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学 位 論 文

Echocardiographic Assessment of Systolic Time Intervals in Vaginal and Cesarean Delivered Neonates

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槇 原 研

ECHOCARDIOGRAPHIC ASSESSMENT OF SYSTOLIC TIME INTERVALS IN VAGINAL AND CESAREAN DELIVERED NEONATES

Ken Makihara, MD,
Toshiyuki Hata, MD, PhD,
Kohkichi Hata, MD, PhD,
Manabu Kitao, MD, PhD.

A short title : Systolic time intervals pre and post delivery

Department of Obstetrics and Gynecology, Shimane Medical University, Izumo 693, Japan

Address correspondence to : Ken Makihara, MD, Department of Obstetrics and Gynecology, Shimane Medical University, Izumo 693, Japan
Tel. Japan 0853-23-2111 (Extension 2735)
Fax Japan 0853-21-7443

PRECIS

Pulmonary hypertension was prolonged in elective Cesarean section infants.

ABSTRACT

Echocardiographic assessments of fetal and neonatal systolic time intervals were made to determine differences in circulatory changes in 40 neonates delivered vaginally and 30 delivered by elective Cesarean section. Left pre-ejection period (LPEP), left ventricular ejection time (LVET), LPEP/LVET, right pre-ejection period (RPEP), right ventricular ejection time (RVET), RPEP/RVET, and heart rate were determined at various time points from antenatal to 120 hours after delivery. There were no significant changes in left systolic time intervals between the two groups at any various time points. However, RPEP and RPEP/RVET values were significantly higher in the Cesarean section group than in those in normal vaginal delivery group, within 12 hours after delivery. These results suggest that the transient pulmonary hypertension after delivery is prolonged in babies delivered by elective Cesarean section.

INTRODUCTION

There have been numerous reports on the increased risk of disadaptations of babies delivered by Cesarean sections[1-4], including hypertension, vascular congestion, cardiomegaly, excessive interstitial or pleural fluid[4], and delayed resorption of fluid[5]. The main disorder observed in these infants is a transient tachypnea[5] and in such cases the vascular congestion induced by the interstitial edema of the lung causes pulmonary hypertension.

The absorption of fetal lung fluid is increased and the production of fetal lung fluid are diminished by catecholamines released by adrenergic stimulations during active labor[6]. Bland et al.[7] found in newborn rabbits that the fetal lung fluid is reduced in amount prior to delivery due to the stimulus of active labor.

Leighton et al.[8] measured right ventricular systolic time intervals at cardiac catheterization and noted that the duration of right pre-ejection period (RPEP) correlates with changes in pulmonary artery diastolic pressure, and Hirschfeld et al.[9] reported that increased pulmonary artery diastolic pressure, pulmonary vascular resistance and mean pulmonary artery pressure resulted in an increased RPEP/right ventricular ejection time (RVET) and that a marked elevation of this ratio indicated the presence of pulmonary hypertension.

The present study was designed to determine if the extent of pulmonary hypertension in infants delivered by elective Cesarean section infants would compare with that in vaginally delivered

infants.

MATERIALS AND METHODS

A longitudinal study from antenatal to early neonatal periods was conducted in 40 infants delivered vaginally (V) and 30 infants delivered by elective Cesarean section (C). Informed consent was obtained from each mother for this study. All infants were delivered in our university hospital after 37 weeks, menstrual age and birth weights were in the normal range (between 10th and 90th percentiles) of the standard intrauterine growth curve for the Japanese[10]. Apgar score values in all infants were 8 and over and no infants had a respiratory problem. Indications for Cesarean section were pelvic disproportion, abnormal fetal presentation, or previous Cesarean section. There were no differences in birth characteristics in V and C groups, determined by unpaired t-test or Wilcoxon-Mann-Whitney test (Table 1).

M-mode echocardiographic recordings of the fetal heart were made about 13 days before the delivery. After the delivery, these recordings were carried out within 15 minutes, and at 3, 6, 9, 12, 18, 24, 48, 72, 96 and 120 hours.

Echocardiographic studies were obtained with a phased array sector scanner (Aloka SSD-720) and a 3 MHz transducer. For the in utero fetal M-mode and electrocardiographic recording, the electrocardiographic signals from abdominal electrodes placed at three points of the maternal abdomen were amplified (MIC-6600, Fukuda Denshi, Japan), filtered (30-100Hz) and recorded simultaneously with M-mode echogram on a monitor occiloscope [11), 12)]. The procedures used to calculate the systolic time intervals

have been described in detail elsewhere[11),12)]. In brief, the left pre-ejection period (LPEP) was obtained by measuring from the initiation of the QRS complex to the aortic valve opening and the left ventricular ejection time (LVET) by measuring from the aortic valve opening to closure. Similarly, the RPEP was obtained by measuring from initiation of the QRS complex to the pulmonary valve opening, and the RVET by measuring from the pulmonary valve opening to closure. Five consecutive beats were measured and averaged for all determinations.

Comparison of each value at each age between V and C groups was made using unpaired t-test. The change in each parameter before and after delivery was tested using analysis of variance and Neuman-Keuls multiple comparison test. A p-value of less than 0.05 was considered to have a statistically significant difference.

RESULTS

Heart rate (HR) increased from before delivery to within 15 minutes after delivery, decreased from just after delivery to 3 hours later, and did not change thereafter, in either group (Fig.1). There were no significant differences in heart rate values (except for 48 hours values) at each age between the 2 groups.

There was no significant difference of each value for LPEP, LVET, and LPEP/LVET at each age in V and C groups (Figs. 2,3, and 4).

The results of right systolic time intervals are shown in Figs. 5, 6 and 7. RPEP and RPEP/RVET values increased from before to just after delivery, in both groups. In group V, RPEP and RPEP/RVET decreased gradually after delivery, while RPEP and RPEP/RVET in group C remained constant until 12 hours after delivery, then declined. There was no significant difference of each value for RPEP and RPEP/RVET at each age (except for at 12 hours later) in V and C groups. Values for RPEP and RPEP/RVET in group C at 12 hours later were significantly larger than those in group V, respectively. The RVET was gradually prolonged after delivery, in both groups. At 24 hours later, the RVET value in group C was longer than that in group V.

DISCUSSION

Following obstetrical delivery, circulatory dynamics in the neonate change dramatically due mainly to four factors: (a) removal of the placenta; (b) decrease in pulmonary vascular resistance; (c) closure of the ductus arteriosus; and (d) closure of the foramen ovale[13]. Elimination of the placental circulation results in a marked increase in overall systemic vascular resistance and the onset of the respiration decreases the pulmonary vascular resistance[13]. With respect to changes of left and right systolic time intervals from fetal to neonatal circulation, we reported that the LPEP remained unchanged before delivery and up to 30 minutes after delivery, but the RPEP increased and the LPEP/LVET decreased from before delivery to 30 minutes after delivery, while the RPEP/RVET increased[12]. In the present study, similar results in changes of left and right systolic time intervals from before to just after delivery were noted in both V and C groups. These findings suggests that a shift of work load from the right to the left ventricle in the neonate occurs to the same degree in vaginal and Cesarean deliveries.

Differences in right systolic time interval values within 12 hours after delivery between the 2 groups were surprising. In group V, RPEP and RPEP/RVET decreased gradually after delivery, whereas RPEP and RPEP/RVET in group C remained high until 12 hours later, then declined. As elevation of the RPEP/RVET indicates the presence of pulmonary hypertension[9], these findings suggest that transient neonatal pulmonary hypertension

is prolonged in neonates delivered by elective Cesarean section. The absorption of lung fluid is increased and the production of lung fluid is diminished by catecholamines[6]. During delivery, the stress of hypoxic change to the fetus leads to a significant elevation of catecholamine concentrations in the umbilical cord plasma[14),15)]. The concentration of catecholamines in neonates delivered by Cesarean section was found by other workers[16)] to be significantly lower than that in babies delivered by the spontaneous vaginal route. The lower levels of catecholamines might relate to the transient prolonged neonatal pulmonary hypertension in Cesarean section infants. The mechanical compression of pelvic squeeze may also promote drainage of lung fluid in the vaginally delivered infants[4)].

The results of these investigations indicate that the transient prolonged pulmonary hypertension exists in elective Cesarean section infants, even in the absence of respiratory problems.

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Table 1 Characteristics of neonates.

Group	N	Birth Age (Weeks)	Birth Weight (g)	Apgar Score
V	40	39.6± 1.1	3202± 373	9.5± 0.8
C	30	39.6± 0.8	3154± 242	9.5± 0.6

V:normal vaginal delivery
C:elective Cesarean section

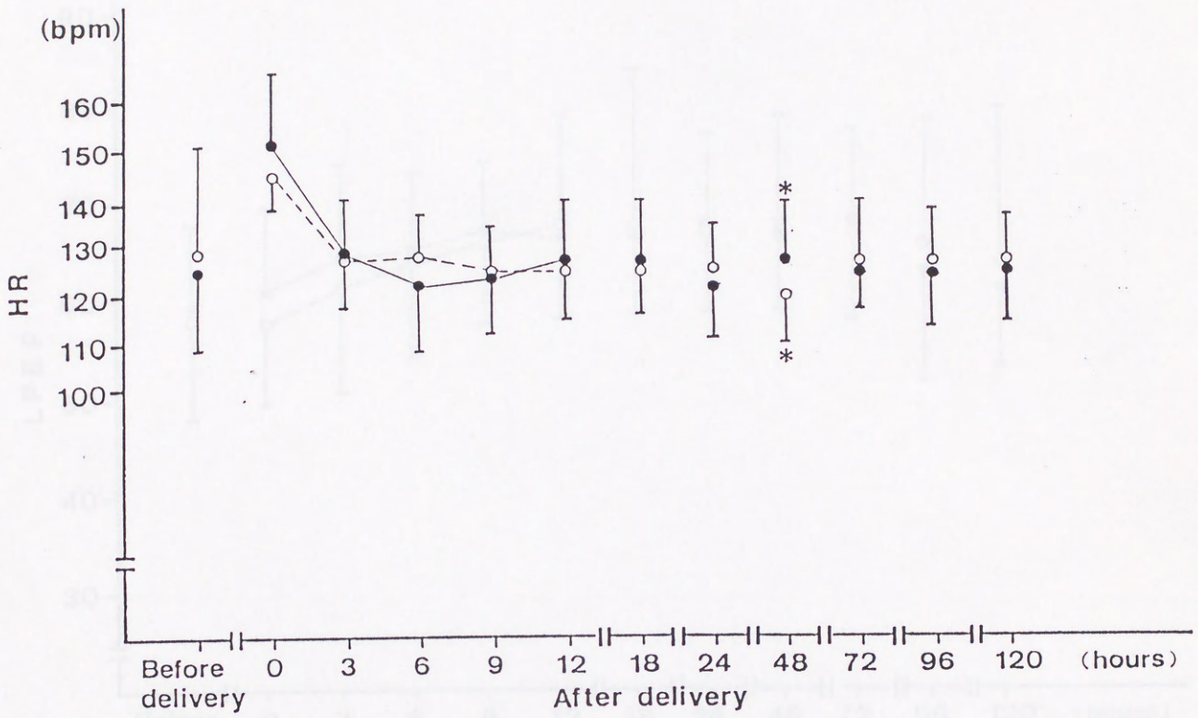


Figure 1 Change in heart rate (HR) (mean±SD)

○ : Group V, ● : Group C, * : P<0.05

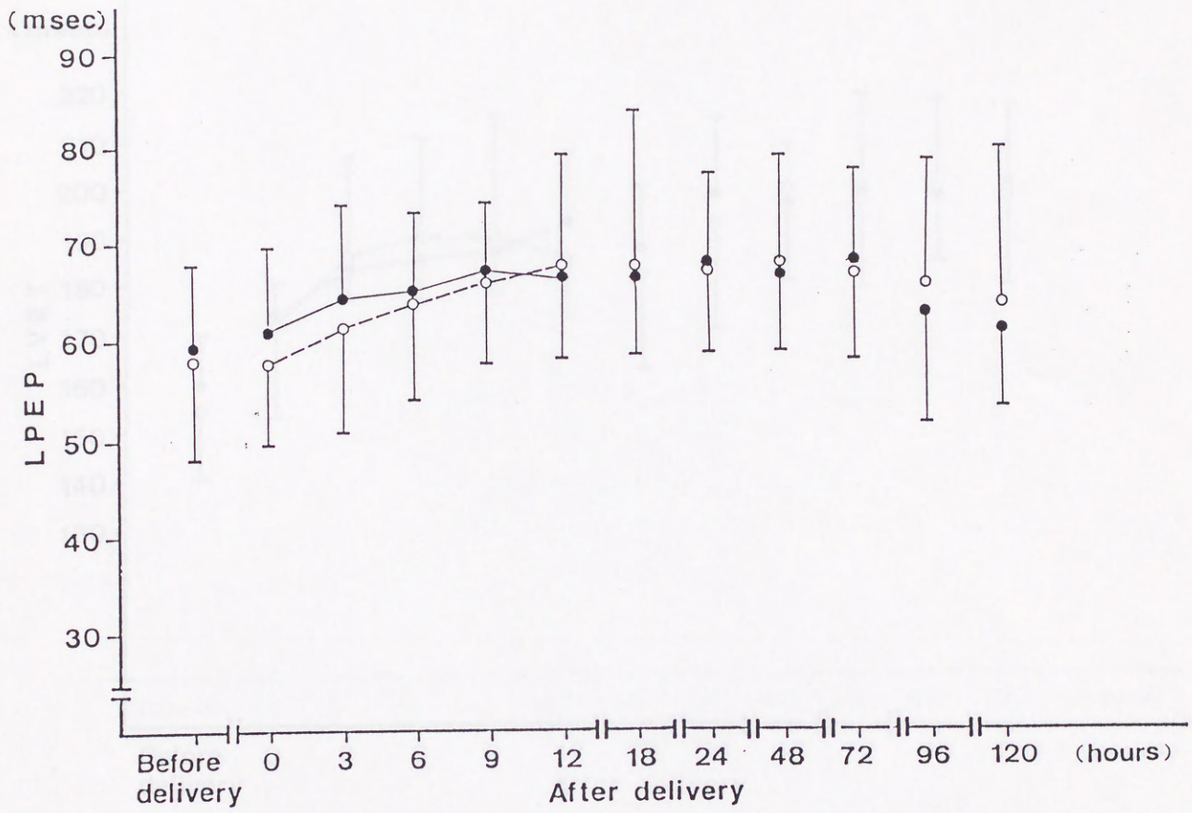


Figure 2 Change in left pre-ejection period (LPEP) (mean±SD)

○ : Group V, ● : Group C, * : P<0.05

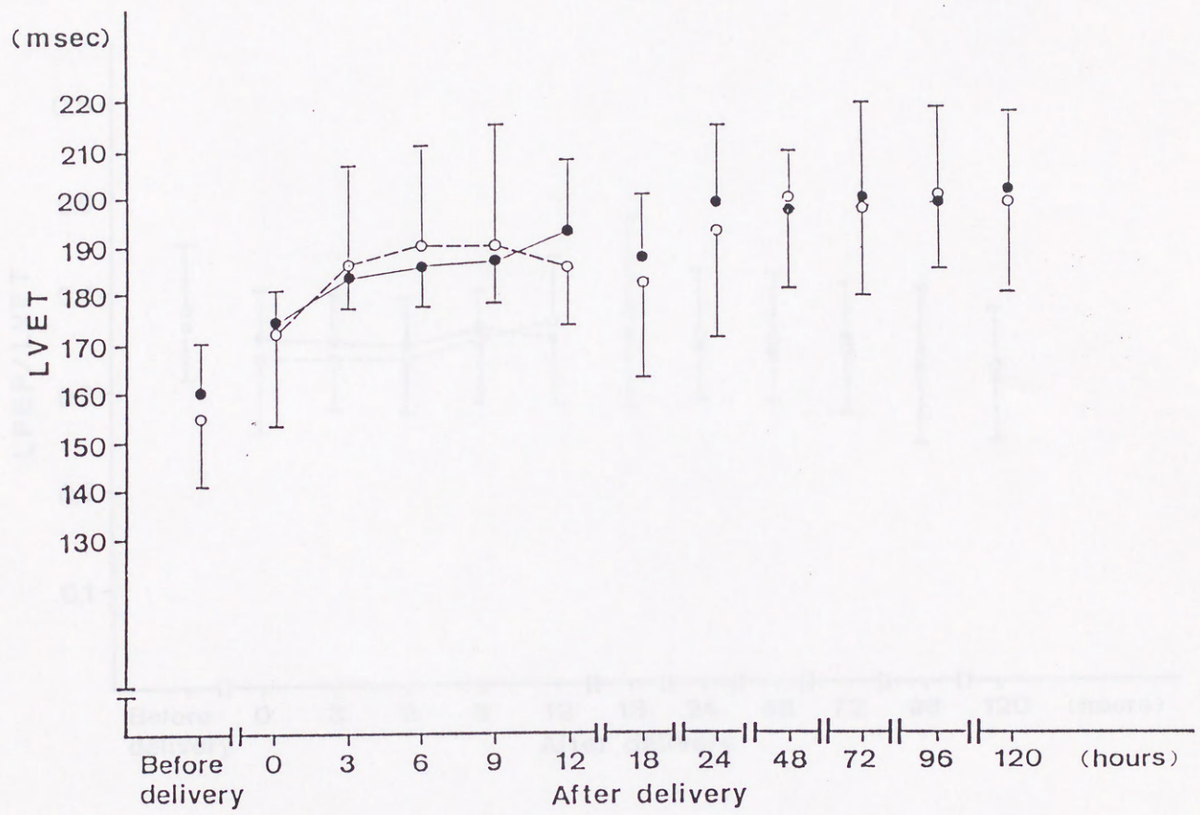


Figure 3 Change in left ventricular ejection time (LVET) (mean±SD)
○ : Group V, ● : Group C, * : P<0.05

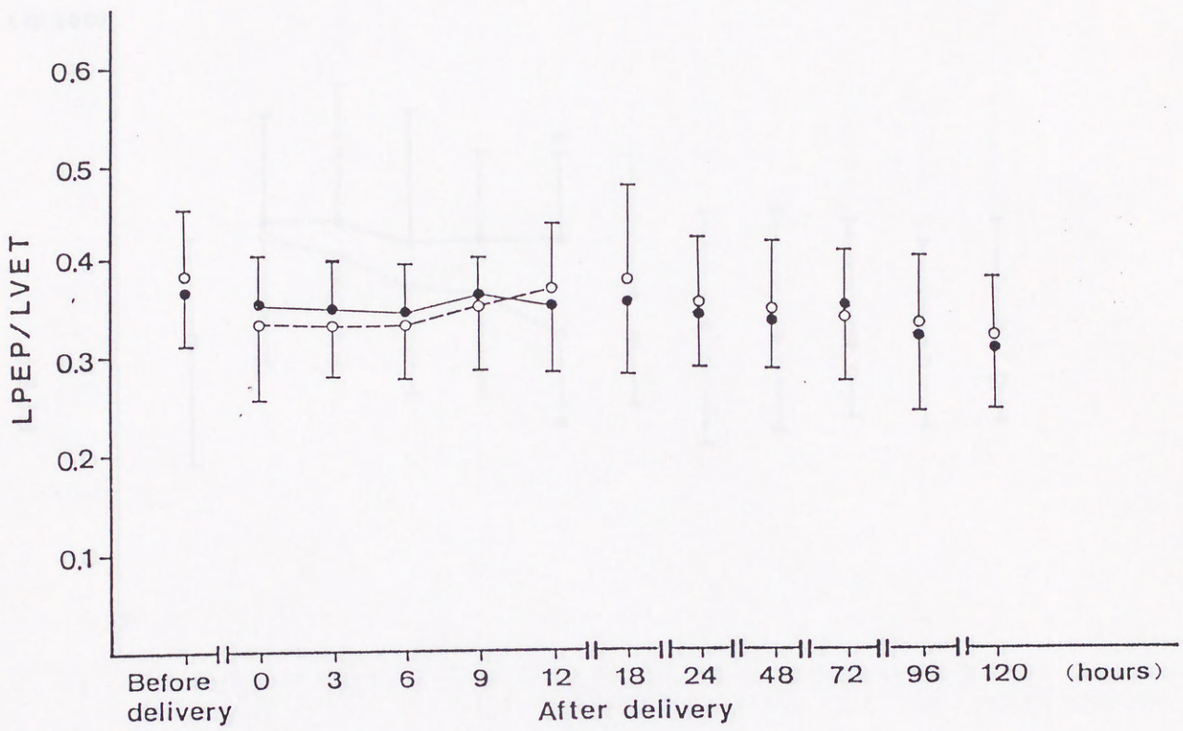


Figure 4 Change in LPEP/LVET (mean±SD)

○ : Group V, ● : Group C, ＊ : P<0.05

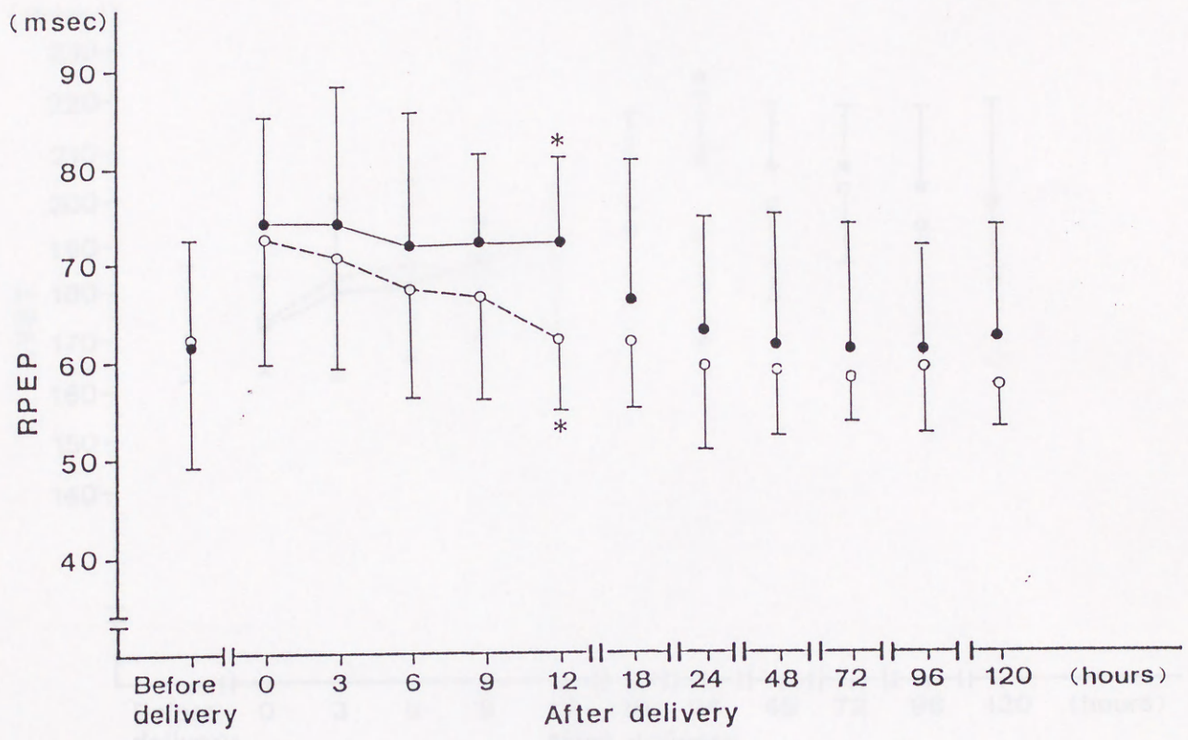


Figure 5 Change in right pre-ejection period (RPEP) (mean±SD)
○ : Group V, ● : Group C, * : P<0.05

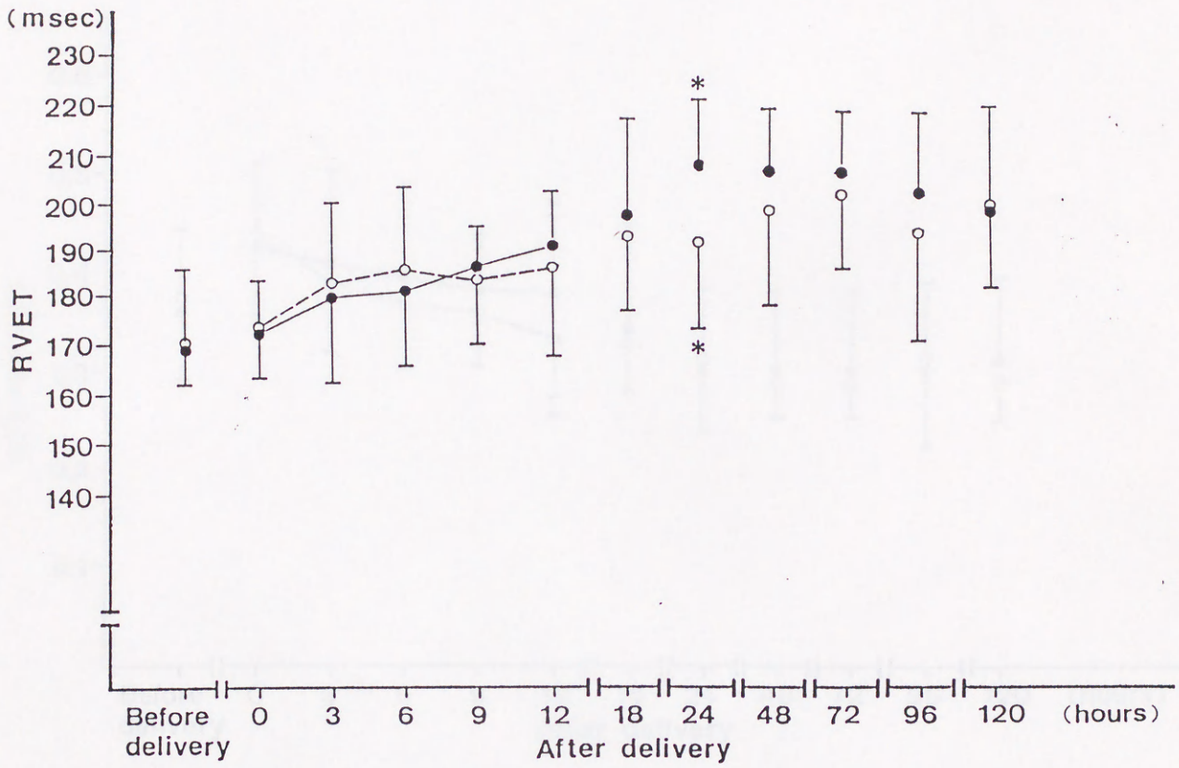


Figure 6 Change in right ventricular ejection time (RVET) (mean±SD)

○ : Group V, ● : Group C, * : P<0.05

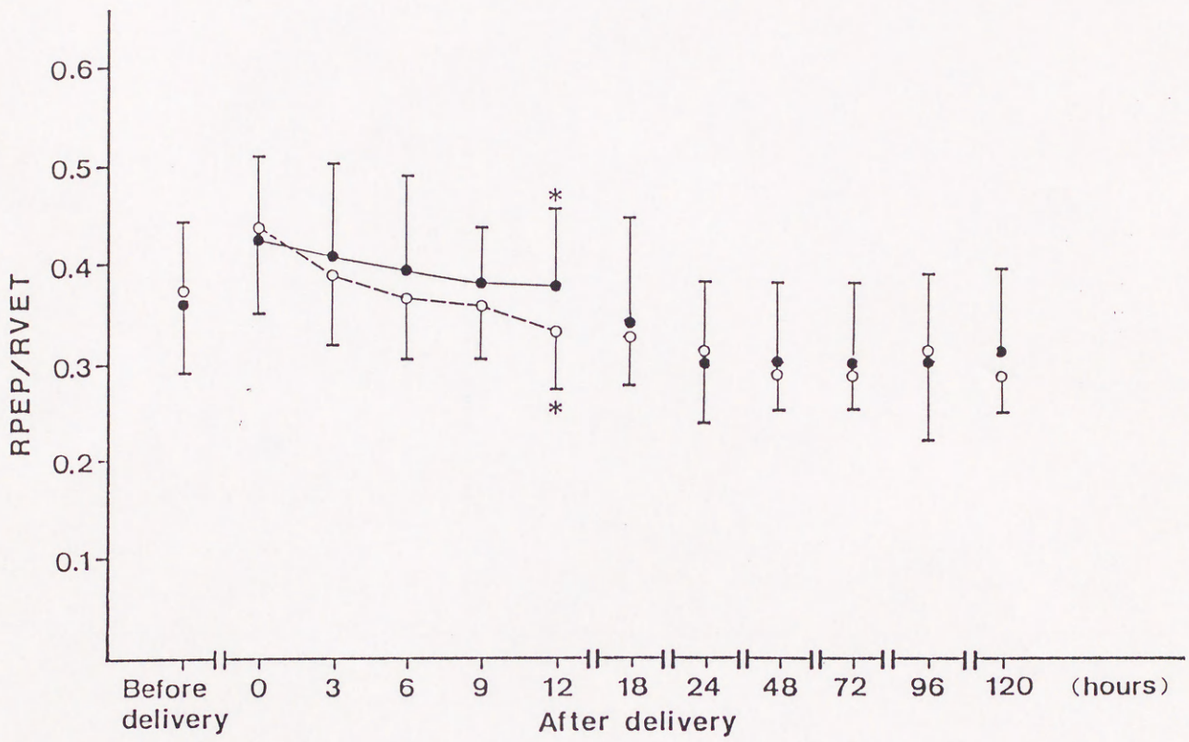
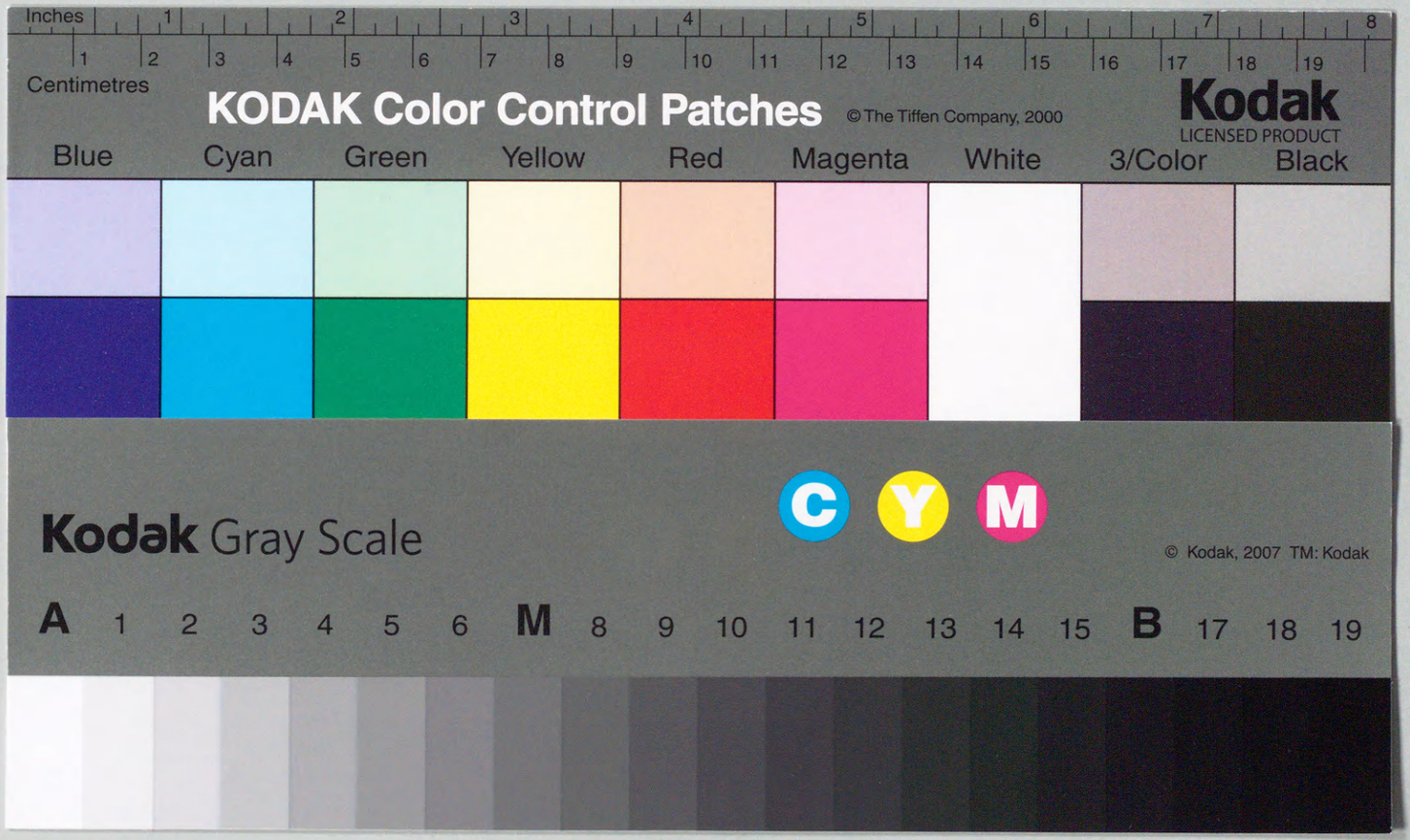


Figure 7 Change in RPEP/RVET (mean±SD) n±SD)

○ : Group V, ● : Group C, * : P<0.05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