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Effect of Neuraxial Blockade on Diastolic Function of Parturients at Term

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Abstract

Maternal diastolic function has been shown to deteriorate during the progression of pregnancy. Neuroaxial blockade has been reported to improve diastolic dysfunction in patient with coronary artery disease. We therefore hypothesized that neuroaxial blockade will improve diastolic function of parturients at term. Sixty two parturients who either underwent Continuous Labor Epidural analgesia (CLE) or Combined Spinal Epidural analgesia (CSE) (35 cases) were enrolled. The subjects underwent echocardiography prior and after induction of neuroaxial blockade. In these parturients there was no evidence of diastolic dysfunction at baseline. Neuroaxial blockade did not alter parameters of diastolic function in these patients. We conclude that neuroaxial analgesia does not acutely change maternal diastolic function during labor.

Introduction

The progression of an uncomplicated pregnancy is associated with substantial alterations in maternal cardiovascular function, including changes in plasma volume, cardiac output, and systemic vascular resistance [1]. Using serial trans-thoracic echocardiography, maternal diastolic function has been investigated and found repeatedly to deteriorate significantly from early gestation to term [2,3]. Epidural anesthesia has also been shown to improve diastolic function in patients with coronary artery disease undergoing revascularization [4], but its effect on diastolic function in parturients has not been reported. Because epidural and combined spinal-epidural anesthesia are commonly used to provide pain relief during labor, and have been reported to blunt the sympathetic nerve activity in parturients, we hypothesized that epidural and combined spinal-epidural anesthesia could alter diastolic function in parturients at term.

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Methods

Sixty-two healthy term parturients who were hospitalized for labor or induction of labor and planned neuroaxial analgesia were recruited. The patients were divided into two treatment groups: patients who received epidural analgesia for labor and patients who received combined spinal-epidural analgesia for labor. Twenty-nine received Continuous Labor Epidural analgesia (CLE) and thirty-five received Combined Spinal-Epidural analgesia (CSE).

This study was approved by the Sharp Health Care Institutional Review Board (Protocol No. 141186) and written informed consent was obtained from all participants. Potential subjects were excluded if they had known structural heart disease, ischemic coronary disease, essential hypertension or hypertensive disorder of pregnancy, congestive heart failure, dilated cardiomyopathy, or infiltrative disease of the myocardium. All patients were in sinus rhythm at the time of recruitment. The patient's age, Body Mass Index (BMI), analog pain score, blood pressure, heart rate, gestational age and volume of I V fluids received since admission were recorded (Table 1). Each patient was then positioned in left lateral decubitus position for transthoracic echocardiography. Imaging and Doppler echocardiography were performed using a Phillips iE33 (Carlsbad, CA) machine and an S5-1 transducer according to the guidelines of the American Society of Echocardiography [5]. A 3-lead EKG was applied to correlate rhythm with echocardiography findings. Then an apical 4 chamber view (A4C) of the left ventricle was obtained. The transmitral flow was recorded with a sample volume positioned at the tips of the mitral leaflets during diastole with leaflet tips fully opened. Early ("E") and late ("A") peak mitral inflow velocity measurements were obtained at end expiration and the E:A ratio was calculated. Tissue Doppler was then used to assess the velocity of the myocardium (e') within the mitral valve annulus, at the septal and lateral walls.

Subjects were studied first prior to initiation of labor analgesia ("Pre") and then after placement

Table 1: Subjects' baseline characteristics.

Variable	CLE		CSE		ALL	
	Mean	SD	Mean	SD	Mean	SD
Age (years)	30	6	31	4	30	5
Gestational Age (days)	277	8	276	8	277	8
BMI	30	5	32	7	31	6
Pre-blockade MAP (mmHg)	86	8	85	11	85	10
HR (bpm)	81	12	81	11	81	14
Pain Score (pre)	2	2	2	2	2	2
Pain Score (post)	1	1	0	1	1	1

Table 2: Hemodynamic data.

Variable	CLE		CSE		p-value
	Mean	SD	Mean	SD	
AHR	10.633	7.522	11.667	11.677	0.665959
ASBP	10.133	6.318	13.083	8.206	0.104101
ADBP	10.267	7.492	13.694	8.369	0.084153
AMAP	8.666	6.671	13.417	6.399	0.00471

AHR: heart rate pre - post block; ASBP: Systolic blood pressure pre-post block; ADBP: diastolic blood pressure pre-post block; AMAP: Mean arterial pressure pre-post block.

of neuraxial analgesia ("Post") as soon as they reported a value <3 on a visual analog pain scale. Clinicians performing the neuraxial anesthetic were not instructed to vary from their routine practice. At the discretion of the clinicians, each patient either received an epidural or a combined spinal/epidural for labor. Bolus and continuous infusion volumes were left to the discretion of the clinicians and the volumes used are listed in the Appendix. Numeric pain score, blood pressure, heart rate, oxygen saturation and IV fluid volume received were recorded before and after the introduction of neuraxial analgesia (Table 1).

The transthoracic echocardiography study was repeated one hour later. Each patient was re-positioned in left lateral decubitus position, and again the 3 lead EKG was used to correlate with echocardiography findings. The views and measurements were repeated in a manner identical to that which had been obtained prior to initiation of neuraxial analgesia and the images and measurements were recorded in the same manner described previously.

Statistical Analysis

A summary of baseline characteristics for both cohorts (CLE and CSE) is presented in Table 1. In this table, data are expressed as a mean and standard deviation. The hemodynamic and Doppler derived variables are presented by cohort and the statistical significance of each variable is determined from measurements before (Pre) and after (Post) neuraxial analgesia within each cohort (Table 2 and 3). The primary endpoints were for all subjects was the E/e' ratio and the E/A ratio and each subject was compared to their own E/e' and E/A ratio prior to neuraxial analgesia. Three measurements were made for each variable and averaged. Septal and lateral mitral annular tissue velocity values were considered separately and averaged. Statistical significance was calculated using a paired difference model with a paired t-test. A sample size of 31 parturients in each group was calculated to have 80% power to detect a difference of 2 with Type 1 error control set at 0.5.

Results

The subjects' baseline characteristics are presented as means and standard deviations. The mean gestational age was 39.6 weeks (277 days). Among both CSE and CLE cohorts, only one patient was less than 37 weeks. The average BMI of both cohorts measured prior to neuraxial analgesia was 31. The subjects' hemodynamic parameters were within published guidelines for normal values. The mean arterial pressure averaged 85 mmHg and the average HR was 81 bpm. The average self-reported pain score prior to analgesia was 2 (out of 10); approximately 1 h after analgesia and just prior to the repeat trans-thoracic examination, the score was 1. Both MAP and pain scores were significantly different before and after neuraxial analgesia for both CSE and CLE cohorts. The patients received approximately 1L fluid between pre-analgesia exam and the post-analgesia exam. Five patients in the CLE cohort and 11 patients in the CSE cohort received ephedrine prior to the post-analgesia TTE study for hypotension as part of the protocol for all patients receiving neuraxial analgesia at Mary Birch hospital. No patient required any additional pharmacological intervention to correct hemodynamic derangements. Because of practical limitations, LV cardiac output and ejection fraction were not directly measured, but no patient

Table 3: Doppler derived data.

	CLE					CSE				
	Pre		Post		p-value	Pre		Post		p-value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
E	16.28	14.17	76.03	14.73	0.46812	79.19	2120	75.54	20.6	0.2504342
A	49.81	9.11	48.19	1222	212664	45.81	9.02	51.42	15.35	0.082741
E/A	1.58	0.43	1.63	0.4	246908	1.75	0.44	1.54	0.46	0.0229142
AE/A			0.48	27	XXXXXX			29	0.25	0.0050235
e' medial	11.36	2.92	10.58	2.13	0.097384	12.45	2.84	10.89	1.78	0.0790022
e' lateral	13.69	3.89	14.13	3.42	0.309959	13.41	2.84	14.93	3.02	0.0632519
e' average	12.52	2.75	12.36	226	0.378308	12.93	2.34	12.91	2.22	0.4920585
E/e' (medial)	7.19	2.49	7.51	227	290812	6.53	1.69	7.09	2.08	0.1756762
E/e' (lateral)	5.97	1.86	5.78	2.02	0.336804	5.96	121	522	1.43	0.0780416
E/e' (average)	6.34	1.7	6.42	1.92	0.425539	6.14	128	5.98	1.58	0.3753544
AE/e' (avg)			1.66891	1.3001	XXXXX			1.64457	1.19134	0.9375702

E=eedydadak peek transmkrel vela*. A= fete tkennultel peek nicely, e' meriekeedy sop& twee doe*, peek nicely, e' leder.* Metal well issue dopplerpeedcvela*

was observed to have either regional or global impairment to LV systolic function and LV systolic function was subjectively observed to be hyperdynamic in both cohorts both before and after neuraxial blockade was performed.

In both the CLE and CSE cohorts, the pain scores and blood pressure changes were consistent with successful analgesia and an induced sympathectomy. It is noteworthy that the patients reported pain at the time of the pre-analgesia echo study of 2/10 and the post-analgesia TTE of 1/10. Despite these differences, there was only a significant difference in the E/A value from the CSE cohort and in the ΔE/A between cohorts. For both cohorts, CLE and CSE, the difference in E/e' values pre-and post-analgesia was not significant. The e' values from neither the medial septum nor lateral free wall were different for either cohort of parturients or the E/e' values either separately or averaged were also not different in either cohort. In addition, there was no difference when the change in average E/e' values (ΔE/e') was compared between both CLE and CSE subjects. Although all the patients in both cohorts were near term, parturients did not demonstrate any evidence of diastolic dysfunction prior to neuraxial analgesia in either cohort. The average e' medial was >8 cm/s in both cohorts and the average e' lateral was greater than 10 cm/s. Patients in both cohorts did not qualify for diastolic dysfunction prior to neuraxial analgesia.

Discussion

We compared Doppler derived trans-mitral flow velocities and tissue velocities in term parturients before and after CSE and CLE and found no significant change in either cohort. In addition, we did not observe that term parturients demonstrated any evidence of diastolic dysfunction at term before or after neuraxial analgesia. Although other studies have reported that diastolic performance deteriorates in pregnant females from early gestation to term, on average, patients in this study demonstrated no evidence of diastolic dysfunction at term prior to neuraxial intervention. In this regard, our results are consistent with reports from Zentner et al. [2] and Bamfo et al. [6] who both noted that diastolic function had diminished throughout term but remained within normal limits at 35-40 weeks. These studies did not assess the acute effect of neuraxial analgesia on diastolic function. Clinically, we did find evidence of a sympathectomy based on significant differences in MAP and self-reported pain scores we found a significant decrease in the E/A ratio in the CSE cohort, but overall, no difference in diastolic function was evident. The Doppler derived trans-mitral velocities have been previously described to change with changes in loading conditions and this isolated difference after CSE is likely explained by pooling of blood in venous reservoirs and decreasing filling volume late in diastole and not a meaningful change in diastolic function [7].

There are several reasons why either CSE or CLE might not alter diastolic function at term. First, none of the patient's met criteria for either impaired relaxation or reduced compliance by published criteria prior to neuraxial analgesia [8]. The preservation of LV diastolic function at term suggests that, in a cohort of healthy parturients, the impact of sympathetically mediated changes in maternal cardiovascular function may be less clinically significant than previously reported. Second, changes in diastolic function associated with gestation have been previously reported over weeks to months, but not over hours. It is possible that the sympathectomy associated with neuraxial analgesia might affect maternal diastolic function, but cannot be detected within the allotted time frame. Changes in diastolic function have been reported for other interventions but only after weeks to months and in these reports the impact on diastolic dysfunction has been variable [9,10].

While the effect of sympathetic nervous activity is well established for systolic function [11,12] there is less evidence supporting a relationship between diastolic function and sympathetic tone. Most studies rely on indirect evidence to demonstrate a relationship using, for example, plasma or urinary levels of nor epinephrine, muscle sympathetic nerve activity or heart rate variability to estimate detect changes in sympathetic tone. Trans-thoracic echocardiography is widely used to estimate and grade diastolic function clinically but exact reliable diagnostic criteria has not been established [7,13]. It may be that, in this context, transthoracic echo was inadequately sensitive to demonstrate any change in diastolic function after neuraxial analgesia.

Limitations

This study has several significant limitations. First, none of the patients in either cohort met published criteria for diastolic dysfunction so alterations in diastolic dysfunction might have been too small to detect at this sample size. In addition, the post blockade study was performed approximately 1 h after the block was administered. The time that elapsed between studies may have been too short to detect any change in diastolic function and it is possible that after a longer interval a change in diastolic function might have been detected. Additionally, dosage of neuraxial blockade was left to discretion of the clinicians and was not uniformly applied within both cohorts. This may have introduced selection bias and obscured an effect that would have been detected had all patients received the exact same dose for neuraxial block.

Conclusion

Our data suggest that neuraxial analgesia has no effect on diastolic function in term parturients one hour after initiation. This was true whether the subject received epidural analgesia alone or combined spinal-epidural analgesia. We note that none of the patients qualified for diastolic dysfunction prior to initiation of analgesia and all patients' demonstrated hemodynamic and clinical evidence of sympathectomy. This data suggests that the immediate effect of neuraxial blockade on systolic function is not reproduced during diastole. We conclude that neuraxial analgesia does not acutely change maternal diastolic function during labor.

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