表1　1次、2次、3次施設別にみた施行率（ガイドライン発刊前）

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
一次	35/39 (90%)	7/39 (18%)	1/6 (17%)	8/39 (21%)	2/8 (25%)	25/38 (66%)	13/34 (38%)	36/39 (92%)	11/39 (28%)
二次	7/7 (100%)	1/7 (14%)	1/1 (100%)	2/7 (29%)	1/2 (50%)	5/6 (83%)	3/7 (43%)	7/7 (100%)	3/7 (43%)
三次	2/2 (100%)	1/2 (50%)	0/1 (0%)	2/2 (100%)	1/2 (50%)	2/2 (100%)	2/2 (100%)	2/2 (100%)	2/2 (100%)

(1)経腟分娩予定の全妊婦に対するB群溶血性レンサ球菌（GBS）培養検査、(2)骨盤位分娩、(3)骨盤位分娩実施時の文書による同意取得、(4)既往帝切妊婦の経腟分娩（VBAC）、(5)VBAC実施時の文書による同意取得、(6)IUGR診断における胎児体重基準値の使用、(7)未分画ヘパリン投与後5—7日に血小板数測定（ヘパリン副作用の早期検出）、(8)薬剤による陣痛促進時のインフォームドコンセント取得、(9)鉗子分娩。

「産婦人科診療ガイドライン2008」発刊前の栃木県における産科診療実態調査

大口昭英、桑田知之、薄井里英、泉　章夫、松原茂樹、鈴木光明

目的：2008年4月、「産婦人科診療ガイドライン2008」が発刊され、今後、産科診療は、このガイドラインに沿って行われていくことが期待される。ガイドライン発刊前の栃木県における産科診療の実態を明らかにすることが本研究の目的である。

対象・方法：2007年11月に、栃木県内の産婦人科外来診療施行96施設にアンケート調査。現在分娩を取り扱っている48施設すべてから回答を得た。NICUの有無及び対応能力に応じて一次（39）、二次（7）、三次施設（2）に分類し、以下の項目の実施率を調査した。(1)経腟分娩予定の全妊婦に対するB群溶血性レンサ球菌（GBS）培養検査、(2)骨盤位分娩、(3)骨盤位分娩実施時の文書による同意取得、(4)既往帝切妊婦の経腟分娩（VBAC）、(5)VBAC実施時の文書による同意取得、(6)IUGR診断における胎児体重基準値の使用、(7)未分画ヘパリン投与後5—7日に血小板数測定（ヘパリン副作用の早期検出）、(8)薬剤による陣痛促進時のインフォームドコンセント取得、(9)鉗子分娩。

結果：一次・二次および三次施設における(1)～(9)の実施率を下表に示す。

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
一次	35/39 (90%)	7/39 (18%)	1/6 (17%)	8/39 (21%)	2/8 (25%)	25/38 (66%)	13/34 (38%)	36/39 (92%)	11/39 (28%)
二次	7/7 (100%)	1/7 (14%)	1/1 (100%)	2/7 (29%)	1/2 (50%)	5/6 (83%)	3/7 (43%)	7/7 (100%)	3/7 (43%)
三次	2/2 (100%)	1/2 (50%)	0/1 (0%)	2/2 (100%)	1/2 (50%)	2/2 (100%)	2/2 (100%)	2/2 (100%)	2/2 (100%)

このように、栃木県において、GBSスクリーニングはすでに広く実施されていた。骨盤位分娩を行う施設は、極めて少なくなっていた。また、骨盤位分娩実施時の文書による同意取得率は低かった。一次・二次施設では、VBAC実施率は低かった。また、VBAC実施時の文書による同意取得率は低かった。IUGR診断における胎児体重基準値の使用はかなり普及していた。一次・二次施設において、未分画ヘパリン投与後5—7日での血小板数チェックは50%未満であった。鉗子分娩の実施は、一次施設で最も低く、多くは吸引分娩のみで対応されていた。

結語：栃木県においては、骨盤位分娩・VBAC実施時の文書による同意取得が行われるように啓蒙活動が必要と思われた。また、未分画ヘパリン投与後5—7日での血小板数のチェックについても実施されるように啓蒙が必要と思われる。

（第33回栃木県母性衛生学会総会　抄録　宇都宮　2008年6月14日）

栃木県内分娩施設における、妊娠糖尿病選別、骨盤位分娩、VBAC に関する実態調査

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目的

産婦人科診療ガイドライン産科編 2008（案）で取り上げられている診療方針について、ガイドライン発行前のその施行実態を調査すること。2007 年 11 月時点で、栃木県内の 96 産婦人科診療施設にガイドライン掲載 30 項目の診療実態についてアンケート調査した。

方法

2007 年 11 月末に、郵送法でアンケートを行った。回答のない場合には 1 ヵ月後に再度アンケートを郵送し、それでも回答の得られない場合には電話アンケートを行った。アンケート内容は 30 項目と多岐にわたったが、今回は(1)妊娠糖尿病選別(GDM スクリーニング)、(2)経腟骨盤位分娩、(3) 帝王切開後の経腟出産(VBAC)に絞って報告する。

結果

アンケートは 99%の施設から回収され、50%（48 施設）が分娩を取り扱っていた。以下は分娩取り扱い施設を対象とした成績である。(1)全妊婦に GDM スクリーニングを実施していたのは 56%（27/48）。GDM 高リスク妊婦に対しスクリーニングを省略して診断検査(GTT)を実施していたのは、31%（15/48）であった。GDM スクリーニングを全妊婦に行っていると答えた 27 施設において、初期と中期の 2 段階スクリーニングを実施している施設は 33% (9/27)であった。2 段階スクリーニングを実施している 9 施設において、妊娠初期の随時血糖のカットオフ値を尋ねたところ、95mg/dl 以上は 1 施設のみであった。また、妊娠中期のスクリーニング方及びカットオフ値を尋ねたところ、50gGCT でカットオフ値 140mg/dl を採用している施設は 2 施設のみであった。GDM 妊婦に対して、分娩後に 75gOGTT を勧めている施設は 21%（10/48）であった。(2)骨盤位経腟分娩を行っている施設は 19%（9/48）であったが、その中で文書による同意を取っている施設は 22%（2/9）であった。(3)VBAC を施行施設は 25%（12/48）であったが、その中で文書による同意を取っている施設は 33%（4/12）であった。

結論

2007 年 12 月時点において、全妊婦への GDM スクリーニング、GDM 高リスク妊婦に対する GDM 診断検査、2 段階スクリーニング及び GDM 妊婦に対する分娩後の 75gOGTT 実施は、まだ充分に浸透していなかった。また、骨盤位経腟分娩・VBAC 施行時の文書による同意取得率はまだ低かった。

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Establishing a reference value for the frequency of fetal movements using modified 'count to 10' method

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Abstract

Aims: To establish a reference value for the frequency of fetal movements perceived by the mother during the second half of pregnancy.

Methods: The study subjects consisted of 705 low risk Japanese pregnant women who continuously received antenatal care. We asked women to record the time required to perceive 10 fetal movements ('count to 10' time) everyday. We asked women to record it, not at a fixed time (i.e. evening time), but whenever they felt the fetus move the most actively. The position during counting (i.e. sitting position) was also not specified, and thus we named this method as modified 'count to 10' method. Satisfactory recordings were obtained from 690 women, which we used for analysis.

Results: The 'count to 10' time was almost the same from 22 weeks (10.9; 7.3–18.0 (median; interquartile range)) until 32 weeks (10.0; 6.2–15.6), and it Thirty-two weeks showed the shortest time, which gradually increased toward 40 weeks (14.8; 9.5–24.0). Its 90th percentile was approximately 25 and 35 min at 22–36 weeks and at 37–40 weeks, respectively.

Conclusions: For the first time we established a reference value for perceived fetal movements throughout the second half of pregnancy. The present modified 'count to 10' method requires less time than the previous method. Approximately 98% (690/705) of women gave us satisfactory recordings. This reference value may be of use in identifying mothers with decreased fetal movements.

Key words: fetal movements, perinatal mortality, reference value.

Introduction

Decreased fetal movements perceived by the mother antecede perinatal morbidity and mortality.[1–5] Perceived fetal movements, especially the frequency of fetal movements, were reported to be the simplest and least expensive technique for monitoring fetal well-being.[4,6]

Some previous researchers introduced several methods for counting fetal movements[2,3,5] and established a reference value according to their methods.[1,7,8] However, they all had disadvantages for clinical use, which may be why they have not been universally used. First, counting obliged women to spend a relatively long time.[2,3] Second, although some studies showed a reference value according to the gestational age, almost all dealt with only women in the near-term period.[1,7] There has been no reference value for fetal movements derived from a large number of pregnant women throughout the second half of pregnancy; from immediately after first perception until delivery.

We attempted to make a reference value for maternally perceived fetal movements throughout the second half of pregnancy: i.e. from 22 gestational weeks

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to delivery, using the modified 'count to 10' method. We studied 705 pregnant Japanese women at low risk who gave birth to term singleton infants.

Materials and Methods

Initial enrollees were 711 pregnant women who continuously received antenatal care in the primary institute (Ohkusa Ladies' Hospital) from at latest 12 weeks of pregnancy until delivery from January 1999 to December 2002. Six women gave birth to preterm infants and the remaining 705 women gave birth to term healthy infants. These 705 women had less than four point of Pregnancy Risk Score according to Nakabayashi[9] at initial visit. According to Nakabayashi, Score 0–1 and 2–3 were tentatively defined as low risk and moderate risk, respectively.[9] From the practical point of view, we considered these 705 women to be of low risk pregnancy, which comprised the present study population. We obtained informed consent from all women.

We asked the women to record the time (minutes) required to perceive 10 fetal movements, the so-called 'count to 10' method,[10] everyday from the first perception week until delivery. A fetal movement was defined as any discrete kick or roll. Continuous movements were considered a single movement. We asked women to count fetal movements whenever they felt the fetus move the most actively within a day. Since it was evening in most cases, most women performed the 'count to 10' at that time, but we did not specify the time for counting. Although we did not order women to lie down while counting, most women did, whereas others counted movements while sitting or standing. The time and position for counting was not settled in each individual participant. For example, one woman did 'count to 10' in the morning time while standing one day, and did it in the evening time while sitting another day. In the generally used 'count to 10' method, evening and lying down were requested while counting,[2,3] but we did not stipulate these conditions. Thus, we tentatively named this method as the modified 'count to 10' method.

To establish a reference value for fetal movements, we have two concerns: incorrect/misreported data and too-wide day-to-day (intraweek) variability of fetal movements. Some women may report incorrect data; some may even submit the recording chart even though they actually did not count the movements. We believe that the most trustworthy examinees may be women who filled in the record almost everyday all throughout the period. We made efforts to exclude possible misreported data. We defined a good recording as a given week with more than four recordings, with seven being full marks. We confined the subjects as women with more than 50% good recording weeks (maybe trustworthy examinees) and deleted all data from the remaining women (maybe un-trustworthy examinees). The number of 'maybe trustworthy examinees' was 690, 97.8% (690/705) of study subjects. We used data only from these 'maybe trustworthy examinees' to establish a reference value ($n = 690$). For these 690 women, we deleted both the shortest and longest minutes within a given week to obtain the average minutes for 'count to 10' in a week-by-week manner. For example, let us assume a woman had a 'count to 10' of 20 min at 38 weeks. As will be described below, 38 weeks had 531 data (average value), and this 20 min was one datum among 531. Finally, 25–37 weeks had more than 600 data (one datum for one woman in a given week), i.e. 646, 683, 692, 692, 690, 688, 688, 688, 688, 687, 684, 679, and 640 data, for 25–37 weeks, respectively. The 22, 23, and 24 weeks had 84, 287, and 490 data, respectively. The 38, 39, 40 weeks had 531, 314, 103 data, respectively. Weak movements and having delivered babies may account for fewer data obtained in the beginning three weeks (22–24) and final three weeks (38–40), respectively, compared to 25–37 weeks.

First, we analyzed general tendency of 'count to 10' time from 22 to 40 weeks of gestation, on presumption of all data among each week as independent, because not all data were paired data. A normality test demonstrated these data (minutes) not to be normally distributed. We calculated the median, 10th percentile, and 90th percentile for a given week and established a reference value from 22 weeks until 40 weeks. Thirty-two weeks showed the shortest 'count to 10' time, and thus we tested the significance of the difference of the 'count to 10' time between 32 weeks and any given week, using the Mann–Whitney test (SPSS, version 13.0 J for Windows).

Next, we selected women who had a good recording at every week during 25 weeks toward just before delivery. Since we excluded women with preterm delivery, we divided such women into four groups: women with delivery at 37, 38, 39, and 40 weeks or more. Each group consisted of 102, 187, 187 and 79 women. Since each group had a multiple paired data, differences of 'count to 10' time among all weeks were tested with the Friedman repeated measures analysis of variance on ranks. When the Friedman test was

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Table 1 Clinical backgrounds and features of the women

Age	28.3 (25–31)
Length of gestation (days)	277 (272–282)
Birth weight (grams)	3104 (2875–3335)
Mode of delivery	
Trans vaginal	89.0%
Cesarian section (elective)	4.7%
(emergency)	6.3%

Median (interquartile range).

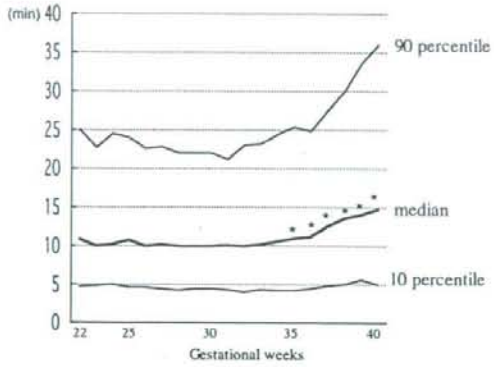

Figure 1 Reference value for the frequency of fetal movements from 22 to 40 weeks of gestation in 690 Japanese women with low-risk singleton pregnancy. This figure indicates the median, 10th percentile, and 90th percentile of time required for the mother to perceive 10 fetal movements in a week-by-week manner for the whole population ($n = 690$). The time required to 'count to 10' at 32 weeks was significantly shorter than that at 35, 36, 37, 38, 39, and 40 weeks of gestation, respectively (*$P < 0.05$).

significant, differences between arbitrary two pairs were compared using Wilcoxon's signed-rank test. $P < 0.05$ was considered significant.

Results

Table 1 indicates the background of the women. Women gave birth to infants at an average of 39.6 weeks of gestation, and 89% delivered vaginally. All infants showed an APGAR score of more than seven at 5 min. There were no fetal/neonatal morbidity and mortality.

Figure 1 shows the general tendency, i.e. the median, 10th percentile, and 90th percentile of the 'count to 10' time according to the gestational week for all women ($n = 690$). The 'count to 10' time was almost the same from 22 weeks (10.9; 7.3–18.0 (median; interquartile range)) until 32 weeks (10.0; 6.2–15.6). Thirty-two weeks showed the shortest 'count to 10' time. The time gradually increased toward 40 weeks (14.8; 9.5–24.0). The time required to 'count to 10' at 32 weeks was significantly shorter than that at 35, 36, 37, 38, 39, and 40 weeks of gestation, respectively ($P < 0.05$). Figure 2A–D shows the results of subgroup analysis, i.e. the median, 10th percentile, and 90th percentile of the 'count to 10' time for four groups of women with delivery at 37 (A), 38 (B), 39 (C), and 40 weeks or more (D). The 'count to 10' time was the shortest at 29, 26, 33, and 28 weeks in women with delivery at 37, 38, 39, and 40 weeks or more, respectively. But, once again, 'count to 10' time was almost the same from 25 weeks until 33 weeks in women with delivery at 37, 38, and 39 weeks, and it was almost the same from 25 until 36 weeks in women with delivery at 40 weeks or more. The 'count to 10' time at 34–37, 34–38, 34–39, and 37–40 weeks was significantly longer than that at 32 weeks in women with delivery at 37, 38, 39, and 40 weeks or more, respectively ($P < 0.05$). Thus, analysis of the whole population ($n = 690$) indicated that the frequency of fetal movements was almost the same from 22 weeks until 32 weeks of gestation, with 32 weeks being the highest, and then it gradually decreased toward 40 weeks. This tendency was endorsed by the subgroup analysis, although the detail differed among subgroups.

The 90th percentile of the 'count to 10' time for all women ($n = 690$) was calculated as approximately 25 min and 35 min at 22–36 weeks and at 37–40 weeks, respectively (Fig. 1). Sub-group analysis also indicated that the 90th percentile of 'count to 10' time for 25–36 weeks and 37–40 weeks were approximately 19–25 and 26–36 min, respectively, although the detail differed among subgroups (Fig. 2A–D). Thus, roughly speaking, 25 min and 35 min before and after 37 weeks, respectively, may possibly indicate decreased fetal movements.

Discussion

We established the reference value for maternally perceived fetal movements throughout the second half of pregnancy from women with singleton low risk pregnancies, using the modified 'count to 10' method. The modified 'count to 10' does not stipulate the counting time (i.e. evening time) or counting position (i.e. laying down). The median time was almost the same from 22 weeks until 32 weeks of gestation, approximately 10 min, and then it gradually increased toward term

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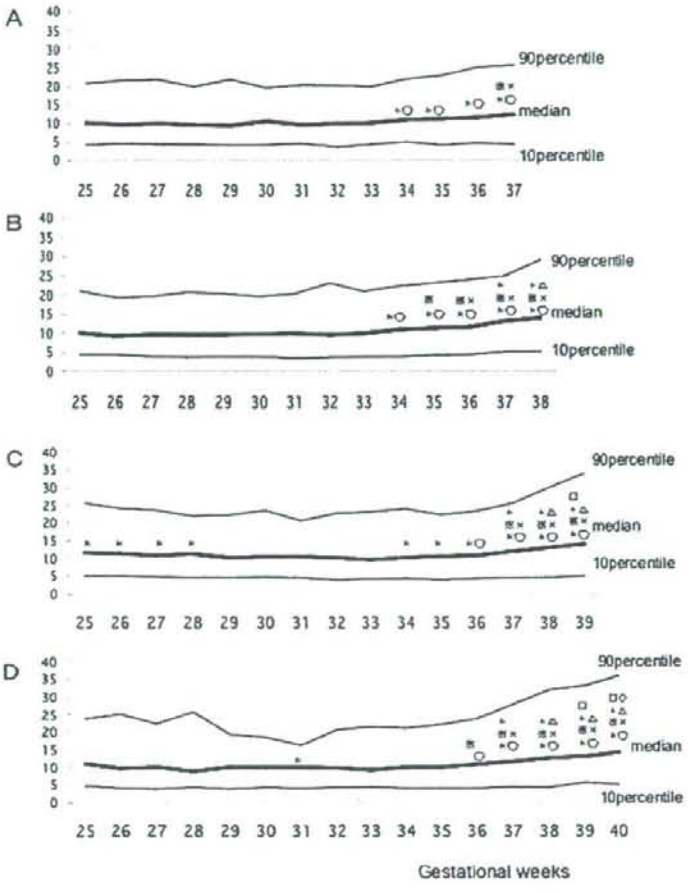

Figure 2 The frequency of fetal movements from 25 weeks of gestation until delivery in women with delivery at 37 (A), 38 (B), 39 (C), and 40 weeks or more (D). This figure indicates the median, 10th percentile, and 90th percentile of time required for the mother to perceive 10 fetal movements in a week-by-week manner for four groups of women with delivery at 37 (A), 38 (B), 39 (C), and 40 weeks or more (D). Marks are indicated if the difference in 'count to 10' time between the corresponding weeks and the indicated weeks is significant ($P < 0.05$; * vs 32 weeks, ○ vs 33 weeks, ※ vs 34 weeks, × vs 35 weeks, + vs 36 weeks, △ vs 37 weeks, □ vs 38 weeks, ◇ vs 39 weeks).

with a median of 14.8 min at 40 weeks, shorter than 21 min[6] reported previously. In addition, we for the first time determined the 90th percentile for the modified 'count to 10' time in a week-by-week manner.

The present study showed perceived fetal movement frequency throughout the second half of pregnancy. Previous researchers showed that the frequency of perceived fetal movements gradually decreased toward term during the last 10 weeks of pregnancy.[1,7] Pearson and Weaver[1] established a rough reference value for perceived fetal movements from 61 pregnant women and showed that daily fetal movement count gradually decreased from 32 weeks to term. Leader *et al.*[7] also established a reference value from 250 pregnant women and showed a gradual decrease from 31 weeks to term; however, these two previous study groups[1,7] did not pay attention to fetal movements before 31 weeks. Sadovsky *et al.*,[8] studying 127 pregnant women, established a reference value for fetal movements from 18 to 40 weeks of pregnancy. Fetal movements gradually increased from 18 to 32 weeks, with 32 weeks being the most frequent, and then gradually decreased toward 40 weeks of gestation. In the present study, the fetal movement count was almost the same from 22 weeks until 32 weeks of gestation, with 32 weeks being the highest, and then it gradually decreased toward 40 weeks. Our data agreed well with previous data that fetal movement

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was most frequent at 32 weeks[5] and it gradually and consistently decreased toward term.[1,7,8] Our data for earlier gestational ages, however, disagreed with the data by Sadovsky *et al.*[5] We showed hardly any change from 22 to 32 weeks of gestation, whereas Sadovsky *et al.*[5] showed a constant increase toward 32 weeks. Sadovsky *et al.*[5] asked the women to count the fetal movements within a limited time, whereas we asked the women to measure the time required to perceive 10 fetal movements ('count to 10'): this difference in the counting technique may account for the different results. The subject number was much larger in the present study ($n = 690$) than in Sadovsky's study ($n = 127$),[5] which leads us to believe that the present study represents perceived fetal movement frequency much more accurately.

The data indicate that decreased fetal movement is a sign of fetal jeopardy.[1–5] For example, an earlier study by Pearson and Weaver[1] showed that only one perinatal death occurred among 108 women with normal fetal movements whereas four deaths occurred among 12 women with decreased fetal activity, making a striking contrast. Berbey *et al.*[4] showed that in both low-risk and high-risk pregnancies, decreased fetal movements reported by the mother predicted a higher incidence of NST abnormality, positive CST test, decrease in amniotic fluid index, and low APGAR score. Now it is widely accepted that maternal perception of decreased fetal movements antecedes a poor perinatal outcome. However, the data are controversial as to whether the employment of fetal movement screening did decrease perinatal morbidity and mortality. Moore and Piacquadio[6] compared the perinatal mortality rate between the period with versus without fetal movement screening. The perinatal mortality rate was 2.1/1000 and 8.7/1000 births with and without movement screening, respectively.[6] Another report indicated that movement screening did not decrease perinatal mortality. Grant and coworkers[11] performed a randomized controlled trial on this issue. They randomly assigned more than 68 000 pregnant women to a 'formal counting' arm or a 'standard care (without formal counting)' arm. Although women assigned to the 'standard care' arm were not formally asked to count fetal movements everyday, they could be asked about fetal movements and obstetricians could even give counting charts to selected women when indicated. Antepartum death rates were similar in the two arms.[11] The authors stated that better compliance, reporting, and acting on reduced movements might make formal counting useful. They did not deny the importance and possible usefulness of perceived fetal movement count in reducing fetal death.[11]

For fetal movement counting, earlier researchers introduced various methods, which can be roughly classified into two;[2,3] counting the fetal movement perceived within a limited time or measuring the time required to perceive some defined number of fetal movements. One disadvantage of the former method is taking a long time, i.e. from as short as 90 min[12] to as long as 12 h per day.[1] Recently, the latter method, especially 'count to 10', is used more widely than the former.[2,3] In the generally reported 'count to 10' method, women are encouraged to lie down and concentrate on fetal activity; evening is usually advised.[2,3,6] Moore and Piacquadio,[6] studying 100 pregnant women from 28 weeks to term, showed that the average 'count to 10' time was 21 min. Our modified 'count to 10' method is unique in that it does not specify the time for counting (for example, evening), and it does not necessarily stipulate that the women lie down quietly. The median 'count to 10' time shown in the present study was 10.0 and 14.8 min at 32 and 40 weeks, respectively, much shorter than the data cited above.[6] Moore and Piacquadio[6] specified counting in the evening, while we asked women to count movements whenever it was most active; this may account for the different results. Regardless of the reason for this difference, our modified 'count to 10' method took much less time, and was much more convenient for pregnant women.

Low compliance has been cited as one important reason why fetal movement screening decreased fetal death less than expected.[6,11,13,14] If the counting program is complicated and demands time, many women will abandon it, leading to low compliance. In fact, women preferred the recording method with less time needed.[15] The modified 'count to 10' method introduced here required less time than any other reported counting programs. The fraction of women who failed to submit a satisfactory chart was very small, and thus our program is considered to show high compliance.

There are two limitations in the present study. First, clinical usefulness of this modified 'count to 10' method is not yet determined. We dealt with low risk pregnancy population, but the incidence rate of fetal/neonatal mortality among the low risk pregnancy is very rare. Actually there were no fetal/neonatal morbidity or mortality in the present study population. Grant *et al.*,[11] performing randomized controlled trial to determine the usefulness of formal fetal movement counting, stated that 1250 women will be needed to prevent one unexplained antepartum late fetal death.

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Furthermore, it is also not yet determined whether the hidden fetal jeopardy undetected by the ordinary maternal check up can be screened by this modified 'count to 10' method. Since fetal/neonatal morbidity and mortality more frequently occur in high risk pregnancies compared to low risk pregnancies,[9,15] reference value for modified 'count to 10' for high risk pregnancy may be useful to picking up fetus facing jeopardy among high risk population. This issue is currently under investigation in our laboratory. Second, it is not yet clarified whether this 90th percentile value is useful as a cut-off value in a given week for identifying women with decreased fetal movements. In fact, no women with more than 90th percentile showed fetal compromise shown by the maternal checkup, including NST, waveform by Doppler, etc. Once again, low frequency of fetal jeopardy arising from low risk pregnancy population[9] may account for this. Study on much larger population, both for high risk and low risk pregnant women, is needed to clarify the clinical significance of this method. Regardless of this, fetal movement count, especially modified 'count to 10' method is the simplest and the least expensive technique for at least speculating/assuming fetal well being. It requires no monitoring devices or laboratory procedures. We believe that this reference value established here may contribute to judging decreased fetal movements in a given gestational week.

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Blood loss in low-lying placenta: placental edge to cervical internal os distance of less vs. more than 2 cm

Shigeki Matsubara*, Akihide Ohkuchi, Masashi Kikkawa, Akio Izumi, Tomoyuki Kuwata, Rie Usui, Takashi Watanabe and Mitsuaki Suzuki

Abstract

Objective: To reconfirm that a low-lying placenta, with placental edge-internal os distance of 0–4 cm, is a risk factor for blood loss during delivery, and to determine whether blood loss differs between edge-os distance of ≤2 cm vs. >2 cm.

Methods: We compared total blood loss between 73 singleton pregnant women with edge-os distance of 0–4.0 cm vs. controls. We also compared total blood loss between pregnant women with distance of 0–2.0 cm (lower) vs. 2.1–4.0 cm (higher).

Results: Total blood loss was significantly greater in women with placental edge-os distance of ≤4 cm than controls in both delivery modes. The lower group showed a significantly higher incidence of excessive hemorrhage during vaginal delivery (60 vs. 19%, P=0.046) and bled more (median 1240 vs. 860 mL, P=0.059) than the higher group. Although this did not reach statistical significance, the lower group more frequently bled antepartum, required emergent cesarean section, and delivered abdominally. Regression analysis showed no association between the amount of blood loss and the edge-os distance in both delivery modes.

Conclusion: Pregnant women with edge-os distance of 2.1–4.0 cm are of highest level of concern as are women with 0–2.0 cm distance.

Keywords: Cesarean section; low-lying placenta; placental edge; placenta previa.

Introduction

Low-lying placenta is defined as a placenta located in close proximity to the internal cervical os but its edge does not reach the os [2, 4, 7]; however, the proximity has not been defined. Some authorities recommend that pregnant women with edge-os distance of 0–2 cm should be delivered by elective cesarean, while those with >2 cm may undergo vaginal delivery [7]. Although this 2 cm rule seems to be well known and widely considered in routine practice, it was deduced from only a few observational studies of relatively small sample size [1, 3, 6, 8]. The endpoints were mainly the eventual mode of delivery, without focusing on blood loss during delivery.

We conducted a retrospective cohort study to determine whether women with edge-os distance of ≤2 cm bleed more than those with >2 cm. The delivery mode in the two groups was also compared.

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Materials and methods

We reviewed all women (n=73) giving birth to singleton infants from January 1994 to December 2005 in our institute, whose placental edge to internal cervical os distance was 0–4.0 cm. Earlier researchers arbitrarily chose the upper limit of distance for low-lying placenta as 3.0 cm [3, 8], 3.5 cm [1], or 5.8 cm [6]. In this study, we used 4.0 cm because we aimed to compare clinical features between ≤2.0 cm vs. >2 cm, and thus 4.0 cm was found convenient. Furthermore, it was difficult to ascertain the edge-os distance of >4 cm with transvaginal ultrasound. The use of 4.0 cm, roughly approximating previous values, will also allow data comparison. We routinely checked the placental location using abdominal ultrasound for each pregnant woman at least twice around 20 and 28 weeks' gestation. In the third trimester, using transvaginal ultrasound, we measured edge-os distance in all women with the placenta located in the lower uterine segment. Distance was determined within three weeks of delivery. All ultrasound results were assessable by attending doctors. Our institute's protocol for treating women with an edge-os distance of 0–4.0 cm is as follows: we informed patients of the risks and benefits for trial of labor. We left it to the discretion of the patients and the attending doctors whether labor would be attempted, or, when bleeding during labor, whether and when emergent cesarean section would be performed. If labor was attempted, a double set up for emergent cesarean section was established. The Ethics Committee of our institute approved this study. Among 73 women, 47 and 26 women eventually delivered abdominally and vaginally, respectively. To confirm whether these 73 pregnant women bled more during delivery compared to those with placenta of edge-os distance of >4.0 cm in both delivery modes, we used controls for each mode of delivery. As controls for abdominal delivery we chose two consecutive women who delivered abdominally after each study subject with an indication other than abnormal plac-

entation, matched for gestational age for each study patient within two weeks; thus, the number of controls for cesarean section was 94 (47×2). As controls for vaginal delivery, we chose two consecutive women who delivered vaginally after each study subject, matched for gestational age within two weeks; the number of controls for vaginal delivery was 52 (26×2). We compared the basic characteristics and amount of blood loss during delivery between study subjects and controls.

Next, we subdivided the 73 women into two groups: women with placental edge-os distance of 0–2.0 cm (n=38; lower group), and those with 2.1–4.0 cm (n=35; higher group). We examined blood loss during delivery in both delivery modes. We also examined the eventual delivery mode: vaginal, elective abdominal, or emergent abdominal delivery. Excessive hemorrhage during delivery was defined as bleeding of more than the 90th percentile value for the Japanese population, which we previously determined [5]; i.e., more than 615 and 1531 mL in vaginal and abdominal delivery, respectively. We compared these values between the lower and higher groups. We further correlated between the amount of blood loss during delivery and the edge-os distance.

Data are expressed as the median (quartile range). Statistical analysis was performed using SPSS (13.0J, SPSS Inc., Chicago) for Windows. Mann-Whitney test, Fisher's exact test, and regression analysis were used where appropriate. The sample sizes were calculated based on the χ^2-test with a significance level of 0.05 and with a power of 0.80. For the comparison between low-lying placenta (+) (0–4.0 cm) vs. (−) (>4.0 cm), the anticipated incidence rates of excessive hemorrhage were according to our previous study [5]: 1) for vaginal delivery 0.44 vs. 0.10 for low-lying (+) vs. (−), respectively, and thus the required sample size was calculated as 13 and 26 cases, and 2) for abdominal delivery, it was 0.33 vs. 0.10 for low-lying (+) vs. (−), and the required sample size was 34 and 68, respectively. For the comparison of excessive hemorrhage between women with an edge-os distance of 0–2 cm vs. 2.1–4.0 cm, the incidence rate has not yet been definitely determined, and thus sample size analysis was unable to be performed.

Results

Table 1 indicates the basic characteristics and blood loss during delivery (cesarean or vaginal) with a low-lying placenta (0–4.0 cm) vs. control (>4.0 cm). Patient background, such as age, parity, previous cesarean section, and gestational age, all of which may influence the amount of blood loss during delivery [5], did not differ between the two groups. Women with a low-lying placenta bled significantly more than controls both in vaginal (median 509 vs. 269 mL, P=0.004) and abdominal (1250 vs. 825 mL, P<0.001) delivery. The incidence of massive hemorrhage was also significantly higher in the low-lying placenta group than in controls both in the vaginal (35 vs. 9.6%, P=0.011) and abdominal (15 vs. 9.6%, P=0.002) delivery.

Table 2 indicates the comparison between lower and higher subgroups regarding the basic characteristics, blood loss during delivery, and eventual mode of delivery. Basic characteristics did not differ between the two groups. The lower group bled more (1240 vs. 860, P=0.059) than the higher group in both vaginal (922 vs. 455 mL) and abdominal (1325 vs. 1230 mL) delivery, but without significance. The incidence of excessive hemorrhage during delivery was higher in the lower group than in the higher group in both vaginal (60 vs. 19%, P=0.046), and abdominal (43 vs. 16%, P=0.063) delivery, with the former showing significance. The lower group exhibited a lower vaginal delivery rate, and also exhibited a higher incidence rate of antepartum bleeding, overall cesarean section, and emergent cesarean section due to bleeding, but without significance.

Figure 1A, B show the correlations between placental edge-os distance and the amount of bleeding in women with vaginal and abdominal delivery, respectively. No correlations were observed between the delivery modes.

Discussion

For the first time, we provided detailed data regarding the relationship between blood loss during delivery and the placental edge-os distance. Women with a distance of 0–2.0 cm bled more, more frequently bled antepartum, more frequently underwent cesarean section overall, and exhibited a higher incidence of excessive hemorrhage than the 2.1–4.0 cm group; however, among these findings, only the rate of excessive hemorrhage during vaginal delivery showed significance, with other comparisons showing no difference between the lower and higher subgroups. No clear correlations were observed between the distance and the bleeding amount in both delivery modes.

We previously demonstrated that the low-lying placenta is an independent risk factor for blood loss during both modes of delivery. In short, excessive hemorrhage occurred more frequently in this condition with an odds ratio of 4.4 (vaginal) and 3.3 (abdominal) compared with not having a low-lying placenta [5]. The present study clearly showed that patients with placental edge-os distance of ≤4.0 cm bled significantly more and showed a significantly higher incidence of excessive hemorrhage during both modes of deliveries than those with placental distance of >4.0 cm. Thus, we reconfirmed that a low-lying placenta (0–4.0 cm) is at high risk for blood loss during delivery, irrespective of the delivery mode. Next, we tried to determine whether clinical features are different between ≤2 cm and >2 cm in low-lying placentas.

Previous studies of low-lying placenta focused mainly on the relationship between edge-os distance and the eventual mode of delivery; the 2 cm cut off seems to have defined the mode of delivery. Table 3 shows the eventual delivery mode in women with placental edge-os distance of ≤2 cm vs. >2 cm. Oppenheimer et al. [6] were the first to propose the 2 cm cut off by showing that among 21 women with edge-os distance of

Table 1 Basic characteristics, result of delivery in women with low-lying placenta and thier controls.

	Low-lying placenta		Controls		P-value	
	Vaginal delivery (n=26)	Cesarean section (n=47)	Vaginal delivery (n=52)	Cesarean section (n=94)	Within vaginal delivery	Within cesarean section
Age (years)	31.0 (28.5–32.7)	31.5 (29.5–34.5)	31.5 (27.7–34.2)	31.5 (28.2–34.7)	NS	NS
Primiparous women (%)	10 (39)	26 (55)	25 (48)	44 (47)	NS	NS
Previous cesarean section (%)	0 (0.0)	9 (19)	1 (1.9)	30 (32)	NS	NS
Birth weeks (week)	38 (37–40)	37 (36–38)	39 (38–40)	37 (36–38)	NS	NS
Birth weights (g)	2823 (2642–3077)	2556 (2196–2842)	2844 (2587–3216)	2745 (2227–3086)	NS	NS
Apgar score at 1 min <4(%)	1 (3.8)	3 (6.4)	5 (9.6)	11 (12)	NS	NS
General anesthesia (%)	–	6 (13)	–	15 (16)	–	NS
Bleeding (mL)	509 (286–1015)	1250 (860–1620)	269 (196–509)	825 (622–1100)	0.004	<0.001
Bleeding ≥615 mL at vaginal delivery (%)†	9 (35)	–	5 (9.6)	–	0.011	–
Bleeding ≥1000 mL at vaginal delivery (%)	7 (27)	–	1 (1.9)	–	0.002	–
Bleeding ≥1531 mL at cesarean section (%)‡	–	15 (32)	–	9 (9.6)	–	0.002
Bleeding ≥2000 mL at vaginal delivery (%)	–	7 (15)	–	3 (3.2)	–	0.016
Transfusion (%)	2 (7.7)	2 (4.3)	0 (0.0)	0 (0.0)	NS	NS

Statistical analyses were performed between women with low-lying placenta and the control, divided by vaginal delivery and cesarean section.
Data are shown as the median (quartile range).
When P-value was ≥0.10, we showed the value as not significant (NS).
†615 mL was estimated as the 90th percentile of bleeding at vaginal delivey in the Japanese population.
‡1531 mL was estimated as the 90th percentile of bleeding at cesarean section in the Japanese population.

Table 2 Basic characteristics and result of delivery according to placental edge to internal os distance.

	Placental edge to internal os distance		P-value
	0–20 mm (n=38)	21–40 mm (n=35)	
Range (mm)	7–20	21–36	–
Age (years)	30 (28–34)	31 (29–34)	NS
Primiparous women (%)	18 (47)	18 (51)	NS
Previous cesarean section (%)	5 (13)	4 (11)	NS
Birth weeks (week)	37 (36–38)	37 (37–39)	NS
Birth weights (g)	2598 (2277–2890)	2818 (2428–3054)	NS
Apgar score at 1 min <4 (%)	1 (2.6)	3 (8.6)	NS
Vaginal delivery (overall) (%)	10 (26)	16 (46)	NS
Trial of labor (%)	11 (29)	18 (51)	0.059
Antepartum bleeding in women with trial of labor (%)	3/11 (27)	4/18 (22)	NS
Antepartum bleeding before labor (%)	11 (29)	7 (20)	NS
Cesarean section (%)	28 (74)	19 (54)	0.094
Emergency cesarean section due to bleeding (%)	12 (32)	7 (20)	NS
Emergency cesarean section due to non-bleeding (%)	3 (7.9)	3 (8.6)	NS
Elective cesarean section (%)	13 (34)	9 (26)	NS
Bleeding (mL)			
All	1240 (670–1622)	860 (479–1250)	0.059
Vaginal delivery	922 (308–1326)	455 (274–601)	NS
Cesarean section	1325 (725–1645)	1230 (1010–1350)	NS
Bleeding ≥615 mL at vaginal delivery†	6/10 (60)	3/16 (19)	0.046
Bleeding ≥1000 mL at vaginal delivery	5/10 (50)	2/16 (13)	0.069
Bleeding ≥1531 mL at cesarean section‡	12/28 (43)	3/19 (16)	0.063
Bleeding ≥2000 mL at cesarean section	4/28 (14)	3/16 (16)	NS
Transfusion (%)	3 (7.9)	1 (2.9)	NS

When P-value was ≥0.10, we showed the value as not significant (NS).
†615 mL was estimated as the 90th percentile of bleeding at vaginal delivey in the Japanese population.
‡1531 mL was estimated as the 90th percentile of bleeding at cesarean section in the Japanese population.

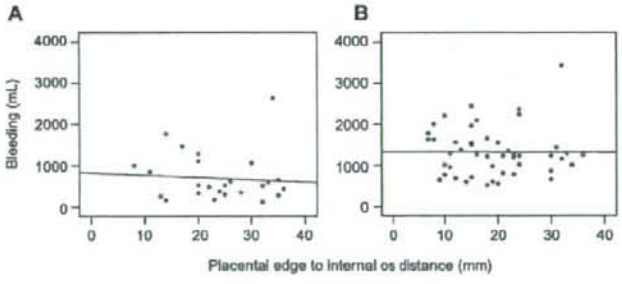

Figure 1 Relationship between placental edge to internal os distance and amount of bleeding in women with vaginal (A) and abdominal (B) delivery. Open circles indicate individual patients. No correlations were observed between the delivery modes ($r=-0.077$ [$P=0.709$], $r=-0.008$ [$P=0.959$], respectively).

0–5.8 cm, seven of eight patients with ≤2 cm had a cesarean because of bleeding compared with no patient with a distance >2 cm [6]. Bhide et al. [1] studying the hitherto largest number (n=79) of women with low-lying placenta (0–3.5 cm), showed a vaginal delivery rate of 5% vs. 44% in women with ≤2 cm vs. >2 cm. Two research groups [3, 8], despite a different study design, also concluded that ≤2 cm vs. >2 cm may determine the eventual delivery mode. The result of the present study was in line with these four previous studies, namely patients with a distance ≤2 cm were less frequently delivered vaginally but without significance. Among the four previous studies cited above, Bhide et al. [1] showed a significant difference in the vaginal delivery rate between ≤2 cm and >2 cm, whereas two other studies [3, 6] provided no statistical analysis. In another study by Predanic et al. [8], the number of patients to compare the rate of delivery mode between ≤2 cm and >2 cm just before delivery was only 29. Thus, although 2 cm cut off has hitherto been considered

Table 3 Delivery mode in women with placental edge-os distance of ≤2 cm vs. >2 cm.

Author	Year	Number studied	Eventual mode of delivery	
			Edge-os distance	
			<2 cm	>2 cm
Oppenheimer et al.	1991 [6]	21	n=8 VD 1 CS 7	n=13 VD 9 CS 4[1]
Dawson et al.	1996 [3]	33	n=18 VD 6 CS 12	n=15 VD 12 CS 3[2]
Bhide et al.	2003 [1]	79	n=40 VD 2 CS 38[3]	n=39 VD 17 CS 22[4]
Predanic et al.	2005 [8]	29[5]	n=13 VD 0 CS 13	n=16[5] VD 6 CS 10[6]
This study		73	n=38 VD 10 CS 28	n=35 VD 16 CS 19

CS = cesarean section, VD = vaginal delivery. Transvaginal ultrasound was used, except for the study by Dawson et al. [3], in which translabial ultrasound was used.
[1]CS for reasons other than bleeding.
[2]Two women had elective CS, and one had CS because of bleeding.
[3]Twenty women had elective CS, six had emergency CS for bleeding, and 12 had emergency CS for reasons other than bleeding.
[4]Twelve had elective CS, two had emergency CS for bleeding, and eight had emergency CS for reasons other than bleeding.
[5]A further 41 cases had edge-os distance of >3.0 cm; however, the upper limit of edge-os distance was not specified in them. Thus, these 41 cases were excluded from this Table. Cases with edge-os distance of 2.0–2.9 cm numbered 16.
[6]Three had elective CS for low-lying placenta, and seven had elective CS for breech presentation.

to determine the mode of delivery [7], this distance was deduced from a few studies, some of which with a small sample size and without statistical analysis. Considering these limitations together with the present data, we conclude that although ≤2 cm vs. >2 cm may affect the eventual mode of delivery, the 2 cm cut off is by no means a definite value. Predanic et al. [8] demonstrated that not only the edge-os distance counts but also the placental migration pattern affected the delivery mode, and thus, further studies with a larger population are needed to clarify this issue.

For the first time, we focused on the relationship between blood loss and the edge-os distance. Women in the lower group bled more, more frequently bled antepartum, more frequently required an emergent cesarean section due to bleeding, and showed a higher incidence of excessive hemorrhage during delivery. Thus, the lower group showed a general tendency toward heavier bleeding pattern than the higher group. This tendency, however, was without statistical significance, except for the rate of excessive hemorrhage during vaginal delivery. In other words, no evidence was found that 2 cm is the definite cut off also for blood loss during delivery. The absence of a clear correlation between distance and blood loss, both in vaginal and abdominal delivery, also supports this view.

Both from the viewpoint of delivery mode and blood loss, the present study did not provide definite data to justify or reject the so-called 2 cm rule. A higher incidence of excessive hemorrhage during vaginal delivery in the lower group, the only finding with statistical significance, may justify this rule. On the other hand, although the lower group bled more, the lack of significance may reject this rule. Our sample size, although the second largest [1], might not be large enough to show significance and thus might be underpowered. However, the present study nonetheless indicates that the 2 cm cut off might not predict the eventual mode of delivery or amount of blood loss. Thus, one should be concerned for all women with a placental edge-os distance of 2.1–4.0 cm as with those having a 0–2.0 cm distance. Further studies with larger populations are needed to confirm whether the 2 cm rule is clinically appropriate, and if not, to define the appropriate distance.

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ORIGINAL ARTICLE

Fetal heart rate pattern reflecting the severity of placental abruption

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Abstract
Objective To identify fetal heart rate (FHR) patterns reflecting the severity of placental abruption, and to determine the incidence of normal FHR pattern in cases of placental abruption.
Materials and methods We analyzed FHR tracings from 40 pregnant Japanese women with placental abruption. We analyzed which FHR patterns appeared more frequently in cases of low 5-min Apgar score, low cord arterial pH, and large separation.
Results Eight out of 40 cases showed a normal FHR pattern, while 32 cases did not show a normal FHR pattern. Undetectable variability and bradycardia appeared more frequently in cases with 5-min Apgar < 7, with cord blood pH < 7.1, and with larger placental separation than in cases without these features. The normal FHR pattern was associated with 5-min Apgar ≥ 7, cord blood pH ≥ 7.1, and separation of <25%.
Conclusion Fetal heart rate pattern reflected the severity of placental abruption. Undetectable variability and bradycardia occurred significantly more frequently in cases of severe placental abruption, and thus may reflect the severity of placental abruption.

Keywords Acidosis · Fetal heart rate pattern · Placental abruption

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Introduction

Placental abruption is associated with significant perinatal mortality and morbidity [1, 2]. Placental abruption is usually diagnosed clinically based on maternal symptoms, physical findings, blood data, and ultrasonography [1, 2]. Electronic fetal heart rate monitoring (FHR) is not only an important tool for the diagnosis of this disease [1, 2], but also may contribute to predicting disease severity.

Previously reported data indicated that placental abruption was associated with various types of FHR patterns, including a decrement in variability, change in baseline FHR, and various types of deceleration [2, 3]. Once separation of the placenta occurs, infants are deprived of an oxygen supply, leading to fetal acidosis of various degrees [2, 4]. Thus, a variety of FHR patterns may appear according to the severity of placental separation; however, no previous studies have focused on the relationship between FHR pattern and the severity of placental separation.

We attempted the present retrospective study to answer the following two questions: (1) What types of FHR patterns appear more frequently according to the severity of placental abruption and thus reflect its severity? (2) Are there women who have normal FHR patterns despite having this disease, and if so, is this status related to disease severity? We evaluated disease severity based on its effects on fetuses/neonates and not on mothers, in order to determine the most ominous FHR pattern for the fetuses/neonates in this disease.

Materials and methods

Study population consisted of 67 women with placental abruption who gave birth to singleton infants from January

2000 to December 2005. During this period we dealt with 6,033 deliveries after 22 weeks of gestation in our institute. Placental abruption was diagnosed when retroplacental hematoma was macroscopically confirmed at the time of delivery. We excluded women with placental abruption incidentally found by pathological examinations. We also excluded women incidentally delivering blood clots just before or at the time of delivery. Among these 67 women, 40 women were referred to our hospital after the diagnosis or suspicion of placental abruption, and the remaining 27 women developed this disease during antenatal follow-up in our hospital.

Among these 67 women, we did not have FHR recordings for 27 women for the following reasons: 8 fetuses were already dead on arrival and 19 women were confirmed to have bradycardia by ultrasonography, and there was no time for FHR recordings. We had FHR recordings made for at least more than 15 min for the remaining 40 women, which we analyzed in the present study. We confined the study materials to the FHR recordings made within 2 h before delivery.

Fetal heart rate patterns were defined according to the criteria by the National Institute of Child Health and Human Development Research Planning Workshop (NICHD criteria) [5, 6]. In brief, bradycardia and tachycardia were defined as baseline FHR < 110 bpm and >160 bpm, respectively. Undetectable variability and minimal variability were defined as FHR with no detectable variability and with variability of <5 bpm, respectively. Late deceleration was defined as gradual decrease of FHR in association with uterine contraction, of which onset, nadir and recovery occurred after the beginning, peak and end of the contraction, respectively. A "normal" FHR monitoring was tracing which met all of the following four criteria: (1) normal baseline (110–160 bpm), (2) presence of acceleration, (3) normal variability (6–25 bpm), and (4) the absence of any type of deceleration [5–7]. We employed the criteria of Kubli et al. [8] for the diagnosis of severe variable deceleration (nadir of <70 bpm and duration of >60 s), which was not defined in the NICHD criteria [6]. Some women concomitantly showed several different FHR patterns, and some showed different FHR patterns during FHR monitoring. For example, a woman showed late deceleration at first, and subsequently bradycardia with minimal variability. In this instance we considered/counted that these three FHR patterns appeared in this woman. FHR recordings were assessed by one of the authors (RU), an expert for FHR reading, who was blinded to the ultimate severity of placental abruption at the time of assessment.

As possible markers representing the severity of placental abruption, we examined three factors: (1) 5-min Apgar score, (2) the pH value of cord arterial blood, and (3) the degree (%) of separation of the entire placental maternal surface observed soon after delivery. Cord blood was obtained just after placental delivery and pH was measured immediately. We tested whether there were significant differences in the incidence of each FHR pattern in women with (1) 5-min Apgar <7 versus ≥7, (2) pH value of <7.1 versus ≥7.1, and (3) different degrees of separation, i.e.: >75, 50–74, 25–49, and <25%. We used Fisher's exact test. A P value of <0.05 was considered significant.

Results

Among 67 women, 27 women were rushed to the emergency surgical unit without FHR recordings. Among these 27 women, 11 women suffered from disseminated intravascular coagulation (DIC) and one woman received a cesarean hysterectomy. No women died. Approximately half of the infants born to these women showed a 5-min Apgar score of <7 and three infants died within 7 days after birth. We excluded these 27 women and analyzed the remaining 40 women with FHR recordings made for at least 15 min.

The 40 women delivered infants at 26–40 weeks of gestation, with a median of 33.8 weeks. Eighty percent of the women gave birth to preterm infants, and the remaining 20% gave birth to term infants. Ultrasonography was done for 38 women for detecting the presence of retroplacental hematoma, and remaining two had no time for that. In 35 out of 38, ultrasonography revealed the presence of a mass beneath the placenta or placental thickening more than 8 cm in tangential section. Five women were delivered due to the presence of nonreassuring fetal status without the clinical signs or ultrasonographic findings for placental abruption, in which placental abruption was observed after delivery. Almost all women (37/40: 93%) delivered by emergency cesarean section. Two women suffered from DIC. No women received a cesarean hysterectomy. No women died. There were three perinatal deaths: one was stillborn at 32 weeks of gestation, and two infants, born at 30 and 31 weeks, respectively, died within 7 days after birth.

Among the 40 women with FHR recordings, 8 (20%) showed a normal FHR pattern, whereas 32 (80%) did not show normal FHR patterns. Figure 1 shows the incidence of various FHR patterns among the 32 women. We focused our attention on these 32 women. Table 1 shows the number of women according to the 5-min Apgar score, cord arterial blood pH, and degree of placental separation, which were available for 32, 27, and 31 women, respectively.

Figures 2, 3, and 4 show the relationship between the incidence of each FHR pattern and possible markers reflecting the severity of placental abruption. Figure 2 shows the incidence of each FHR pattern in women with infants with

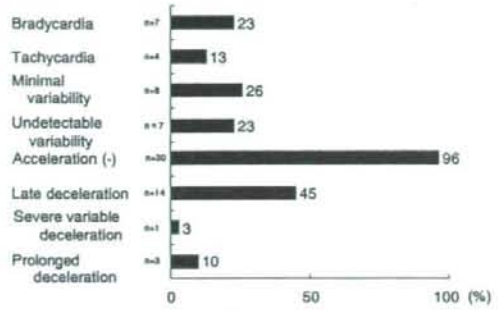

Fig. 1 Incidence of various FHR patterns. The *bars* and the adjacent *numbers* indicate the incidence (%) of various FHR patterns observed in 32 women. FHR patterns were defined according to the criteria by the National Institute of Child Health and Human Development Research Planning Workshop (*NICHD* criteria). The number (*n*) on the vertical axis indicates the number of women who showed each FHR pattern. Many women showed several FHR patterns, and thus the total incidence of all patterns is >100%

Table 1 Apgar score, cord arterial blood pH, and degree of separation in women who did not show normal FHR pattern according to NICHD criteria

	Number of women with data available	Measured value	Number of women (%)
5-min Apgar score	32	<7	12(37)
		≥7	20(63)
Cord arterial blood pH	27	<7.1	8(29)
		≥7.1	19(70)
Degree of placenta separation	31	≥75	6(19)
		50–74	4(12)
		25–49	8(25)
		<25	13(41)

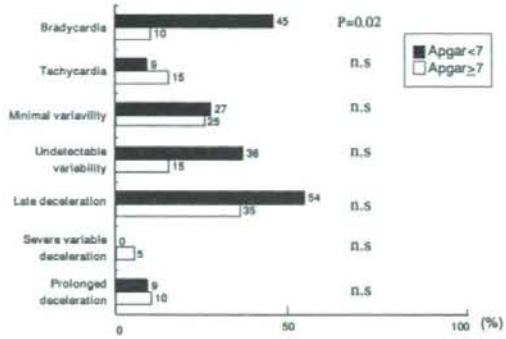

Fig. 2 Incidence of various FHR patterns in women with a 5-min Apgar score of <7 versus ≥7. The *bars* and the adjacent *numbers* indicate the incidence (%) of various FHR patterns in women with infants with 5-min Apgar score of <7 (*black*) versus those of ≥7 (*blank*). *n.s.* not significant

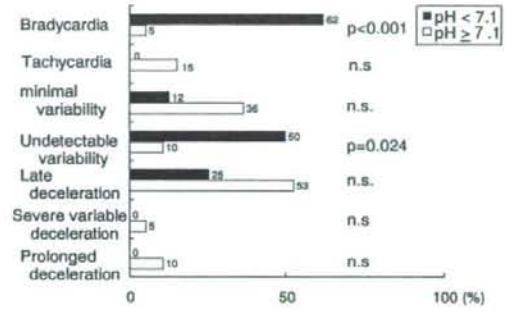

Fig. 3 Incidence of various FHR patterns in women with cord arterial blood pH of <7.1 versus ≥7.1. The *bars* and the adjacent *numbers* indicate the incidence (%) of various FHR patterns in women with cord blood pH of <7.1 (*black*) versus ≥7.1 (*blank*). *n.s.* not significant

a 5-min Apgar score <7 versus ≥7. Bradycardia occurred significantly more frequently in the lower Apgar score group than in the higher Apgar score group. Undetectable variability, minimal variability, and late deceleration also tended to occur more frequently in the lower Apgar score group, but the association was not significant. Figure 3 shows the incidence of FHR patterns in women with a cord blood pH of <7.1 versus ≥7.1. Bradycardia and undetectable variability appeared significantly more frequently in cases with cord blood pH of <7.1. The incidence of bradycardia was strikingly different between the two groups: 62 versus 5% in cases with versus without severe acidosis (pH < 7.1), respectively ($P < 0.001$). There were no significant differences in the incidence of the other FHR patterns between the two groups. Figure 4 shows the incidence of bradycardia and undetectable variability according to the degree of placental separation: >75% ($n = 6$), 50–74% ($n = 4$), 25–49% ($n = 8$), and <25% ($n = 13$). Bradycardia and undetectable variability occurred in 4, 2, 0, 1, and 3, 2, 0, 2, cases, in these groups, respectively. Bradycardia and undetectable variability appeared more frequently in cases with larger separation compared to those with smaller separation. Combining the two larger quarters (>75% plus 50–74%) together and the two smaller quarters (25–49% plus <25%) together, the incidence of bradycardia and undetectable variability showed a significant difference between the larger (>75% plus 50–74%) versus the smaller (25–49% plus <25%) separation: 60% (4 + 2/6 + 4) versus 5% (0 + 1/8 + 13) ($P < 0.005$) for bradycardia, and 50% (3 + 2/6 + 4) versus 10% (0 + 2/8 + 13) ($P = 0.02$) for undetectable variability. There was no relationship between the degree of separation and the incidence of various FHR patterns except for these two FHR patterns (data not shown). Four women showed bradycardia and undetectable variability

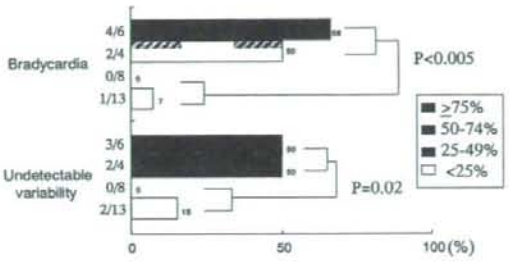

Fig. 4 Incidence of bradycardia and undetectable variability according to the degree of placental separation. Degree of separation was classified into four categories: separation of ≥75, 50–74, 25–49, and <25%. The *bars* and the adjacent *numbers* indicate the incidence (%) of bradycardia and undetectable variability in each group of women with different degrees of separation. The numbers on the vertical axis (4/6, etc.) indicate the incidence of the indicated FHR pattern among women with the indicated degree of separation. For example, four out of six women with separation of ≥75% showed bradycardia

at the same time. All these women showed a 5-min Apgar score <7, cord blood pH < 7.1, and separation >50%.

Twenty percent of the women with FHR recordings showed normal FHR pattern throughout the monitoring period regardless of the presence of clinically overt and macroscopically confirmed placental abruption. All these women showed a 5-min Apgar score ≥7, cord blood pH ≥ 7.1, and separation <25%.

Discussion

In this study we made two important observations. First, both undetectable variability and bradycardia reflected the severity of placental abruption. Undetectable variability or bradycardia was observed more frequently in women with neonates with a low 5-min Apgar score, with a low pH of cord blood, and with a larger placental separation than in women without these features. Second, among the women for whom FHR recordings were available 20% of the women showed normal FHR patterns, and all of them gave birth to infants with a high Apgar score and with cord blood pH > 7.1. They all showed placental separation of <25%.

Some previous researchers showed that undetectable variability had a close association with low cord blood pH or decreased base excess (BE), and thus with fetal acidosis. Low et al. [9], studying the relationship between the FHR pattern just before delivery and cord blood BE, showed that absent variability was observed ten times more frequently in women with cord blood BE < −16 mEq/l compared to those with cord blood BE > −8 mEq/l [9/71 (13%) vs. 1/71 (1.4%)], and concluded that absent variability is the most specific marker for predicting decreased BE of cord blood [9]. Another research group demonstrated that women with absent variability showed a much higher incidence of cord blood pH of <7.2, compared to those with normal variability [24% (5/21) vs. 3% (11/403)], indicating that absent variability predicted a low cord pH value [10]. Some other researchers showed that minimal/absent variability predicted the development of severe acidemia of neonates most significantly [11]. Bradycardia is also considered to be closely associated with fetal acidosis. Gilstrap et al. [10] showed that 18% (30/165) of women with mild bradycardia and 27% (33/121) of those with moderate/severe bradycardia, respectively, had a cord blood pH value of <7.2, and concluded that bradycardia can predict newborns at higher risk of acidosis. Although all these data indicate that both undetectable variability and bradycardia indicate fetal acidosis, it has not yet been clarified whether this also holds true for women with placental abruption. There were hitherto no data available regarding this.

This study for the first time proved that this also holds true in cases of placental abruption. Undetectable variability and bradycardia reflected the severity of placental abruption. Since the previous studies cited above [9–11] showed that undetectable variability and bradycardia predicted fetal acidosis, our data were theoretically reasonable. In fact, in a study attempting to clarify the tolerable decision-to-delivery interval in women with "severe" placental abruption, the presence of bradycardia was used as a criterion for "severe" separation [12]. Once placental separation occurs, retroplacental hematoma develops, destroying villous tree architecture and depriving the fetus of an oxygen supply [1, 2, 4]. The larger the separation, the more acidic the fetus becomes, which may lead to a lower Apgar score [1, 2]. Thus, we employed these three factors to evaluate the severity of placental abruption.

Some women with clinically apparent placental abruption showed a normal FHR pattern, which has been proved to strongly predict the absence of fetal acidosis [5]. These patients constituted 20% (8/40) of the women with FHR recordings, and 12% (8/67) of all initial enrollees with or without recordings. If the separation area is small and sufficient healthy placenta remains to supply oxygen to the fetus, then the fetus will surely avoid acidosis. In fact, the present study indicated that all women with a normal FHR pattern showed placental separation of <25%. Furthermore, they all delivered infants with an Apgar score of ≥7 and with a cord blood pH of ≥7.1. A recent review of placental abruption stated, "there is evidence that if the FHR pattern is normal, then delay such that the maternal status is stabilized, is appropriate" [12]. This statement is supported by the present observations. However, the present study population is small to definitely determine this point, and we must wait further data to accumulate.

The present data may not alter the routine obstetrical practice. This is the limitation of the present study. First,

although we showed that undetectable variability and bradycardia were significantly associated with the severity of placental abruption, women with suspected abruption and these FHR patterns would always be delivered emergently even without the present data. We did not find ominous patterns specific to placental abruption. Second, it is not definitely determined whether we can really consider other ominous FHR patterns as "not so emergent". There are other ominous FHR patterns in addition to undetectable variability and bradycardia, such as recurrent late deceleration, prolonged deceleration, and severe variable deceleration [5, 6]. Although the present study showed that the incidence of these ominous FHR patterns did not differ between low versus high Apgar, cord blood pH of <7.1 versus ≥7.1, and large versus small separation, we are not confident whether we can wait in the face of these patterns, and if we can wait, for how long. Further studies of a larger population will be needed to clarify whether some other patterns specific to placental abruption do exist, and whether other FHR patterns generally believed to indicate fetal acidosis really do not have any association with the severity of this disease.

We found ultrasound signs for retroplacental hematoma in 35 out of 38 women and thus the sensitivity of ultrasound for detecting placental abruption was calculated to be 92% (35/38), much higher than the 24% reported by Glantz and Purnell [13]. In their report, women with positive ultrasound findings delivered at an average of as long as 18 days after the positive scan and only 53% were delivered by cesarean section. This leads us to assume that the cases of abruption described in the report by Glantz and Purnell suffered less severe abruption than those in the present study. This may account for the difference in sensitivity of ultrasound between the present and previous study [13].

In conclusion, we found that two FHR patterns, i.e., undetectable variability and bradycardia, reflected the severity of the placental abruption. These two patterns were associated with abruptions >50% in over 50% of cases and thus these patterns demand immediate delivery in women with suspected placental abruption.

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