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Institutional report - Coronary

Intraoperative heart rate variability of a cardiac surgeon himself in coronary artery bypass grafting surgery

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Abstract

The mental strain of a cardiac surgeon may differ when he performs coronary surgery from and when he only assists in performing coronary surgery. In 50 selected cases of on-pump heart arrested coronary artery bypass grafting (CABG), an attending-consultant surgeon performed 30 procedures of CABG (Group A) and an attending-consultant surgeon supervised the remaining 20 cases of CABG performed by two resident surgeons (Group B). Intraoperative Holter electrocardiograms of the attending-consultant surgeon were recorded and analyzed for heart rate variability (HRV). In Group A, the ratio of low frequency to high frequency was at a peak in the beginning of the operation and gradually decreased toward the end of the operation. In Group B, the ratio of low frequency to high frequency was at a peak in the phase of aortic cross-clamp, coronary anastomosis, and unclamping. When an attending-consultant surgeon performed the operation himself, the most anxious part of the operation was at the beginning and thereafter the level of anxiety gradually declined. In contrast, when he assisted a resident, the highest level of anxiety was when the aortic cross-clamp was in place and out of place and during the coronary anastomosis.

Keywords: Heart rate variability; Mental strain; Coronary artery bypass grafting

1. Introduction

The manner in which attending-consultant surgeons educate resident-trainees in cardiothoracic surgery remains an issue of intense debate because teaching them without affecting the surgical results is thought to be educationally demanding. Since supervising and assisting residents and fellows seems to be more mentally demanding than performing the procedure itself, it would be worthwhile to determine the intraoperative heart rate variability (HRV) of the attending-consultant surgeon himself as a measure of mental strain.

The autonomic nervous system is a major determinant of the functional properties of the heart in that it alters spontaneous sinus node depolarization and cardiac rhythm, which can be assessed by the rhythm of the sinus node. It has been very useful in the past to transform HRV into power spectral density to monitor a variety of pathological physical and mental states and to measure the sympathovagal balance [1].

This study determined whether there were any differences in the HRV when an attending-consultant surgeon performed coronary artery bypass grafting (CABG) surgery and when he supervised and assisted CABG.

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2. Materials and methods

With institutional review board approval and informed consent, 50 cases of on-pump and cardioplegically arrested CABG were enrolled in this study from April 2005 to August 2007. The exclusion criteria were a poor cardiac function less than a 40% ejection fraction, a difficult aorta to manipulate, definite indications for off-pump CABG, and refusal on the part of the patients. An attending-consultant surgeon performed 30 cases of CABG, called Group A and the remaining 20 cases were performed by two residents under the strict supervision of the attending-consultant surgeon, called Group B. Table 1 shows the patients profile. The resident-trainee surgeons refused to have their intraoperative electrocardiogram recorded. All the patients underwent postoperative coronary angiograms to verify the graft patency before being discharged.

2.1. Measuring HRV

Electrocardiograms were run continuously on a solid-state very small autonomous recording device (RAC-3103, Nihon Kohden, Japan) from the moment a surgeon walked into the operating room to the moment the surgeon finished the operation. All digital data were transferred to a personal computer after surgery and analyzed off-line using commercially available software by an EKG technician. The length of the tachogram and the type analysis were

Table 1
Patient profiles

	Group A ($n=30$)	Group B ($n=20$)	P-value
Age (mean)	47–82 (72.2)	54–77 (68.6)	NS
Male	18 (60.0%)	12 (60.0%)	NS
NYHA, mean	2.7	2.2	NS
EF	50–70 (61.8)	52–66 (60.7)	$P<0.01$
DM	11 (36.7%)	7 (35.0%)	NS
CVD	3 (10.0%)	0 (0.00%)	NS
CRF	4 (13.3%)	0 (0.00%)	NS
Number of grafts	87	54	$P<0.01$

NYHA, New York Heart Association status; EF, ejection fraction; DM, diabetes mellitus; CVD, cerebral vascular disease; CRF, chronic renal failure.

selected according to the recommendations of the guidelines [1]. The variations in heart rate were evaluated by time and frequency domain measures of this tachogram. The commercial program (Memcalc, Nihon Kohden, Japan) calculated the power spectral density using the fast Fourier transformation and distinguished a low-frequency (LF) component of 0.04–0.15 Hz and a high-frequency (HF) component of 0.15–0.4 Hz. It is assumed that when sympathetic activity increases, the power LF increases; conversely, when vagal activity increases, the power of HF increases. Therefore, it is important to calculate the LF/HF ratio, in which the lower the ratio the more stable the mental strain. The normal value of the LF/HF ratio is 1.5–2.0 [1].

The overall procedure of CABG was divided into six well-defined steps to evaluate the most demanding parts of the procedure and to allow for a proper comparison between the two groups as shown in Table 2. The statistical significance of the baseline patients' demographics and postoperative mortality and morbidity were analyzed by the paired Student's t-test.

3. Results

3.1. Mortality and postoperative morbidity

Table 3 shows no statistically significant differences to be observed between the two groups.

3.2. HRV analysis

Fig. 1 shows comparison of the mean LF to HF ratio between the two groups.

In Group A, the LF/HF ratio was highest at the beginning of the surgery, i.e. phase I, and it showed a gradual decrease toward the end of the surgery. In Group B, LF/HF ratio was highest during the phase IV, i.e. cross-clamp, coronary anastomosis, and unclamp.

Table 2
Six serial phases during coronary artery bypass grafting

Phase I	Incision
Phase II	Graft harvesting
Phase III	Cannulation and CPB on
Phase IV	Cross-clamp, anastomosis, and unclamp
Phase V	CPB off and decannulation
Phase VI	Hemostasis and closing

CPB, cardiopulmonary bypass.

Table 3
Surgical results

	Group A ($n=30$)	Group B ($n=20$)	P-value
In-hospital death	0 (0.00%)	0 (0.00%)	NS
Reoperation for any reasons	0 (0.00%)	0 (0.00%)	NS
Cardiac morbidity	0 (0.00%)	0 (0.00%)	NS
Neurological morbidity	0 (0.00%)	0 (0.00%)	NS
Renal morbidity	0 (0.00%)	0 (0.00%)	NS
Pulmonary morbidity	1 (3.33%)	1 (5.00%)	NS
Infective morbidity	0 (0.00%)	0 (0.00%)	NS
Graft patency	98.9%	100%	NS

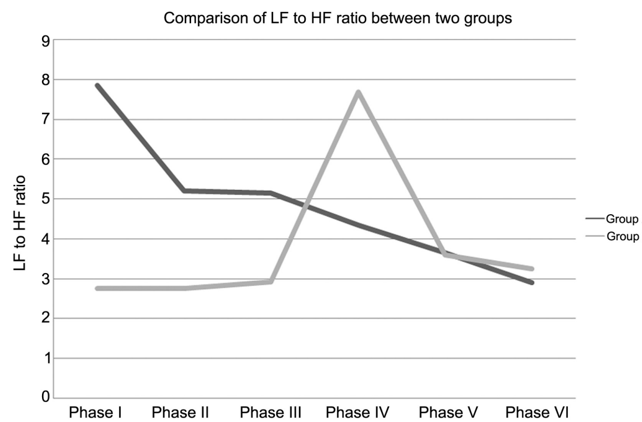

Fig. 1. Comparison of the mean low frequency component to the high frequency component ratio between the two groups.

4. Discussion

HRV is studied in many aspects of cardiac autonomic functions. Most investigators of HRV agree that the LF/HF ratio reflects the sympathovagal balance more reliably than any other components of HRV [2, 3].

Mental strain in the operating room is very difficult to define and to measure. It seems that measuring HRV is currently the best method of assessing mental strain and is more sensitive than measuring heart rate alone [4–8]. Needless to say, cardiac surgeons are always under tense mental and socio-legal strain to yield satisfactory results for both the patients and referring cardiologists. The results themselves could be assessed from various points of view. Quantitative and qualitative audits of performance of cardiac surgeons are of intense general interest and under critical surveillance [9].

This particular study observed two striking facts. One was that the LF/HF ratio of the attending-consulting surgeon, the best indicator of strain in response to stress and problems, was the highest in the beginning of all operations and it thereafter steadily stabilized and decreased toward the end. This tendency was observed throughout this series of relatively easy and straightforward CABG cases. Second was that LF/HF ratio of the attending-consulting surgeon became highest in the phase of heart arrested and coronary anastomosis when he supervised a resident-trainee surgeon as an assistant.

These two observations deserve two comments: first, in the hands of an attending-consultant surgeon, once the operation begins, the mental and physical strain tend to decrease and he then becomes comfortable because the rest of the surgical procedures are the same actions that he performs every time during coronary surgery. Second, an attending-consultant surgeon intrinsically pays very careful and tense attention to the phase of arresting the heart, coronary arteriotomy, and sewing coronary grafts when he supervises a resident-trainee surgeon because an attending-consultant surgeon intrinsically knows those phases are the most important stage of coronary surgery.

The limitations of this study include that this study just measured HRV of a single surgeon and therefore there is no control data for the HRV. This limitation will be overcome by a future study measuring the HRV of several surgeons.

In summary, this study is the first report to measure and evaluate the intraoperative HRV of a cardiac surgeon and it showed that there was a clear difference between when an attending-consultant surgeon performs CABG and when he supervises and assists CABG. When an attending-consultant surgeon performed the operation himself, the most anxious part of the operation was at the beginning and thereafter this gradually declined. In contrast, when he assisted a resident, the highest level of anxiety was when the aortic cross-clamp was in place and out of place and the coronary anastomosis was being performed.

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eComment: Stress levels of the surgeon within and beyond the operating room

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I read with great interest the report by Dr. Song and co-workers evaluating the heart rate variability as a measure of stress levels of a cardiac surgeon [1]. Notably, the stress levels differ from performing a coronary artery bypass grafting (CABG) procedure on their own or assisting it to residents. Interestingly, the resident-trainee surgeons refused to have their intraoperative electrocardiogram recorded, which would have been of distinct interest in my personal view. It seems that the more experienced a surgeon, the greater is the expected decline in stress levels throughout a standardized procedure at daytime. However, the impact of on-call procedures during after-office hours might be determined in the future.

Stress levels of a given surgeon should be regarded in a larger perspective beyond the OR. Pressure due to time constraints, administrative pressure and/or personal attitudes towards stress management are likely to influence the response of a given surgeon to stress. It would be interesting to know whether stress levels in the OR are similar as following administrative tasks outside the OR?

In surgical training in general surgery, intraoperative cardiac rate increased by 4–10%, particularly in the resident serving as primary surgeon during laparoscopic cholecystectomy [2]. The most stressful moments of the aforementioned general surgical procedure were the draping of the surgical field, trocar placement, clip application, and extraction of the gallbladder. Perceived stress levels among surgeons during a 24-hour-shift correlate with heart rate variability, whereas fatigue does not [3]. Stress-coping strategies may play a role in this regard, too [4].

Thus, the stress of the surgeon within and beyond the OR is of distinct interest.

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