

Original Article

A comparison of upper airway parameters in postpartum patients: vaginal delivery vs. caesarean section

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Abstract: Mallampati class has been shown to increase during labour. The influence of delivery mode on this change is not known yet. The aim of our study is to investigate the changes of upper airway parameters in parturients after caesarean section and vaginal delivery. Ninety parturients undergoing elective caesarean section and ninety parturients with vaginal delivery were enrolled. The parameters of Modified Mallampati test (MMT), inter-incisor distance, thyromental distance, sternomental distance, neck circumference were measured before labour (T0) and 1 h (T1), 6 h (T6) and 24 h (T24) after delivery. Overall, 39 parturients (45.3%) with increases in MMT class in the vaginal delivery group within 24 h After childbirth, were more than that in the caesarean section group [24 parturients (26.7%), $P=0.01$]. In the vaginal delivery group, the incidence of the increases in MMT class at T1 and T6 were similar, which were higher than that at T24 ($P=0.015$). In the caesarean section group, the incidence of MMT class increases at T6 was significantly higher than that at T1 ($P=0.015$) and T24 ($P=0.015$). Our findings indicate that increase in Mallampati class may be more significant and may take place earlier in parturients undergoing vaginal delivery than in those undergoing elective caesarean section.

Keywords: Airway, anesthesia, labour, obstetric, Modified Mallampati test

Introduction

Airway management is of vital importance to anesthesia safety. The incidence of failed tracheal intubation in the pregnant population is perhaps eight times higher than in the nonpregnant population during induction of general anesthesia [1-3]. As the seventh major cause for death of parturients, 33% of anesthetic accidents arise from difficult airway [4]. During pregnancy, the chest expansion, abnormal structure of bone joint [5] and change of soft tissues such as airway edema [6] may lead to difficult intubation.

Modified Mallampati test (MMT), which estimates the size of the tongue relative to the oral cavity, serves as a commonly used simple airway assessment parameter with favorable reproducibility, and is suitable for the prediction of difficult airway before anesthesia [7, 8]. Mallampati classes 3 and 4 are associated with difficult airway in parturients, with an increased relative risk of 7.6 and 11.3, respectively [9].

Previous studies have revealed that the Mallampati class of pregnant population may increase with the gestation weeks, and may further increase at the early stage after delivery [6, 10, 11]. However, the mode of delivery are not stratified in any of the studies, and the changes of airway after delivery between parturients undergoing caesarean section and those with vaginal delivery are not outlined. Therefore, this study aims to compare the airway changes between parturients undergoing caesarean section and those with vaginal delivery. Besides MMT, inter-incisor distance (IID), thyromental distance (TMD), sternomental distance (SMD), neck circumference (NC) [12-17] were employed to comprehensively evaluate the status of difficult airway.

Material and methods

Subjects

This prospective observational study was approved by the Ethics Committee of the Obstetrics

and Gynecology Hospital of Fudan University (Ref: [2011] 6). Ninety parturients undergoing elective caesarean section (caesarean section group) and ninety parturients with vaginal delivery (vaginal delivery group) were enrolled, and written informed consent was obtained from each parturient.

The inclusion criteria of parturients were ASA I or II, monofetal pregnancy at ≥ 36 week gestation, primiparity, age 20 to 40 years, height 155 to 175 cm and body weight 50 to 100 kg. No parturient had intrathecal block contraindications, gestational diabetes mellitus, and hypertension in pregnancy, preeclampsia, placental presentation and fetal distress. Parturients with hemorrhage more than 1000 mL during operation, emergency transference to caesarean section in vaginal delivery group, or resuscitation after severe postpartum hemorrhage were excluded from the study.

Anesthesia and analgesia

In caesarean section group, peripheral vein access was established after entering operation room, intravenous transfusion of 10 mL \cdot kg⁻¹ \cdot h⁻¹ crystalloid fluid was conducted, and heart rate, blood pressure, electrocardiogram and pulse oximetry were continuously monitored. Puncture was carried out in space between L3 and L4, epidural space was located by loss-of-resistance technique, and a 25 gauge pencil-point needle was inserted into subarachnoid space. Isobaric bupivacaine 8 to 9 mg was injected within 30 s, and epidural catheter was retained. The parturients were placed supine with 15° left lateral tilt, sensory block level was measured, and the operation began when the sensory block level reached T6. During anesthesia, intravenous injection of phenylephrine 50 to 100 μ g was performed in case of systolic blood pressure lower than 90 mmHg or decrease in blood pressure for more than 25% of baseline value, and atropine 0.25 to 0.50 mg was injected when heart rate was lower than 50 beats/min.

In vaginal delivery group, all parturients were managed with epidural block for labour analgesia, peripheral vein access was established at cervical dilatation of 2 to 3 cm, and heart rate, blood pressure and pulse oximetry were continuously monitored. Puncture was carried out at the L2-L3 interspace, epidural space was located by loss-of-resistance technique, and

4-cm catheterization to the head direction was conducted. The parturients were placed supine with 15° left lateral tilt, an experimental 3 mL of 1% lidocaine was administered through epidural catheter, then 10 to 20 mL mixture of 0.1% ropivacaine + 0.5 μ g/mL sulfentanyl was given at intervals. PCA pump was utilized when VAS score was lower than 30, and the analgesics were 0.1% ropivacaine + 0.5 μ g/mL sulfentanyl, with maintenance dose of 5 mL/h. The volume of PCA bolus was 5 mL, and the locked time was 15 min. Epidural administration of drugs was ceased after complete cervical dilatation, and was restarted after fetal disengagement. Epidural catheter was withdrawn at the completion of lateral perineal incision suture.

Data collection

Airway-related parameters were measured at the following time points: before labour (T0, during stay in anesthesia preparation room in caesarean section group and cervical dilatation 2 to 3 cm in vaginal delivery group), 1 h, 6 h and 24 h after delivery (T1, T6 and T24). All the parameters were measured by two experienced anesthesiologists, with parturients in the semi-sitting position. These two anesthesiologists see the same patient at all of the time points. The parameters included IID, TMD, SMD, NC, MMT [12-17]. The view on MMT was graded as follows: class I = soft palate, fauces, uvula, and pillars visible; class II = soft palate, fauces, and uvula visible; class III = soft palate and base of the uvula visible; class IV = soft palate not visible at all.

The duration of operation in caesarean section group, duration of labour in vaginal delivery group and volumes of hemorrhage and intravenous fluid infusion in both groups were recorded.

Statistical analysis

According to previous study, the proportion of parturients expected to have an increase in MMT class after delivery would be 40% [10], and the sample size should be 81 in each group at the difference between groups being 20% with a type I error of 0.05 and a power of 80%. With the potential exclusion of parturients, the sample size was set at 90 in each group.

Data are presented as mean \pm SD. Proportions were used as descriptive statistics for categorical variables. The normality of data distribution

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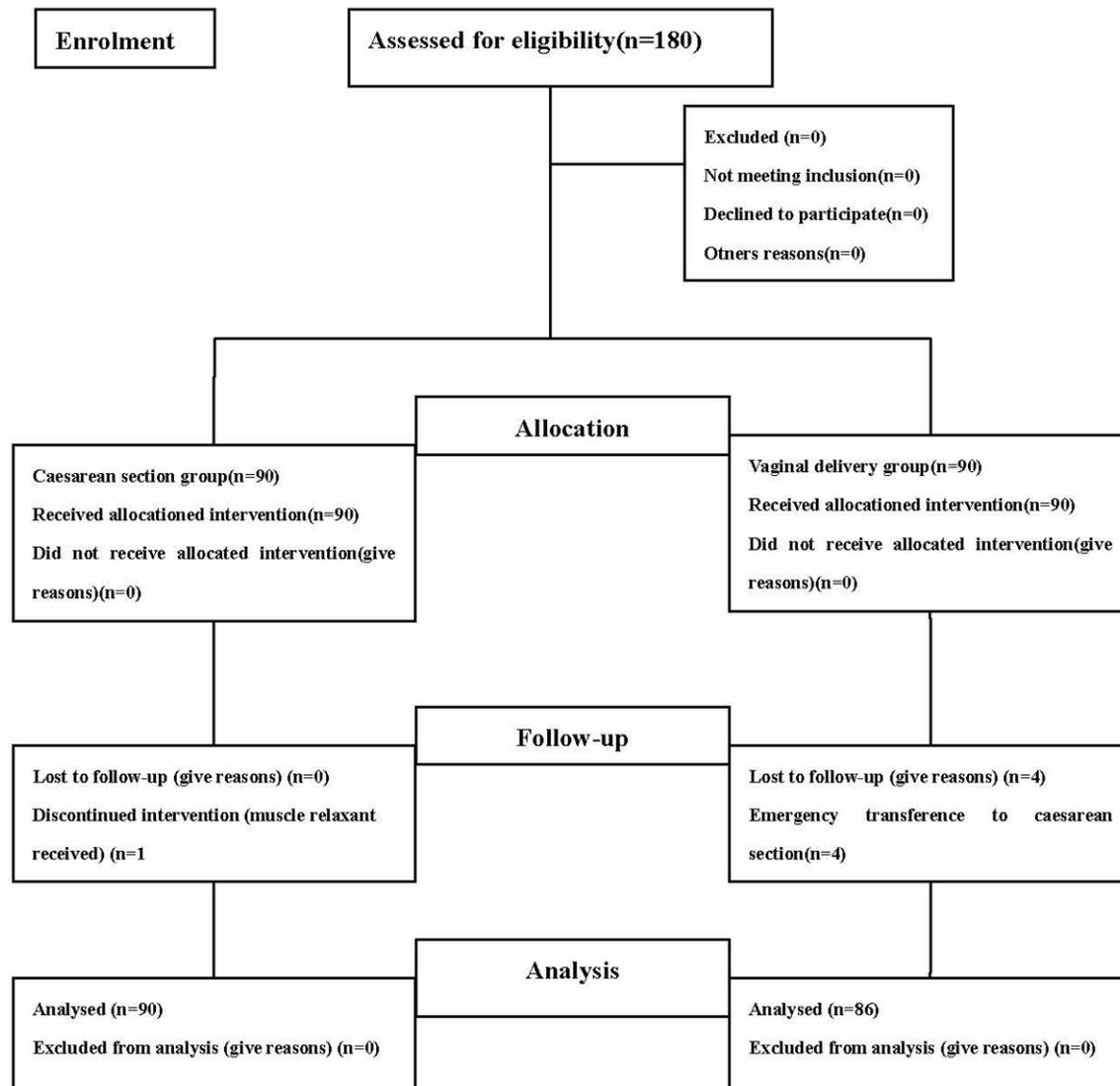


Figure 1. CONSORT flow diagram. Ninety parturients undergoing elective caesarean section (caesarean section group) and ninety parturients with vaginal delivery (vaginal delivery group) were enrolled. Four parturients from vaginal delivery group were excluded due to emergency transference to caesarean.

was assessed using the Kolmogorov-Smirnov test. The paired t-test or Wilcoxon test for two related samples were used for measurement data or ranked data for within-group comparisons respectively. Differences between groups were evaluated using the Student's t test for independent samples, the Mann-Whitney U test for parametric or nonparametric data, respectively. Analysis of categorical data was performed using chi-squared and Fisher's exact tests. SPSS version 17.0 (SPSS, Inc., Chicago, IL, USA) was used for all statistical analyses. *P* value less than 0.05 was considered statistically significant for all analyses.

Results

Four parturients in vaginal delivery group were excluded from the study due to transference to caesarean section, the flow diagram was show in **Figure 1**. Therefore, a total of 176 parturients completed the study, with 90 in caesarean section group and 86 in vaginal delivery group. The general characteristics of parturients in two groups were demonstrated in **Table 1**. There was no significant difference in age, body weight, height and days of pregnancy between two groups. The duration of labour in vaginal delivery group was significantly longer than the

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Table 1. General characteristics of parturients in two groups

| Parameters | Vaginal delivery group (n=86) | Caesarean section group (n=90) |
|------------------------------------|-------------------------------|--------------------------------|
| Age (yr) | 29.0±3.0 | 29.8±3.0 |
| Body weight (kg) | 69.48±7.29 | 71.57±9.29 |
| Height (cm) | 162.7±4.7 | 161.7±4.6 |
| Gestation (day) | 274.9±6.6 | 273.6±6.4 |
| Duration of labour/operation (min) | 453.8±189.6 | 33.4±5.7* |
| Volume of hemorrhage (mL) | 267.8±65.0 | 275.9±73.6 |
| Fluid infusion (mL) | 245.3±121.9 | 1316.7±186.6* |

Data were expressed as means ± standard deviation. Subjects in both groups were comparable with respect to age, body weight, height, gestation and volume of hemorrhage. *Caesarean section group vs vaginal delivery group, $P < 0.05$.

Table 2. Measurements of IID, TMD, SMD and NC in two groups

| Parameter | Vaginal delivery group | | | | Caesarean section group | | | |
|-----------|------------------------|----------|----------|----------|-------------------------|----------|-----------|-----------|
| | T0 | T1 | T6 | T24 | T0 | T1 | T6 | T24 |
| IID (cm) | 4.5±0.8 | 4.5±0.8 | 4.5±0.7 | 4.5±0.7 | 4.4±0.7 | 4.4±0.7* | 4.3±0.8* | 4.4±0.7 |
| TMD (cm) | 8.9±1.2 | 8.8±1.0 | 9.0±1.1 | 9.0±1.1 | 9.0±0.9 | 8.9±0.8* | 9.0±0.8 | 9.2±0.7 |
| SMD (cm) | 15.0±2.2 | 15.0±2.0 | 15.0±2.0 | 15.1±2.1 | 15.5±1.4 | 15.3±1.3 | 15.3±1.3 | 15.4±1.3 |
| NC (cm) | 33.3±1.7 | 33.3±3.7 | 33.5±1.8 | 33.4±1.8 | 33.5±1.8 | 33.5±3.8 | 34.1±1.9* | 33.8±1.7* |

Data were expressed as means ± standard deviation. Subjects in both groups were comparable with respect to IID, TMD, SMD and NC at T0. *vs T0 within groups, $P < 0.05$.

duration of operation in caesarean section group, while the volume of intravenous fluid supplementation during labour in vaginal delivery group was significantly smaller than that during operation in caesarean section group.

The measurements of ID, TMD, SMD and NC in two groups at different time points were illustrated in **Table 2**. There was no significant difference in ID, TMD, SMD and NC between two groups before labour. ID, TMD, SMD and NC were not significantly changed after delivery in vaginal delivery group. In caesarean section group, SMD was not significantly changed after delivery; ID was smaller at T1 and T6 than that at T0, and was reversed at T24; TMD was smaller at T1 than that at T0, and was reversed at T6 and T24; and NC at T6 and T24 were significantly longer than that at T0.

The MMT classes of parturients in two groups at different time points were shown in **Figure 2**. There was no significant difference in MMT class between two groups at T0. In vaginal delivery group, the MMT class at T1 was significantly higher than that at T0 ($P < 0.05$), while the MMT classes at T6 and T24 were not significantly different from that at T0. In caesarean section group, the MMT classes at T1 and T6 were significantly higher than that at T0 ($P < 0.05$), while

the MMT class at T24 was not significantly different from that at T0. The changes of MMT classes in two groups were demonstrated in **Table 3**. Overall, there are 39 parturients (45.3%) with increases in MMT class in the vaginal delivery group within 24 h after childbirth, which were higher than that in the caesarean section group [24 parturients (26.7%), $P=0.01$]. In the vaginal delivery group, there was no significant difference for the incidence of the increases in MMT class between the time point of T1 and T6. However the incidence of the increases in MMT class at T24 was significantly lower than that at T1 ($P=0.015$). In the caesarean section group, the incidence of MMT class increases at T6 time point was significantly higher than that at T1 ($P=0.015$) and T24 ($P=0.015$).

Discussion

Many studies have revealed that the incidence of difficult airway, which is mainly reflected as the Mallampati class, may increase with the gestation weeks, and this is more significant just before and after labour [6, 11]. However, the ways of labour are not stratified in any of the studies. In this study, we revealed that increased Mallampati class could be found after delivery both in some parturients undergoing caesarean section and those with vaginal deliv-

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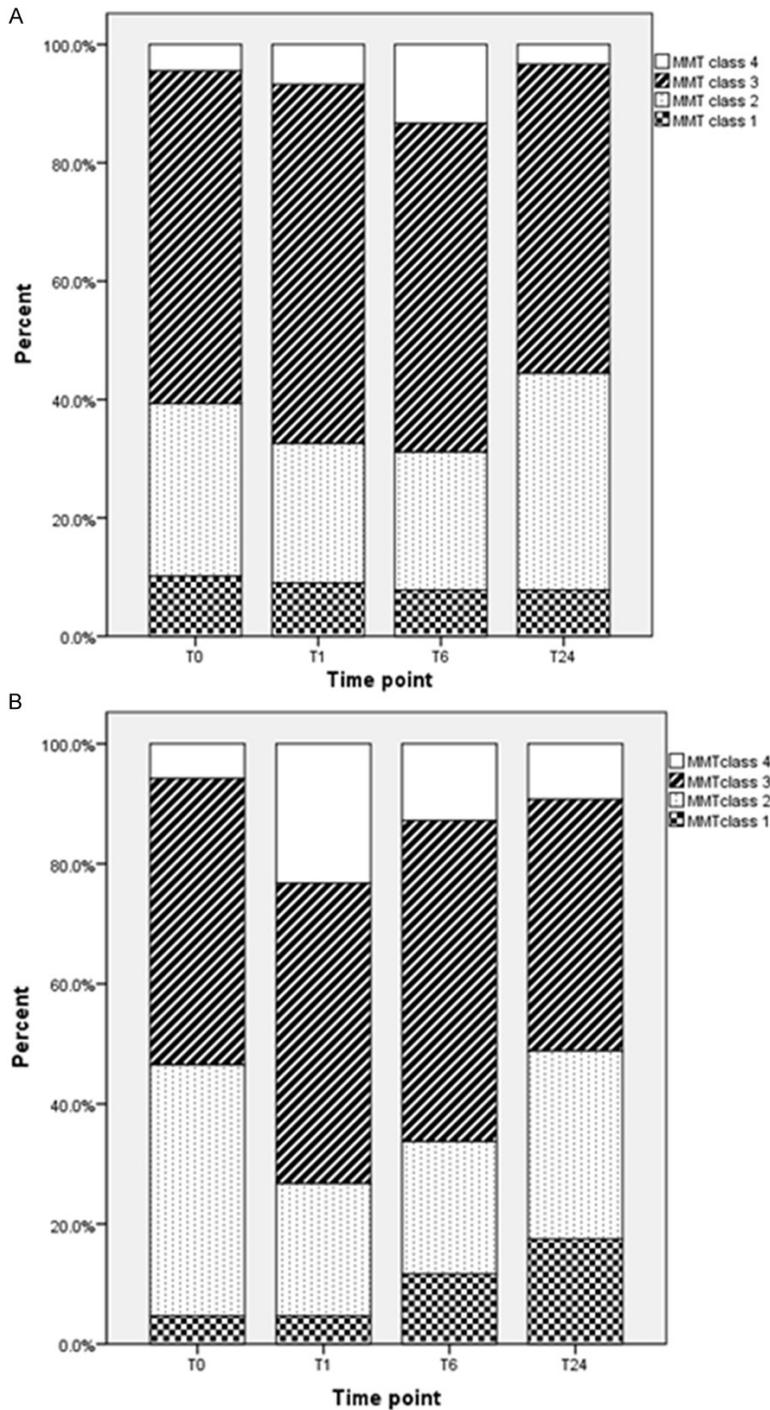


Figure 2. MMT classes at different time points in caesarean section group (A) and vaginal delivery group (B). In caesarean section group, the MMT classes at T1 and T6 were significantly higher than that at T0 ($P < 0.05$), while the MMT class at T24 was not significantly different from that at T0 time point. In vaginal delivery group, the MMT class at T1 was significantly higher than that at T0 ($P < 0.05$), while the MMT classes at T6 and T24 were not significantly different from that at T0.

ery. The percent of parturients undergoing vaginal delivery with Mallampati class incre-

ase was 38.3% 1 h after delivery, which was the highest, then gradually decreased with time, and was still as high as 22.1% 24 h after delivery. However, the highest percent of parturients undergoing caesarean section with Mallampati class increase (24.4%) occurred 6 h after delivery, and the percent was 11.1% 24 h after delivery.

The causes of Mallampati class increase after delivery are undetermined. The study involved the measurement of upper respiratory tract, oral cavity and pharyngeal volume indicated that local reversible edema might be the major contributor [10], and edema might be related to the water-sodium retention induced by transfusion, oxytocin application and stress reaction [18].

In this study, we observed that the peak Mallampati class increase took place 6 h after delivery in parturients undergoing caesarean section, and that occurred 1 h after delivery in those with vaginal delivery. The causes of the differences have not been exactly explored, and it is presumed that the increased returned blood volume by uterus contraction and tissue edema resulted from rise of central venous pressure and capillary transmural pressure may be the partial explanation [19]. The duration of vaginal delivery may be longer, the stress reaction may take place earlier, and the application of oxytocin is usually much earlier than fetal disengagement, all of which may lead to the presentation of tissue edema soon after delivery. However, the

tissue edema may occur relatively later in parturients undergoing caesarean section due to

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Table 3. Changes of MMT classes in two groups

| Parameter | Vaginal delivery group | | | Caesarean section group | | |
|-------------------|------------------------|------------|------------|-------------------------|------------|-------------|
| | T1 | T6 | T24 | T1 | T6 | T24 |
| Increase (vs T0) | 33 (38.3%) | 24 (27.9%) | 19 (22.1%) | 10 (11.1%)* | 22 (24.4%) | 10 (11.1%)# |
| Decrease (vs T0) | 4 (4.7%) | 13 (15.1%) | 24 (27.9%) | 1 (1.1%) | 6 (6.7%) | 14 (15.6%)# |
| No change (vs T0) | 49 (57.0%) | 49 (57.0%) | 43 (50.0%) | 79 (87.8%)* | 62 (68.9%) | 66 (73.3%)* |

Data were expressed as *n* (%). *Caesarean section group vs vaginal delivery group, $P < 0.01$; #Caesarean section group vs vaginal delivery group, $P < 0.05$. At T1 time point, there were significantly fewer parturients in caesarean section group gained increase in MMT class over T0 time point than in vaginal delivery group.

shorter duration of operation and later application of oxytocin and uterus contraction after fetal disengagement. Besides, the parturients undergoing vaginal delivery may have diet after delivery without fluid transfusion, while the colloid osmotic pressure may be decreased in those with caesarean section undergoing crystalloid transfusion after delivery, and later airway edema may be aggravated.

Various airway assessment methods were employed in this study, including the measurement of parameters of IID, TMD, SMD, NC, which are indicators for difficult airway. Though there existed some changes at some time points, no clinical significance was found, and this may be related to the limited observation duration (no longer than 30 h), in which the above parameters associated with the anatomic measurement of skeleton, muscle and subcutaneous fat may not be significantly altered.

Mallampati classes 3 and 4 are associated with difficult airway in parturients, with an increased relative risk of 7.6 and 11.3, respectively [9]. This study demonstrated that the percents of parturients with Mallampati classes 3 and 4 increased after delivery, which indicated that the incidence of difficult airway increased with the duration of labour.

Though regional anesthesia is dominantly used in caesarean section, general anesthesia may be adopted in emergency operation due to severe hemorrhage after delivery. This study revealed that the MMT class was still increased 6 h after caesarean section in some patients, and that was not completely reversed within 24 h, which indicated the necessity of intensive assessment of airway within 24 h after delivery if general anesthesia was applied.

To prevent bias, two senior anesthesiologists were assigned to evaluate and grade the airway of parturients, if two anesthesiologists gave dif-

ferent results, they would discuss to get a final classification. Guru et al [20] demonstrated that epidural anesthesia had no impact on the airway of parturients after vaginal delivery, therefore, parturients undergoing labour analgesia were selected in this study.

However, there are some limitations for this study. Firstly, only the time points of 1 h, 6 h and 24 h after delivery were chosen for airway assessment. Airway changes at other time points could only be speculated, but not be sure. Such as in the caesarean section group, the incidence of the increases in MMT class at T6 time point was significantly higher than that at T1 and T24. But we cannot confirm that whether or not T6 is the highest time point when MMT increases. Perhaps the highest time point appears between 1 h to 6 h, or between 6 h to 24 h after childbirth, that should be waited for further study to clarify. Secondly, parturients with obstetric complications were not involved in this study. It has been revealed that preeclampsia, gestational diabetes mellitus, hypertension in pregnancy and albuminuria may have effect on circulation of pregnant population, and may influence the edema status during pregnancy and labour. Hence, further studies should address the changes of airway after delivery in pregnant population with the above complications.

In all, Mallampati class may increase after delivery, and the increase in Mallampati class may be more significant and may take place earlier in parturients undergoing vaginal delivery than in those undergoing elective caesarean section. In addition, the increase may not be fully reversed by 24 h post-labour in parturients with either mode of delivery. Therefore, if general anesthesia is carried out within 24 h after delivery, the airway should be re-evaluated to prepare for the difficult intubation.

Disclosure of conflict of interest

None.

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