, but are not limited to, endocrine disorders such as hyperthryroidism and pheochromocytoma, cardiac disorders such as pre-excitation syndromes and re-entrant pathways, drug withdrawal and undiagnosed infection. Patients with these conditions can be, and usually are, safely anesthetized, but minimizing the risk involved dictates first treating the underlying disorder (Table, available as Additional Material at www.cja-jca.org).

The second reason is that, even in the absence of underlying pathology, untreated sinus tachycardia can increase the risk for perioperative complications. In a study by Frolich and Caton, the authors found that a high baseline HR was strongly predictive of marked hypotension, defined as a > 30% decrease in mean arterial BP, following spinal anesthesia in prehydrated pregnant patients.[8] Patients with a baseline HR > 90 beats·min^{-1} had an 83% chance of developing marked hypotension after subarachnoid block *vs* a 25% chance in parturients whose preoperative HR was < 90 beats·min^{-1}.

Rose *et al.* conducted a large, prospective study to determine the contribution of various risk factors for postoperative cardiac events.[9] Both intra- and postoperatively, tachycardia (HR > 120 beats·min^{-1} for longer than ten minutes) and hypertension (systolic BP > 200 mmHg for longer than five minutes) were found to be associated with an increased incidence of postoperative cardiac events. These findings are supported by the work of Leung and Dzankic, who found intraoperative tachycardia and emergency surgery to be the most important predictors of adverse outcomes in geriatric surgical patients.[10] Neither study evaluated what effect preoperative tachycardia had on outcomes.

Caution must be observed when extrapolating the results of these findings to patients presenting with baseline tachycardia. Unlike preoperative tachycardia which can signify long-standing, pre-existing pathology, the development of sudden intra- or postoperative tachycardia often indicates that an adverse event has already occurred. Nevertheless, the findings of Rose *et al.* and Leung and Dzankic do warrant consideration. Although no data exist on the relationships between preoperative and intraoperative tachycardia, and preoperative tachycardia and complications, previous studies have found associations between preoperative and intraoperative BP, and preoperative BP and perioperative complications.[11–13] It is therefore possible that a similar relationship exists for preoperative and intraoperative HR. For preoperative tachycardia due to a known etiology (e.g., pain or anxiety), appropri-

ately treating the causative factor should eliminate this association.

Considering the frequency with which anesthesiologists are confronted with unexplained preoperative tachycardia, it is surprising that so little research has been done on the subject and no guidelines exist to steer management. In the absence of any treatment algorithm, the ultimate decision as to whether proceed or cancel the case depends primarily on the comfort level of the intraoperative caregivers (i.e., the anesthesiologist and surgeon). Factors that must be considered in this decision include the type, urgency and expected length of surgery, the patient's age and co-morbidity, and the response to therapeutic interventions.

So what should be done with the patient who presents to the OR with profound, unexplained tachycardia poorly responsive to anxiolytics, analgesics and fluid challenge, in whom the urgent nature of the surgery dictates proceeding? No research has been conducted on this subject, but several adjustments in the anesthetic management ought to be considered. These include:

1. The use of invasive monitoring for early detection of hemodynamic changes, ischemia or arrhythmias;
2. Avoidance of drugs with sympathomimetic effects;
3. Perioperative beta-blockade in the absence of any contraindications;
4. The use of non-depolarizing muscle relaxants for intubation in the absence of anticipated airway issues.

The first two recommendations are relatively benign and intuitive, and thus require no explanation. The last two are more controversial. In surgical patients at high risk for cardiac complications, the judicious use of beta-blockers has been found to reduce peri- and postoperative morbidity and mortality.[14,15] The use of this drug class has not been evaluated in healthy patients due to the low risk of anesthesia and surgery in these individuals. However, given the known adverse effects of persistent, untreated tachycardia, treatment with beta-blockers might be beneficial in some patients. Possible consequences of untreated perioperative tachycardia include an increased risk of ischemia, high output heart failure and arrhythmias.

Unlike non-depolarizing muscle relaxants, the pharmacologic effects of succinylcholine are protean and unpredictable. The drug stimulates not only nicotinic receptors in sympathetic and parasympathetic ganglia, but muscarinic receptors in the heart as well. In low doses, this generalized autonomic stimulation can manifest as a negative chronotropic and inotropic response that may be attenuated by prior administration of atropine. However with higher doses, the stimulatory effects often become apparent, which can lead to cardiac arrhythmias.[16] In animals, circulating catecholamine levels increase fourfold after succinylcholine administration,[17] and the threshold of the ventricle to catecholamine-induced arrhythmias is lowered.[18] Stimulating events such as endotracheal intubation add to these arrhythmogenic effects. In the first case reported, it is impossible to determine whether or not the development of ventricular fibrillation after anesthesia induction was due to the hemodynamic effects of succinylcholine, propofol, intubation, or a combination of the three. In addition to precipitating arrhythmias, the pharmacodynamic effects of succinylcholine may also predispose patients with profound tachycardia to heart failure and ischemia.

In summary, we report three cases in which pronounced, unexplained preoperative tachycardia was a harbinger of an adverse, perioperative cardiac event. It is our hope that these cases will stimulate discussion among experts to establish a set of guidelines for dealing with this scenario based on sound, scientific evidence, and to underscore the need for more research in the area.

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