ST- segment depression and myocardial contractility during Cesarean section under spinal anesthesia

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Purpose: To evaluate myocardial contractility during ST segment depression in healthy parturients during Cesarean section (CS).

Methods: Forty-seven consecutive term parturients undergoing elective CS under spinal anesthesia were studied. The ST segment was recorded continuously on leads II and V5 using a Holter monitor. Myocardial performance was evaluated by measuring cardiac index (CI), heart rate (HR), pre-ejection period (PEP), ventricular ejection time (VET), systolic time ratio (STR, PEP/VET), and ejection fraction (EF) with an impedance cardiograph.

Results: Fourteen patients (30%) developed ST segment depression within 15 min after delivery and the remaining 33 (70%) did not (controls). Seven patients developed a 1 mm change, five patients a 2 mm change and the remaining two a 3 mm change in the ST segment. Compared with pre-anesthesia values, the mean HR increased from 103 ± 10 to 116 ± 10 (1SD) bpm ($P = 0.001$), CI from 4.7 ± 0.7 to 5.6 ± 1.7 L·min⁻¹ ($P = 0.01$), EF from 0.58 ± 0.08 to 0.66 ± 0.05 ($P = 0.01$) and STR decreased from 0.26 ± 0.06 to 0.2 ± 0.04 ($P = 0.01$) during ST segment depression. At this time, CI, HR and EF were greater and STR smaller than values obtained 15 min after delivery in the control subjects.

Conclusion: ST-segment depression occurring during CS is associated with a hyperkinetic myocardial contractile state.

Objectif : Évaluer la contractilité du myocarde pendant le sous-décalage du segment ST chez des parturientes en santé qui subissent une opération césarienne (OC).

Méthode : On a étudié quarante-sept parturientes qui se sont successivement présentées pour une OC sous rachianesthésie. On a procédé à l'enregistrement continu du segment ST en D II et V5 à l'aide d'un moniteur Holter. On a évalué la performance myocardique en mesurant l'index cardiaque (IC), la fréquence cardiaque (FC), la phase de prééjection (PPE), le temps d'éjection ventriculaire (TEV), la durée de l'éjection (PPE/TEV) et la fraction d'éjection (FE) avec un cardiographe à impédance.

Résultats : Quatorze patientes (30 %) ont développé un sous-décalage du segment ST en 15 min ou moins après l'accouchement, mais non les autres patientes (70 %, témoins). Sept patientes ont développé un changement de 1 mm du segment ST, cinq en ont développé un de 2 mm et les deux autres de 3 mm. Les valeurs obtenues comparées à celles d'avant l'anesthésie font que la FC moyenne s'est accrue de 103 ± 10 à 116 ± 10 (1 écart-type) bpm ($P = 0,001$), l'IC est passé de $4,7 \pm 0,7$ à $5,6 \pm 1,7$ L·min⁻¹ ($P = 0,01$), la FE de $0,58 \pm 0,08$ à $0,66 \pm 0,05$ ($P = 0,01$) et la durée de l'éjection a diminué de $0,26 \pm 0,06$ à $0,2 \pm 0,04$ ($P = 0,01$) pendant le sous-décalage du segment ST. À ce moment, les valeurs de l'IC, de la FC et de la FE étaient plus élevées, et la durée de l'éjection plus courte, que les valeurs mesurées 15 min après l'accouchement chez les sujets du groupe témoin.

Conclusion : Le sous-décalage du segment ST qui se produit pendant l'OC est associé à un état de contractilité myocardique hyperkinétique.

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MANY authors^{1,2} have reported ST-segment depression in 25-60% of healthy women undergoing cesarean section (CS). We report data on ventricular contractility including cardiac index (CI), stroke volume index (SVI), prejection period (PEP), ventricular ejection time (VET), systolic time ratio (STR, PEP/VET) and ejection fraction (EF) associated with ST-segment depression during elective CS under spinal anesthesia.

Methods

After approval by the Institutional Review Board, informed consent was obtained from 47 consecutive non-smoking healthy women (ASA I or II) with an uncomplicated singleton term pregnancy. Following an intravenous infusion of 1500 ml Ringer's lactate solution, spinal anesthesia was induced to T₄ sensory level using bupivacaine 0.75%. Left uterine displacement was maintained and intravenous ephedrine used to treat systolic pressure < 100 mm Hg. Synthetic oxytocin was administered intravenously at a rate 2 mu-minute over 30 min.

A QMED Holter monitor (QMED Holter One TC monitor, QMED Inc, Lawrence Harbor, NJ 08878) was used to record ECG continuously on leads II and V5. A significant ST-depression was defined as a change of ≥ 1 mm (0.1 mV) from the isoelectric line starting 60 ms after the J point and lasting ≥ 40 seconds.¹ An impedance cardiograph (NCCOM3-R7, CDDP system, Bomed Medical Manufacturing Ltd, Irvine, CA) was used for the noninvasive measurement of CI, SVI, EF, PEP, VET and STR (PEP/VET).³

The body mass index (BMI, (weight in kg/height in m²) was calculated. Most ST- changes occurred within 15 min after delivery. Data were obtained at the following time (T) points: T1- prior to anesthesia (baseline), T2- five minutes before the onset of ST-segment depression, T3- during ST segment depression, and T4- at the end of surgery. In those who did not develop ST segment changes data obtained at delivery and 15 min after delivery were substituted for

T2 and T3 respectively. Results were expressed as mean $\pm$ 1SD. Repeated measures analysis of variance and Student's t test were used for statistical comparisons at $P < 0.05$.

Results:

Fourteen patients (30%) developed ST-segment depression (ST group) lasting two - five minutes in both leads II and V and the remaining 33 did not (controls). Age, height, weight and BMI did not differ among groups (Table I). Approximately 28% of patients required ephedrine in both groups. Seven patients developed a 1 mm change in the ST segment, five patients a 2 mm change and the remaining two a 3 mm change.

In the ST group, the HR and CI were greater at T2 and T3 compared with T1 values (Figure 1). The HR decreased at T3 and T4 in controls. The HR was faster at T2 and T3 and the CI greater at T3 in the ST group compared with matching values in the control group (Figure 1). The SVI did not differ among the groups at any point (Table II). In all patients, the onset of ST segment change was heralded by tachycardia (Figure 2).

The STR decreased at T3 in both groups from their respective T1 values. The STR was smaller in the ST group at T2 and T3 compared with values in the other group. (Table II). The PEP at T3 was 38% shorter in the ST than in the control group. The EF increased in the ST group at T2 and T3 from the T1 values and

TABLE I Demographic data

Parameter	ST-segment group (n = 14)		Control group (n = 33)	
	Mean $\pm$ SD	Range	Mean	Range
Age (yr)	33 $\pm$ 7	17-39	32 $\pm$ 4	22-43
Height (cm)	159 $\pm$ 10	143-170	161 $\pm$ 7	150-178
Weight (kg)	71 $\pm$ 22	45-108	75 $\pm$ 20	45-143
Body mass index (kg.m ²)	28 $\pm$ 7	19-37	29 $\pm$ 6	19-45

No significant differences were noted between the groups in any of the parameters

TABLE II Ejection fraction (EF), systolic time ratio (STR) and Stroke volume index (SVI, ml.m²)

Time Points	EF	EF	STR	STR	SVI	SVI
	ST group	Controls	ST group	Controls	ST group	Controls
T1	0.58 $\pm$ 0.08	0.57 $\pm$ 0.08	0.26 $\pm$ 0.11	0.31 $\pm$ 0.11	45 $\pm$ 7	47 $\pm$ 15
T2	0.63 $\pm$ 0.08*†	0.58 $\pm$ 0.08	0.21 $\pm$ 0.06†	0.30 $\pm$ 0.1	49 $\pm$ 13	50 $\pm$ 13
T3	0.66 $\pm$ 0.06*†	0.60 $\pm$ 0.09	0.2 $\pm$ 0.04*†	0.25 $\pm$ 0.1*	48 $\pm$ 14	50 $\pm$ 13
T4	0.61 $\pm$ 0.07	0.60 $\pm$ 0.09	0.26 $\pm$ 0.11	0.26 $\pm$ 0.11	41 $\pm$ 9	47 $\pm$ 13

Legend: T1- baseline; T2 - 5 min before ST-segment event; T3 - During ST event; T4 - end procedure. * - significantly different from the respective T1 value; ; † - different from the other group. STR = PEP/VET

FIGURE 1 Heart rate (HR) and cardiac index (CI) in the ST group (ST, $n = 14$) and in controls (C, $n = 33$) at baseline (T1), 5 min before ST event (T2), during ST event (T3) and at the end (T4).

* -significantly different from T1; † -different from the other group. In controls, values at delivery (Point A) and 15 min after delivery (Point B) were used. Data is mean $\pm$ 1SD.

was significantly greater at these times compared with values in the control group (Table II).

Discussion

Impedance cardiography has been used in pregnant women for the measurement of CI and STR.³ The technique has sufficient accuracy for detecting trends.^{4,5} Our data show that myocardial performance is not impaired during an ST event and that tachycardia is a harbinger of an impending ST event. In our study, ST-events occurred regardless of BMI, a known risk factor for coronary artery disease.⁶ Depression of the ST segment due to ischemia may affect myocardial contractility.⁷ However, trans-sternal echocardiography done in parturients during a ST event has not shown any myocardial dysfunction.¹

We evaluated myocardial contractility using CI, STR, and EF. During ST segment change CI increases with no significant change in SV. Both STR and PEP are relatively insensitive to changes in HR.⁸ The PEP represents isovolumic contraction of the ventricle.⁸ A shorter PEP or a decreased STR indicates augmented inotropic state and the opposite is true of impaired function.⁸ According to Stack *et al.*,⁹ a STR value of ≤ 0.34 is not associated with impaired contractility. In our study, PEP, STR, EF and HR data point to augmented ino- and chronotropic states during ST event.

The etiology of ST event during CS is unknown. Exercise electrocardiography yields a false positive

FIGURE 2 Nomogram generated by the Holter monitor showing the heart rate (HR) before and during ST event in leads II (Channel A) and V (Channel B). Abbreviation used: BPM - beats-minutes.

results in pregnant and non-pregnant females.^{10,11} The mechanisms responsible for these spurious results may also cause the ST-segment changes during CS. Fortunately, ST-segment depression is not associated with impaired myocardial function. In our opinion, further intervention and cardiology consultation are warranted only if the ST-segment change lingers in

the recovery room and/or is associated with persistent chest pain. A closer watch is recommended if the patient has preexisting heart disease.

References

- 1 *Zakowski MI, Ramanathan S, Baratta JB, et al.* Electrocardiographic changes during cesarean section: a cause for concern? *Anesth Analg* 1993; 76: 162–7.
- 2 *Palmer CM, Norris MC, Giudici MC, Leighton BL, DeSimone CA.* Incidence of electrocardiographic changes during cesarean delivery under regional anesthesia. *Anesth Analg* 1990; 70: 36–43.
- 3 *Mandell GL, Jamnback L, Ramanathan S.* Hemodynamic effects of subarachnoid fentanyl in laboring parturients. *Reg Anesth* 1996; 21: 103–11.
- 4 *Fuller HD.* Evaluation of left ventricular function by impedance cardiography: a review. *Prog Cardiovasc Dis* 1994; 36: 267–73.
- 5 *Cybulski G, Mikiewicz Z, Szulc J, Torbicki A, Pasierski T.* A comparison between the automatized impedance cardiography and pulsed-wave Doppler echocardiography methods for measurements of stroke volume (SV) and systolic time intervals (STI). *J Physiol Pharmacol* 1993; 44: 251–8.
- 6 *Burkman RT.* Obesity, stress, and smoking: their role as cardiovascular risk factors in women. *Am J Obstet Gynecol* 1988; 158: 1592–7.
- 7 *Konstadt S, Reich DL, Thys DM, Aronson S.* Transesophageal echocardiography. In: Kaplan JA (Ed.). *Cardiac Anesthesia*, 3rd ed. Philadelphia: W.B. Saunders Company, 1993; 342–85.
- 8 *Hassan S, Turner P.* Systolic time intervals: a review of the method in the non-invasive investigation of cardiac function in health, disease and clinical pharmacology. *Postgrad Med J* 1983; 59: 423–34.
- 9 *Stack RS, Sohn YH, Weissler AM.* Accuracy of systolic time intervals in detecting abnormal left ventricular performance in coronary artery disease. *Am J Cardiol* 1981; 47: 603–9.
- 10 *Asher UA, Ben-Shlomo I, Said M, Nabil H.* The effects of exercise induced tachycardia on the maternal electrocardiogram. *Br J Obstet Gynaecol* 1993; 100: 41–5.
- 11 *Cummings GR, Dufresne C, Kich L, Samm J.* Exercise electrocardiogram patterns in normal women. *Br Heart J* 1973; 35: 1055–61.