# Duration of the active phase of labor in spontaneous and induced labors

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Duration of the active phase of labor in spontaneous and induced labors

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The authors have no conflicts of interest in connection with this article

Key words: labor duration, induction, cesarean delivery, ten group classification system

Key message: The active phase of labor was longer in induced labors compared to labors with spontaneous onset in nulliparous women. In parous women the difference was small and probably of little clinical importance.

Abbreviations: BMI, body mass index; TGCS, Ten group classification system; WHO, World Health Organization; Hazard Ratio (HR)
Abstract

Introduction. The aim of the study was to compare the duration of active phase of labor in women with spontaneous or induced start of labor. Material and methods. An observational cohort study was performed at Stavanger University Hospital in Norway between January 2010 and December 2013. Information related to pregnancies and deliveries were collected prospectively and recorded in an electronic birth journal. The hospital is serving an unselected population of 19,524 births. Women with a single fetus at term, cephalic presentation and no previous cesarean delivery were included (Ten Group Classification System 1-4). Duration of active phase of labor was compared in women with induced labor vs. women with spontaneous start of labor by the use of survival analyses. The main outcome measure was duration of active phase of labor. Results. Active phase of labor was longer in induced labors compared to labors with spontaneous onset in nulliparous women (unadjusted HR 0.76 (95% CI 0.71 – 0.82), adjusted HR 0.86 (95% CI 0.82-0.95). The estimated median duration was 108 minutes longer in the induced group. In parous women induced labors had shorter duration before six hours in active labor, but after six hours induced labors had longer duration. The overall difference in parous women was small and probably of little clinical importance. Conclusion. Active phase of labor was longer in induced than spontaneous labors in nulliparous women.
**Introduction**

There is ongoing discourse within the obstetrical community regarding the normal progression and duration of labor (1). Labor dystocia is one of the main indications of unplanned cesarean deliveries thus knowledge of the normal range of progression and duration is of utmost importance for a precise diagnosis and clinical management (2). The World Health Organization (WHO) recommends defining the start of the active phase of labor as when the cervix is effaced and dilated four cm in women with regular contractions (3). Accordingly, the time span between this event and delivery of the fetus constitutes the duration of active labor. However, in a contemporary cohort, a number of interventions take place, which shorten labor duration and will therefore interfere with calculation of mean and median duration. For this reason, survival analyses can be used when conducting such studies to ameliorate the effects of interventions on studies of duration (4). It is documented in previous studies that duration of labor is influenced by factors such as parity (5), age (6), ethnicity (5), BMI (7), fetal position (8), use of oxytocin (9, (10) and epidural analgesia (11).

Induction of labor is becoming increasingly common in obstetrics. Different induction methods have been compared with regards to safety and efficacy (12). Retrospective studies indicate an increased risk of operative interventions in induced labors (13, (14), but it is unclear whether these interventions are due to the induction itself, or due to the pregnancy complications, which bring it about (15, (16, (17). Some studies indicate that prolonged labor has potential adverse effects on mother and fetus and duration of labor following labor induction warrants investigation (18).

The Ten Group Classification System (TGCS) was described in 2001 and originally used to assess cesarean delivery rates in different groups of laboring women (19). TGCS 1 comprises nulliparous women with a singleton fetus in cephalic presentation from 37 weeks
of gestation with spontaneous start of labor. TGCS 2a is equal to TGCS 1 except for induction of labor. TGCS 3 comprises parous women with a singleton fetus in cephalic presentation from 37 weeks of gestation without a previous cesarean delivery. TGCS 4a equals TGCS 3 except for induction of labor.

We aimed to compare the duration of active phase of labor in women with spontaneous or induced start of labor using survival analyses. In order to achieve comparable groups, we used the TGCS, focusing on comparisons between the nulliparous women in group 1 and 2a, as well as the parous women in group 3 and 4a.

**Material and methods**

The labor ward at Stavanger University Hospital serves as the only delivery unit in the region for a population of 320,000 people, with around 4800 deliveries yearly. Information related to pregnancies and deliveries were collected prospectively and recorded in an electronic birth journal (Natus), and continuously maintained using standardized procedures for data entry and quality control. The study period was from 1st of January 2010 to 31st of December 2013. The study was in accordance with the Helsinki Declaration and approved by the regional ethics committee in western Norway (REK 2014/1925).

The main outcome was duration of labor defined as time from start of active phase until delivery. Estimated date of delivery was determined by a second trimester ultrasound scan (eSnurra) (20) or from menstrual data when no ultrasound results were available. In women with Bishop score <6, misoprostol was used as induction agent, and 25 micrograms were administered vaginally every four hours up to a maximum dose of 100 micrograms/day over a maximum of two days. In women with Bishop score ≥6, amniotomy was performed and oxytocin added after four hours if regular contractions were not established.

The progress of labor was monitored using a partograph with a four-hour action line as recommended by the WHO, and prolonged first stage diagnosed when the action line was
crossed. This definition was used in both nulliparous and parous women, and augmentation with oxytocin during the first stage was only administered to women with a diagnosis of prolonged labor. During the second stage, augmentation with oxytocin could be started at the discretion of the birth attendant when the contractions were considered insufficient.

Amniotomy was not routinely performed during the active phase of labor, but always prior to oxytocin augmentation. Oxytocin was administered as an intravenous infusion of 5IE (0.01 milligrams) oxytocin in 500 ml saline and the infusion rate started at 6 milliunits/min (30 ml/h), with a dose increment of 3 milliunits/minute (15 ml/h) every 15 minutes to a maximum of 40 milliunits/minute (180 ml/h) until progress of labor or regular contractions at a rate of 3-5/10 minutes was achieved. A combination of low-dose ropivacaine/fentanyl was used for epidural analgesia.

Operative vaginal delivery was considered in all women after 60 minutes of active pushing, in accordance with national guidelines (21). The preferred device for operative vaginal delivery in the department is the Malmstrom metal cup.

**Statistical analyses**

Chi-square test was used to compare categorical variables, and continuous variables were compared using Mann–Whitney U-tests. The duration of active phase of labor was evaluated using survival analyses. Women with missing information about start of active phase of labor or cesarean section performed during the latent phase were left censored. Women with active phase of labor >24 hours or an operative delivery were right censored. The analyses were performed by comparing TGCS 1 vs. 2a and 3 vs. 4a. Kaplan–Meier (one minus survival) plots were created and the groups compared using the Log rank test. In multivariable Cox regression analyses, maternal age, body mass index (BMI), gestational age and birth weight >4000 g were included as possible confounders. Amniotomy, oxytocin augmentation and epidural analgesia were initiated after start of active phase and considered as mediators and not as confounders, and were therefore not included in the regression analysis. The
assumptions of proportional hazards for the Cox regression analyses were checked using log
minus log plots. Statistical analyses were performed with IBM SPSS Statistics for Windows,
v. 21.0 Armonk, NY: IBM Corp

Results
Out of a total of 19,524 women delivered at the hospital during the study period, 16,660
(85.3%) were in TGCS 1-4. The 359 (2.2%) women in group 2b and 4b with planned
cesarean section before onset of labor were not included. Fifty-three women were left
censored due to lacking information about the start of active phase of labor and 30 women
due to cesarean section performed in the latent phase. Three women were right censored due
to a labor duration recorded as more than 24 hours and 3238 women were right censored due
to operative deliveries. The study population is illustrated in Figure 1.

The women in the induction groups differed from their spontaneously laboring
counterparts by being older, having higher BMI and a higher gestational age (Table 1). The
women in this group gave birth to babies with higher birth weight, and there was more use of
oxytocin and epidural analgesia. The rates of both cesarean section and operative vaginal
delivery were higher in the induction groups.

The median duration of active phase of labor in TGCS 1 was 368 minutes, in TGCS 2a
335 minutes, in TGCS 3 it was 165 minutes and in TGCS 4a 134 minutes. Using Kaplan
Meier analysis the estimated median duration of active phase was longer in all groups. In
TGCS 1 the estimated median duration was 433 (95% CI 419-446) minutes, 541 (95% CI
502-580) minutes in TGCS 2a, 168 (95% CI 164-172) minutes in TGCS 3 and 142 (95% CI
135-149) minutes in TGCS 4a. Figure 2 illustrates 1-survival plots for TGCS 1 compared to
TGCS 2a (p <0.01; Log rank test). After 12 hours in active labor 12.6 % (95% CI 11.8% -
13.5%) were undelivered in TGCS 1 vs. 13.4% (95% CI 11.9-15.1%) in TGCS group 2a.
The duration of the active phase of labor was significantly longer in TGCS 3 compared to 4a as illustrated in Figure 3 (p =0.02; Log rank test), but the lines were crossing. Before six hours in active labor, induced labors had shorter duration, but after six hours induced labors were slower. The difference in 1-survival plots illustrated in Figure 3 did not differ substantially. The frequencies of undelivered women after 12 hours were 2.4% (95% CI 2.1-2.8%) vs. 3.7% (95% CI 3.0-4.4%) in TGCS 3 and TGCS 4a respectively.

Using Cox regression analysis the duration of active phase of labor in nulliparous women was longer in induced labors. The unadjusted Hazard Ratio (HR) was 0.76 (95% CI 0.71 – 0.82) for TGCS 2a vs. TGCS 1. Increasing maternal age, gestational age and BMI, and birth weight >4000 g were all factors associated with longer duration of active phase of labor. The adjusted HR for duration of active phase of labor in TGCS 2a vs. 1 was 0.86 (95% CI 0.82-0.95). Details are presented in Table 2. We refrained from comparing group 3 and 4a using Cox regression analysis due to violation of the proportional hazards assumption.

Discussion

We found that active phase of labor was longer in induced labors compared to labors with spontaneous onset in nulliparous women. In parous women we also observed a difference, but it was small and probably of little clinical importance.

It is clinically important in counseling nulliparous women before induction to balance pros and cons, and they should be informed that the length of active phase of labor is longer in induced labors. Induction is known to take time, but often it is presumed that it is the establishment of active labor, rather than the active phase that takes the time. This knowledge is also important when it comes to the logistics and management of a labor and delivery suite regarding labor ward design, planning and bed management.

The strengths of our study are a high number of women included, prospectively gathered data, an unselected population, and clear guidelines for defining start of active phase
of labor in the hospital. Furthermore, a consistent definition and diagnosis of prolonged first
stage of labor was used, and oxytocin augmentation performed in accordance with the WHO
partograph. The use of TGCS to categorize laboring women into well-defined groups for
comparison to other delivery units is also important.

Survival analyses are a useful method when interpreting data with a high number of
interventions. Cases with interventions are not excluded, but censored at the time of
intervention. However, survival analyses do have limitations and rely on rather strong
assumptions such as independent censoring. The frequencies of operative interventions varied
between groups, and especially cesarean sections performed in the first stage of labor have
important influence on the remaining time in labor. Nevertheless, the results from this study
clearly demonstrate how comparing simple medians of duration will yield unreliable results in
a contemporary birthing cohort. Epidural analgesia and oxytocin augmentation might
influence duration, but could not be included in the Cox regression analysis because they
were started during the active phase and should be considered as moderators and not as
confounders. The importance of epidural analgesia and oxytocin augmentation is difficult to
investigate because slow progress is an indication for starting these interventions.

The study was conducted within a single hospital, which is a limitation. Furthermore,
Norwegian national guidelines recommend considering operative vaginal delivery after 60
minutes of active pushing regardless of parity and epidural use (21); which differs from other
guidelines, i.e. guidelines from the National Institute for Health and Care Excellence (22).
This reduces the external validity of the study for hospital units with a longer duration of
bearing down. The Friedman partograph with WHO alert and action lines (3, (23) and its
definition of start of active labor has been used for labor management of both nulliparous and
parous women throughout the study period. Accordingly, the results are not necessarily
representative of a cohort managed with a parity specific partograph.
Advantages and disadvantages related to labor induction are frequently a part of the obstetrical discourse. Induction of labor one week past term might reduce the frequencies of intrauterine fetal death, but according to some studies, induction of labor leads to a higher cesarean delivery frequency (13, 14). However, a recent meta-analysis reported reduced frequencies of cesarean sections in induced labors (17).

There is no established definition of labor dystocia, though it is one of the main indications of unplanned cesarean sections (10). The active management of labor concept recommends active phase of labor to be limited to 12 hours (24); however, a high proportion of nulliparous women need augmentation with oxytocin to achieve this (10). It is important to note that our study is observational and does not imply causality between induction and longer duration of labor in nulliparous women, merely an association.

A reduction of interventions in uncomplicated deliveries is warranted. The risks of complications associated with long duration of active phase of labor such as postpartum hemorrhage (25) have to be weighed against potential adverse effects of augmenting labor with oxytocin such as fetal distress (10, 26) and anal sphincter injuries (27). Childbirth satisfaction is another important outcome, and in some studies long duration is associated with lower maternal satisfaction (28); which might lead to cesarean section due to maternal request in later pregnancies. However, a systematic review shows that rather than labor duration, the most important factors in women’s satisfaction in childbirth are personal expectations, support from caregivers, quality of the caregiver-patient relationship and involvement in decision making (29, 30).

In conclusion, we found that the duration of active phase of labor differs in spontaneous and induced labors in nulliparous women and clinicians should take this into account when counseling women before labor induction and management during prolonged labor.
ACKNOWLEDGMENTS

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References

Table 1 Characteristics of the study population

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<th>Parous women</th>
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<td></td>
<td>Spontaneous start</td>
<td>Induced (TGCS 2a)</td>
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<tr>
<td></td>
<td>(TGCS 1)</td>
<td>(TGCS 2a)</td>
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<tr>
<td></td>
<td>n = 5417</td>
<td>n = 1769</td>
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<td>Characteristics related to the mother</td>
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<tr>
<td>Maternal age in years ; median (IQ-range)</td>
<td>27 (7)</td>
<td>28 (7)</td>
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<tr>
<td>Prepregnant BMI (weight/m^2) ; median (IQ-range)</td>
<td>22.3 (4.4)</td>
<td>23.6 (5.9)</td>
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<tr>
<td>Gestational age in days ; median (IQ-range)</td>
<td>283 (10)</td>
<td>287 (14)</td>
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<td>Characteristics related to labour</td>
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<td></td>
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<tr>
<td>Delivery method</td>
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<tr>
<td>Spontaneous (%)</td>
<td>68.5%</td>
<td>49.5%</td>
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<tr>
<td>Operative vaginal (%)</td>
<td>24.5%</td>
<td>31.9%</td>
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<tr>
<td>Cesarean section (%)</td>
<td>7.0%</td>
<td>18.6%</td>
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<td>Augmentation (%)</td>
<td>32.9%</td>
<td>62.5%</td>
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<td>Epidural analgesia (%)</td>
<td>43.3%</td>
<td>70.5%</td>
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<td>Characteristics related to the newborn</td>
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<tr>
<td>Mean birth weight (g) ; median (IQ-range)</td>
<td>3450 (570)</td>
<td>3525 (675)</td>
</tr>
<tr>
<td>Head circumference (cm) ; median (IQ-range)</td>
<td>35 (2)</td>
<td>36 (2)</td>
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p-values from Mann–Whitney U-test or Chi-squared test. Values are median with interquartile range given in parantheses, or percentages.
Table 2 Hazard ratio for duration of active phase of labour

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<th>Unadjusted values</th>
<th>Adjusted values</th>
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<tr>
<td></td>
<td>HR</td>
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<tr>
<td>TGCS 1</td>
<td>1.0</td>
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<tr>
<td>TGCS 2</td>
<td>0.76</td>
<td>0.71-0.82</td>
</tr>
<tr>
<td>Maternal age</td>
<td>0.96</td>
<td>0.96-0.97</td>
</tr>
<tr>
<td>BMI</td>
<td>0.97</td>
<td>0.97-0.98</td>
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<tr>
<td>Gestational age</td>
<td>0.97</td>
<td>0.97-0.98</td>
</tr>
<tr>
<td>Birth weight &gt;4000g</td>
<td>0.54</td>
<td>0.49-0.60</td>
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HR = Hazard ratio, BMI = body mass index, TGCS = ten group classification system

*p<0.05 for all unadjusted and adjusted values*
Figure 1: Flow chart of study population

All births = 19524

TGCS 1-4
n = 19060

TGCS 5-10 = 2864

TGCS 2b and 4b = 359

n = 16301

Left censored = 83
Censored due to duration of labour > 24h = 3

n = 16215

TGCS 1
n = 5417

Uterine delivery
n = 1706

TGCS 2a
n = 1769

Uterine delivery
n = 888

TGCS 3
n = 7189

Uterine delivery
n = 414

TGCS 4
n = 1840

Uterine delivery
n = 230
Figure 2: Kaplan-Meier plot (1-survival) illustrating duration of active phase of labour in the primiparous groups 1 (continuous line) and 2a (dotted line) using ten group classifications system.
Figure 3: Kaplan-Meier plot (1-survival) illustrating duration of active phase of labour in the parous groups 3 and 4a using ten group classifications system.