Early puerperium involution of the uterus after Caesarian section: Basic data for use in an assessment index

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Abstract

Purpose
The purpose of this study was to elucidate the chronological changes that take place during involution of the uterus after Caesarian section (CS) to obtain basic data for use in the assessment of an involution state.

Methods
The participants were 70 women who underwent CS of a single, full-term fetus and experienced a normal postoperative course thereafter. Fundal length and height of the uterus were measured from puerperium day 0 to puerperium day 7. Forty-eight of the 70 women were included in color analysis of the lochia using a self-administered questionnaire to record daily changes in lochia color. Statistical analysis was performed using SPSS ver. 22.0 software, and P < 0.05 was considered statistically significant.

Results
Mean fundal length gradually decreased from 18.1±0.32 (mean±SE) cm on puerperium day 0 to 15.6±0.21 cm on puerperium day 3 and 13.4±0.20 cm on puerperium day 7. Mean length decreased approximately 1 cm per day on puerperium days 1 and 2 (p < 0.01) and an additional 1 cm on puerperium day 4 and puerperium day 6 (p < 0.01). Median fundal height was one finger-width below the navel on puerperium day 0, two finger-widths on puerperium day 3, and three finger-widths on puerperium day 6, although there was wide variation in the measurements.

Lochia color, as checked by the puerperal women, showed significant change starting on puerperium day 6 (p < 0.05); however, 30% of the puerperal women still had red-colored lochia.

Conclusion
Post-CS fundal length was longer and showed more marked changes in comparison to vaginal births. Our investigation of changes in fundal height, as determined via palpation, indicated that three days were required for the height to decrease by one finger-width below the navel and that there was wide variation in the data. Notably, assessments dependent upon palpation are particularly susceptible to individual interpretation. In comparison to vaginal births, in CS births, lochia color change and involution of the uterus take longer to occur and the uterus is softer.

The results of this study, wherein satisfactory postpartum progress was observed after normal, standard CS of single full-term fetuses, represented basic data related to early puerperium involution of the uterus following CS; these data can be utilized as assessment criteria in the future.

Key words: Caesarian section, early puerperium, fundal length of the uterus, involution of the uterus, palpation

I. Introduction
In recent years, the rate of Caesarian sections (CS) have increased in Japan (Ministry of Health, Labour and Welfare, 2014, p.28). Consequently, CS is becoming a more commonly performed procedure. The percentage of CS performed in general hospitals rose from approximately 17% in 2002 to 24.1% in 2011 (Ministry of Health, Labour and Welfare, 2014, p.28). In addition, the number of elderly primigravida has been increasing

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annually (Mothers’ & Children’s Health & Welfare Association, 2013, p.49) due to advancements in fertility treatments and the inclination to marry later in life which has been implicated in decline of birth rates. In cases of high-risk elderly primigravida, CS is performed more frequently than at other ages (Higuchi, Ban, Hayashi, et al., 1989, p.985). Such medical and societal changes may further increase the cases of CS in the future.

However, of all the involution-related phenomena that take place in the puerperium period, involution of the uterus undergoes the most significant morphological and physiological changes. The observation of these changes is important in determining the further steps in nursing for promoting the health condition. The stages of involution of the uterus in cases of vaginal birth are well documented, and there are established indices used to assess these stages (Araki, 2010, pp.309-310; Kitagawa & Uchiyama, 2013, p.767; Mori, Takahashi, Kudo, et al., 2015, p.291). Although it is known that involution of the uterus following CS takes longer than it does after vaginal birth (Kitagawa & Uchiyama, 2013, p.832; Negishi, Kishida, Yamada, et al., 1999, p.14; Shalev, Royburt, Fite, et al., 2002, p.39), few studies have investigated the process of uterine involution following CS, and consequently, there are currently no standards of staging.

A study investigating involution of the uterus following CS reported intermittent data for two days, one month, and three months post-partum, and there was no clinically applicable data because the assessments were performed by ultrasound or Magnetic Resonance Imaging (Dicle, Kucukler, Pirnar, et al., 1997; Negishi, Kishida, Yamada, et al., 1999). A retrospective observational study investigating data during hospitalization reported data obtained via palpation; however, no objective quantitative data on fundal length were shown (Wakabayashi & Iwatani, 2000).

Fudinal length is one of the important indices used to evaluate involution of the uterus during the puerperium period, and the creation of standards for this assessment index is significant and necessary. Lochia color is another parameter used to assess the state of puerperal involution of the uterus. As with fundal length, there have been no studies analyzing lochia color; consequently, the changes that take place in lochia color following CS remain unclear.

Thus, we herein elucidated the chronological changes in fundal length and lochia color following CS to obtain basic data for creating an assessment tool designed for versatile use in clinical settings.

II. Methods

1. Participants

The participants were 70 women who underwent CS with a single, full-term birth and made satisfactory progress after CS (those with uterine myoma, morphological abnormalities of the uterus, and those with missing data were excluded). These participants were selected from a total of 240 pregnant women scheduled for delivery at either Hospital A or Hospital B between May 2008 and December 2013. Epidural anesthesia was used for the CS, and 93% of 70 participants had a scheduled cesarean section. Written informed consent was obtained from all participants prior to their participation in the study. Of these 70 women, data pertaining to lochia color were completely recorded for 48 women and analyzed. All data were collected from puerperium day 0 to puerperium day 7.

The postpartum care is not different from A Hospital and B Hospital, the following rooming-in system and self-demand feeding.

2. Methods

1) Method of measuring fundal length and fundal height

Fundal lengths were measured by a midwife or a nurse. We explained to the nursing professionals how to measure length of the uterine fundus as follows, using a measure from the pubic bones superior border to fundus of uterus. We confirmed that the abdominal gauze (a thin film-like dressing) used after delivery did not affect the measurements. The measurements were performed by ultrasound or Magnetic Resonance Imaging (Dicle, Kucukler, Pinar, et al., 1997; Negishi, Kishida, Yamada, et al., 1999).

Fudinal length is one of the important indices used to evaluate involution of the uterus during the puerperium period, and the creation of standards for this assessment index is significant and necessary. Lochia color is another parameter used to assess the state of puerperal involution of the uterus. As with fundal length, there have been no studies analyzing lochia color; consequently, the changes that take place in lochia color following CS remain unclear.
2) Examination of lochia color

The participants recorded daily changes in lochia color using a self-administered questionnaire, making these data comparative. Therefore, a standard color chart (Munsell® Color System chart) was used to minimize individual variations in color perception. Several midwives selected “Blood color (red): Munsell 7.5R4/14” and “Brown: Munsell 7.5R3/6” from the Munsell Book of Color: Glossy Edition (Munsell®) to describe lochia color. Since the midwives were unable to determine a color midway between blood color and brown (reddish brown), the participants were instructed to indicate “midway color” on the questionnaire when the observed lochia color ranged between these two colors. These three colors (blood-colored, brown, and gradation of these two colors i.e., “midway color”) were printed and distributed with the questionnaires to be used as samples. The participants were asked to check and record their lochia color against the samples every day until discharge from the hospital.

3. Methods for analysis

Repeated-measures one-way analysis of variance (ANOVA) was used for measuring changes in fundal length, and subsequently, the Bonferroni’s multiple-comparison test was performed. T-tests were used for comparison of two fundal length groups divided according to birth history (parity). We used Cochran’s Q-test and the McNemar test to assess the changes in lochia color.

Statistical software used in this study was IBM SPSS Statistics ver. 22.0, and P < 0.05 was considered statistically significant. We used Cohen’s f to evaluate the effect size of our repeated-measures one-way ANOVA, Cohen’s d on the t-test and multiple comparisons, and odds ratio on the McNemar test (Mizumoto & Takeuchi, 2008, pp.62-64). Calculation of effect size was performed using G*Power3.1.9.2 for Windows.

4. Ethical considerations

The participants were provided with both oral and written requests to participate before the commencement of the study, and their consent was obtained. The written requests included an overview of the study, which explained that their personal data would be statistically processed so that their names and other personal information could not be identified and that they could withdraw from the study at any time and for any reason without it incurring a disadvantage to them in any way. It also stated that the data obtained in the study would be strictly protected and that the results of the study would be utilized in conference presentations and articles published in academic journals.

This study was conducted with the approval of the Research Ethics Committee of the Prefectural University of Hiroshima (Approval no. 10).

III. Results

1. Participant background

Background information of the participants is shown in Table 1. Age was 32.6 ± 4.9 (mean ± SD) years old; gestational age at birth was 38 weeks 1 day ± 3.8 days; birth weight of the newborn was 2917.8 ± 269.5 g, and the intrapartum bleeding volume was 503.2 ± 289.3 g. Twenty-two participants were primigravida and 48 were multigravida.

2. Changes in fundal length

Fundal length (mean value) gradually decreased from 18.1 cm on puerperium day 0 to 15.6 cm on puerperium day 3 and 13.4 cm on puerperium day 7. On puerperium days 0 to 2, fundal length decreased approximately 1 cm per day and gradually decreased by several millimeters per day after puerperium day 4. Statistically significant changes in fundal length (one-way ANOVA; p < 0.01, effect size f = 0.16) were noted. Each fundal length comparison (between puerperium day 0 and 1, puerperium day 1 and 2, puerperium day 2 and 4, and puerperium day 4 and 6) showed statistically significant differences (Bonferroni correction, p < 0.01; Fig. 1).

Table 1  Characteristics of participants  (n=70)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (in years)</td>
<td>32.6 ±4.9</td>
</tr>
<tr>
<td>Length of pregnancy (week+day)</td>
<td>38W+1d ±3.8d</td>
</tr>
<tr>
<td>Birth weight (g)</td>
<td>2917.8 ±269.5</td>
</tr>
<tr>
<td>Amount of bleeding during labor (g)</td>
<td>503.2 ±289.3</td>
</tr>
<tr>
<td>Number (primipara/multipara)</td>
<td>22 / 48</td>
</tr>
</tbody>
</table>

*mean ± SD
The effect size was $d = 0.52$, and a difference of approximately 1 cm was detected.

The comparison of the participants by birth history indicated that the fundal length of primigravida participants on puerperium days 0, 1, 3, and 5 were approximately 1 cm higher (t-test, $p < 0.05$, effect size $d = 0.73$) than those of multigravida participants on corresponding days (Fig. 2).

### 3. Changes in fundal height as measured by palpation

Measurements via palpation are shown in Figure 3. The median fundal height measured by palpation on puerperium day 0 was one finger-width below the navel, with a range of between 2 finger-widths below the navel and 3 finger-widths above the navel. On puerperium day 3, the median fundal height was two finger-widths below the navel with a range of between 0 to 3 finger-widths, and on puerperium day 6, it was 3 finger-widths below the navel with a range of between 1 and 5 finger-widths.

As shown in Figure 3, the ranges showed large individual variation. The ranges for puerperium day 0 and day 5 and particularly the ranges thereafter showed wide variation, while the variation in the ranges during the midway period between those two, i.e., puerperium days 2 to 4, tended to be relatively smaller.

The median values for the palpation data are shown in the illustration in Figure 4. The initial measurement on puerperium day 0 was one finger-width below the navel. This measure decreased to two finger-widths below the navel on puerperium day 3 and three finger-widths below the navel on puerperium day 6, indicating a decrease in fundal height by one finger-width over a 3-day period.
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period. A single finger-width is equivalent to approximately 2 cm of fundal length.

4. Changes in lochia color as recorded by the puerperal women

On puerperium day 1, approximately 60% of the participants recorded red lochia. This figure decreased to approximately 48% by puerperium day 4 (Fig. 5). Statistically significant differences were apparent on puerperium day 6 [McNemar’s test, p < 0.05, effect size odds ratio = 3.97 (two-sided test)], with approximately 30% of the participants recording red lochia.

IV. Discussion

1. Changes in fundal height and length

In cases of vaginal birth, fundal length on postpartum day 1 ranges from 12 to 13 cm (Fujita, Manabe, Morooka, 1994, pp.65-66; Kitagawa & Uchiyama, 2013, p.767), and is approximately 7 cm on postpartum day 6. In the current study, fundal length following CS was 17.0 cm on postpartum day 1 and 13.8 cm on postpartum day 6. This indicated a clear difference from vaginal births at the time immediately after birth, with longer fundal length following CS. In cases of CS, delays in walking after childbirth and insufficient degree of cervix dilatation (Kitagawa & Uchiyama, 2013, p.832) is considered to interfere with lochia discharge and be related to delays in the return of the uterus to anteversion (Mulic-Lutvica & Axelsson, 2007, pp.213-215).

In the current study, fundal length decreased at 1 cm per day from puerperium day 0 to puerperium day 2 and several millimeters per day thereafter. As shown in Figure 1, statistically significant differences were recorded every other day starting on puerperium day 2. The pattern of rapid decreases in fundal length in the early puerperium followed by more gradual decreases thereafter may be a characteristic of involution of the uterus following CS. Many studies have reported shrinkage of approximately 1 cm per day in vaginal birth (Fujita,
The gradual nature of changes in involution of the uterus following CS also corresponds to measurements via palpation. In contrast to cases of vaginal birth (in which fundal height decreases one finger-width per day) (Araki, 2010, pp.309-310; Mori, Takahashi, Kudo, et al., 2015, p.291), in this study, we detected a pattern in which a decrease of one finger-length was recorded over the course of three days following CS. In addition, there was a trend toward smaller variation in palpation measurements from puerperium day 2 to puerperium day 4. The observation frequently made by midwives that “there was no change in palpation data from the previous day” matches the hypothesis that involution of the uterus may have a stagnant period during which it may be difficult to detect changes.

According to Wakabayashi & Iwatani (2000, p.111), the mode of palpation measurements of fundal height following CS are one finger-width on puerperium day 0, two finger-widths on puerperium day 2, and three finger-widths on puerperium day 5. Although the results of this study showed similar values, the fact that the previous study included cases of twins and preterm births may account for the differences. As indicated by the ranges recorded for palpation measurements, there was wide variation in fundal height measurements. This may be due to individual differences among finger size of the midwives and nurses caring for these patients in addition to individual differences in the puerperal women. Therefore, when using palpation measurements for assessment, it is necessary to consider not only individual differences among puerperal women but also individual differences among the practitioners taking the measurements.

The measurements for fundal length and fundal height obtained in this study were from the same participants and were not taken using ultrasonography but were rather performed manually by nursing professionals at the participants’ bedside; this method made these data highly significant.

There was a higher rate of multigravida women in this study, and it was assumed that many repeated CS cases could affect the results. Previous studies have included both women whose birth histories affected postpartum involution of uterus (Negishi, Kishida, Yamada, et al., 1999; Wakabayashi & Iwatani, 2000) and those whose birth histories did not affect postpartum involution of uterus (Lavery & Shaw, 1989). In addition, the women in those previous studies included both vaginal and CS births, and the measurement periods and methods differed, making a parallel comparison with our study impossible. The results of the present study indicated that fundal length was longer in primigravida women; this result was consistent with those of other studies of CS cases (Wakabayashi & Iwatani, 2000, p.112). However, differences in fundal length due to birth history in CS cases were small in all cases (approx. 1 cm in this study, approx. 0.3 finger-widths in Wakabayashi & Iwatani (2000, p.114) study), indicating that the use of palpation does not substantially influence the results.

2. Changes in lochia color

Lochia color is normally red until puerperium day 4 and then shifts to brown which is maintained until puerperium day 8 (Araki, 2010, p.312; Kitagawa & Uchiyama, 2013, pp.771-772). The current study of CS cases indicated that 60% had red lochia on puerperium day 1 and 30% had red lochia on puerperium day 6. A study of vaginal births reported that 32% had red lochia on puerperium day 3 and 1.6% had red lochia on puerperium day 6 (Narita, Noda, Seki, 1983, p.805). Accordingly, it is considered that, as with fundal height, changes in lochia color occur more slowly in CS cases in comparison to vaginal birth cases (Wakabayashi & Iwatani, 2000, p.115; Yoshida, 2010).

However, there is a report of red lochia lasting up to puerperium day 12, which is longer than that reported by classic studies on the subject (Sherman, Lurie, Frenkel, et al., 1999, pp.399-400). Systematic review conducted by Fletcher, Grotegut, & James (2012) reported that the average duration of postpartum blood loss was stable during 24 to 36 days. Comparative investigation of the changes in lochia color and duration of these
changes by type of birth is required.

The data in our study were recorded by the puerperal women themselves. Such data, based on the experiences and perspectives of puerperal women, may be utilized in health guidance designed to improve self-care and may further help in developing the standards for self-judgement for puerperal women.

3. The possibility of using the results of this study as an assessment index

Our investigation of fundal length following CS included measurements from puerperium day 0 to puerperium day 7. These data can be applied to puerperal women during hospitalization following CS. Chronological changes in fundal length showed statistically significant differences. The effect size was moderate at $d=0.52$, and the difference was 1 cm. Since the daily decrease in cases of vaginal birth is 1 cm, it is easy to compare the measurements. Meanwhile, through the use of palpation, we detected a change of one finger-width (approximately 2 cm) over the course of three days. When used as a method to determine the state of involution of the uterus. Palpation is simple and non-invasive and is therefore practical to use in clinical settings. Hence, we believe that the palpation data obtained in this study are practically applicable.

Factors that influence involution of the uterus are considered to include age, gestational age at birth, and the size of both the fetus and fetal appendages (Kitagawa & Uchiyama, 2013, pp.832-838; Lavery & Shaw, 1989, p.483; Yoshida, Sugiyama, Maruyama, et al., 2006, p.508). In the current study, participants who had factors that could influence involution of the uterus were excluded. Therefore, the included participants were those who underwent normal and standard CS with full-term, single-fetus pregnancies. The data obtained from such population may represent basic data for early puerperium involution of the uterus following CS and can therefore be used as an assessment standard.

4. Limitations and future challenges of this study

Since the results of this study were in a specific population of women, it would be difficult to use these data in cases of multiple births, myoma of the uterus, preterm births, or other conditions. In addition, quantity of the lochia and the breast feeding state, medical reason for a cesarean are unidentified, and anamnesis of Caesarean operation, they were not analyzed. Including these issues, data analyses for multiple births and according to gestational age are required in the future.

There were large individual differences shown in this study. It is considered as a background that the error between measurers didn’t be confirmed. The data were obtained from two medical facilities in Japan and the participants were all Japanese. Thus, analysis of data obtained outside Japan and investigation of other factors remain to be addressed in future studies.

V. Conclusions

As a result of our investigation of the state of uterine involution from puerperium day 0 to puerperium day 7 of 70 puerperal participants who underwent CS for a full-term, single fetus childbirth, we elucidated the following:

1. Fundal length decreased from 18.1±0.32 (mean±SE) cm on puerperium day 0 to 15.6±0.21 cm on puerperium day 3 and to 13.8±0.21 cm on puerperium day 6. At a certain data point, primigravida women had significantly longer fundal lengths than did multigravida women; however, the difference was approximately 1 cm. In cases of CS births, uterine shrinkage was more gradual than in cases of vaginal birth, particularly in the late puerperal period.

2. Median fundal height, as measured by palpation, was one finger-width below the navel on puerperium day 0, two finger-widths on puerperium day 3, and three finger-widths on puerperium day 6, indicating a height reduction by one finger-width over a three-day period. A single finger-width was equivalent to 2 cm of fundal length. There was wide variation in measurements performed using palpation, indicating large individual differences between both puerperal women and the practitioners conducting the measurements.

3. Our investigation of lochia color, as perceived by the puerperal women, indicated that 60% of the participants reported red color on puerperium day 1 and
31% reported red color on puerperium day 6, indicating a significant change. In cases of CS, approximately 30% of the participants reported red lochia during puerperium week 1, indicating a trend toward delayed red coloring in comparison to cases of vaginal birth. Since these data represent the perceptions of the puerperal women themselves, they can be used in health guidance designed to improve self-care.

4. The data obtained in this study are basic data related to early puerperium involution of the uterus following CS and can be used as an assessment index.

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Reference
産褥早期における帝王切開後の子宮復古
—アセスメント指標のための基礎データ—

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抄録

目的
帝王切開後の子宮復古について経日的に変化を明らかにし、子宮復古状態のアセスメントのための基礎データを得ることを目的とした。

方 法
単胎で正期産にて帝王切開分娩し、その後順調に経過した70名を対象に、産褥0日から7日目まで子宮底長および子宮角高を計測した。この70名のうち、悪露の色調に関する分析対象は48名であり、日々の悪露の色調の変化を自記式の質問票を用いて調査した。統計ソフトは、SPSS ver. 22.0を使用し、有意水準を5%未満とした。

結 果
子宮底長（平均値）は、産褥0日の18.1±0.32 (mean±SE) から徐々に下降し、産褥3日目には15.6±0.21cm、産褥7日目には13.4±0.20cmとなった。産褥2日目までは1日当たり約1cmずつ下降し (p＜.01), さらに1cm下降したのは4日目および6日目であった (p＜.01)。産褥0日の子宮底長（中央値）は臍下1横指、産褥3日目は臍下2横指、産褥6日目には臍下3横指となった。また、レンジが大きかった。

産褥後悪露の色調は6日目から有意に変化し (p＜.05) が、3割の産褥はまだ赤色悪露が続いていた。

結論
帝王切開後の子宮底長は経日的に変化し、明らかに増加していた。また、触診による子宮底長の変化では、1横指下降に3日間を要すること、データのレンジが大きいことがわかった。特に触診値においては、そのアセスメントに個人差を考慮する必要がある。悪露の色調変化は同様に遅れる傾向を認め、子宮の退縮は経日的に比して遅く、緩やかであった。

正期産かつ単胎で術後順調な、極めて一般的でスタンダードな帝王切開事例を前提とした本研究結果は、産褥早期におけるCS後の子宮復古に関する基礎的データであり、評価基準の一つとなりうる。

キーワード：帝王切開、産褥早期、子宮底長、子宮復古、触診