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How do sustained birth tears after vaginal birth affect birth tear patterns in a subsequent birth?

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Abstract

Background: Tears are common after vaginal birth, and different impact factors are known. However, the impact of tears from a previous birth to the tears of a subsequent birth is unknown. Therefore, we aimed to evaluate the distribution of birth tear patterns according to the sustained tears in a previous birth, in addition to other impact factors.
Methods: In a retrospective cohort study, we evaluated all women up to parity 4 with subsequent vaginal, singleton births of vertex presentation at ≥37 + 0 gestational weeks between 1/2005 and 12/2016. Their tears were grouped into tear patterns and were analyzed by parity. Tear patterns in the subsequent births were analyzed in association to the patterns of the previous births and impact factors were evaluated.
Results: We counted 4017 births in 1855 women [P1: 1368 (34.1%), P2: 1730 (43.1%), P3: 741 (18.4%), P4: 178 (4.4%)]. The frequency of tears and episiotomies decreased with higher parity, whereas the frequency of intact perineum increased. Twenty-eight different unique tear patterns were found. We could show that birth tear patterns changed with increasing parity and were associated with sustained tears in a previous birth. In addition, some impact factors on tear patterns could be identified.
Conclusion: The distribution of the single tear types is in accordance with the current literature. However, it is new that distinct tear patterns are associated to sustained tear patterns of previous births. Furthermore, we demonstrated some weak associations of tear patterns to certain impact factors, such as more episiotomies, low-grade perineal or vaginal tears isolated or in combination with other tears with increasing fetal weight and head circumference in the higher parities, and with a longer duration of the second stage and the pushing phase in lower parities.

Keywords: birth lacerations; birth tears; birth trauma; impact factors; tear patterns; vaginal birth.

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Introduction

Vaginal births are accompanied by genital tears in 50–91.5% of cases, such as trauma on the perineum, the cervix, the vagina, and the vulva [1–11]. Some risk factors for such trauma are known, for example advanced maternal age, nulliparity, diabetes, obesity, fetal macrosomia, a prolonged second stage of labor, operative-assisted vaginal births, maternal birth position, fetal occipito-posterior position, and technique of perineal protection [1]. Genital tract trauma can cause physical short-term and long-term maternal morbidities, such as higher blood loss, impaired wound healing, pain, sexual disorders, anal and urine incontinence, and genital prolapse. This can result in psychological morbidity and immense negative socio-economic consequences [12–14]. Pregnant women are concerned about their physical well-being and about their sexuality and often confront birth attendants with requests for a planned cesarean as their mode of delivery in order to protect their perineum and birth canal. Especially after having sustained severe or widespread tears in a previous birth, many questions arise concerning the possible tear patterns in a subsequent birth. Therefore, it is essential to provide women with detailed information about the incidence, distribution, risk factors for, and consequences of the different types of birth tears and the possible tear pattern in a subsequent birth. However, the impact of sustained tears and specific tear patterns in a previous birth on the tear patterns in a subsequent birth is unknown. Therefore, we first aimed to evaluate the distribution of birth tears in multiparous women by parity. Second, we aimed to evaluate the distribution of tear patterns in women with subsequent births according to their sustained tears in their previous birth. Third, we aimed to evaluate other possible impact factors. An understanding of the distribution of birth tear patterns will improve the clinician's ability to counsel women regarding their expected birth tears in the next birth and empower their decisions about birth mode.

Materials and methods

In a retrospective cohort study, we evaluated all women with vaginal births between 1/2005 and 12/2016 who gave birth at least twice in our center to a singleton in vertex presentation at ≥37+0 gestational weeks and who were at least 18 years of age. We excluded multiple pregnancies, preterm deliveries, fetal transverse or breech positions, and fetal malformations. The study was approved by the Ethical Board of the district (KEK-ZH-Nr. 2016-02079). We had women up to parity 11 but included only women up to parity 4 in the final analysis in order to get enough cases per parity. Maternal, fetal, and obstetrical data were extracted out of our computerized in-house data system (Perinat 6.1.9.3). These data included maternal age and body mass index (BMI), ethnicity, gestational age, fetal weight and head circumference, APGAR scores, umbilical cord pH, birth mode, analgesic procedures during birth, quality of fetal heart tracing, duration of the active and passive second stage of labor, fetal position in the birth canal, and blood loss. Obstetrical care was standardized in our hospital during the study period. Epidural anesthesia was applied upon the patient`s request or upon medical advice. Within the 12 years of the study period, no substantial changes were done in our obstetrical standard care regimen. No changes appeared regarding the rates of vacuum-assisted births, spontaneous births with Kristeller maneuver, or the length of the pushing phase. Nevertheless, some light changes appeared. The average age of laboring women increased over time and the rates of episiotomies decreased in all parity groups. In nulliparous women, a slight increase in the length of the passive second stage of labor was seen, whereas in multiparous women, a decrease in the rate of epidural application was found over the years in our hospital.

First, we evaluated the sustained single tear types in detail in every woman, related to the classification of birth lacerations of the obstetric clinical data definitions by the American College of Obstetricians and Gynecologists [6]. They were assessed as intact (I), labial tear (L), vaginal tear (V), paraclitoral tear (P), low-grade perineal tears (P1+2), high-grade perineal tears (P3+4), and episiotomy (E). Since women could sustain more than one tear type at the same time, all tear combinations were grouped into tear patterns from the seven single tear types mentioned. Tear patterns were then evaluated by parity using frequency tables and mosaic plots. Further analysis was performed with the ten most frequent tear patterns out of the 28 different patterns found. Second, tear patterns in the subsequent births were analyzed given the tear patterns of the previous births and visualized in a mosaic plot.

A mosaic plot is a graphical summary of the conditional distributions in a contingency table and graphically displays the distribution of two qualitative variables. The width of the entire X-axis and length of the entire Y-axis equal to 100% of the numbers of observations in all categories of these two variables. Each width of a rectangle in the mosaic plot represents the proportion of observations in the respective category on the X-axis, similarly for the height of the rectangles and the categories on the Y-axis. For the presentation of the distribution of tears types and tear patterns by parity, the single tears and the tear patterns were displayed on the Y-axis, and parity, on the X-axis. For the presentation of the tear patterns in dependence on the tear patterns of a previous birth, the tear patterns in the previous birth were displayed on the X-axis, and the tears patterns of the subsequent birth, on the Y-axis. For the illustration of the association between the tear patterns and the different impact factors, we plotted the conditional means of the continuous impact factors by parity in tile plots. The rectangular tiles were colored with increasing intensity according to increasing values of conditional means of each continuous variable. For the illustration of the association of the categorical impact factors, we plotted the conditional counts by parity in frequency plots.

Baseline characteristics of the cohort were compared using the χ^2 test for categorical and the one-way F-test for continuous variables at 5% level. The statistical software R (The R Project for Statistical Computing) version 3.5.0 was used for every analysis.

Results

A total of 4120 births in 1892 women with parities 1–11 met the inclusion criteria. After excluding women with parity 5–11 and ensuring that each woman had at least two births in parities 1–4, 4017 births of 1855 women remained [P1: 1368 (34.1%), P2: 1730 (43.1%), P3: 741 (18.4%), P4: 178 (4.4%)]. The characteristics of the study cohort are shown in Table 1.

There is evidence of significance at a level of 5% among the four parity groups for some factors. Women of higher parity, older age, higher BMI, and with a non-Caucasian ethnicity presented more often with a spontaneous birth, a lower epidural rate, a shorter active and passive second stage of labor, more frequent with fetal a malpresentation, less often with abnormal fetal heart tracing, with a higher fetal weight and head circumference, and less often with an umbilical artery pH below 7.15. No evidence for significant differences was found for gestational age at birth and the APGAR scores at 5 min between the groups.

Distribution of tear types by parity

The maximum number of different tear types per woman was three. The frequencies of the seven different tear types by parity are shown in Figure 1. The sum of the single tears was more than the number of women per parity group and the rates of the single tear types per parity were more than 100% as women could sustain more than one tear type at the same time. In parity 1, 1922 single tears were found in 1368 women, whereas 2022 tears were found in 1730 women of parity 2, 806 tears in 741 women of parity 3, and 189 tears in 178 women of parity 4.

The overall frequency of the single tear types including episiotomies but excluding intact category (P1+2, P3+4, V, L, P, E) decreased with higher parity, whereas the frequency of intact perineum (I) increased. Overall, an intact perineum was found in 26.9% of women, with rates of 8.9% in parity 1, 31.7% in parity 2, 44.1% in parity 3, and 47.8% in parity 4. The overall episiotomy rate was 15.9%. Episiotomy rates substantially decreased with increasing

Table 1: Baseline characteristics of the study cohort by parity 1 (P1) to parity 4 (P4).

	P1 (n=1368)	P2 (n=1730)	P3 (n=741)	P4 (n=178)	P-value
Maternal age, years	28.4 (5.2)	30.7 (5.1)	32.0 (4.7)	33.8 (4.6)	<0.001
Body mass index (BMI), kg/m^2	22.1 (3.5)	22.9 (4.2)	23.7 (4.2)	25.4 (5.2)	<0.001
Ethnicity					
Caucasian	1044 (76.3)	1254 (72.5)	474 (64.0)	106 (59.6)	<0.001
Non-Caucasian	324 (23.7)	476 (27.5)	267 (36.0)	72 (40.4)	
Gestational age, days	278.9 (8.1)	278.8 (7.5)	278.5 (7.6)	277.3 (8.2)	0.077
Birth mode					
Spontaneous	1269 (92.8)	1667 (96.4)	730 (98.5)	178 (100.0)	<0.001
Spontaneous with Kristeller	21 (1.5)	14 (0.8)	5 (0.7)	0 (0.0)	
Vacuum assisted	78 (5.7)	49 (2.8)	6 (0.8)	0 (0.0)	
Analgesia					<0.001
Epidural	495 (87.5)	366 (54.7)	114 (40.3)	29 (41.4)	
Others (N_2O, opioids)	65 (11.5)	278 (41.6)	156 (55.1)	39 (55.7)	
No analgesia	6 (1.1)	25 (3.7)	13 (4.6)	2 (2.9)	
Duration of the second stage of labor, min	76.5 (53.8)	29.3 (37.5)	23.1 (31.0)	17.4 (22.5)	<0.001
Duration of the pushing phase, min	32.2 (22.7)	14.4 (14.2)	12.9 (15.1)	11.6 (11.2)	<0.001
Fetal heart tracing					<0.001
Physiological	696 (51.0)	1138 (66.2)	532 (72.7)	131 (74.4)	
Suspicious	608 (44.5)	517 (30.1)	181 (24.7)	41 (23.3)	
Pathological	61 (4.5)	63 (3.7)	19 (2.6)	4 (2.3)	
Fetal position					<0.001
Left occipitoanterior (LOA)	821 (60.0)	989 (57.2)	433 (58.4)	108 (60.7)	
Right occipitoanterior (ROA)	526 (38.5)	680 (39.3)	287 (38.7)	62 (34.8)	
Left occipitoposterior (LOP)	8 (0.6)	27 (1.6)	13 (1.8)	3 (1.7)	
Right occipitoposterior (ROP)	10 (0.7)	31 (1.8)	7 (0.9)	3 (1.7)	
Face position (FC)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	
Forehead position (FH)	3 (0.2)	3 (0.2)	1 (0.1)	1 (0.6)	
Fetal weight, g	3360.1 (397.5)	3492.0 (424.0)	3524.9 (424.4)	3520.5 (475.6)	<0.001
Fetal head circumference, cm	34.5 (1.3)	34.8 (1.3)	34.9 (1.2)	34.9 (1.4)	<0.001
APGAR at 5 min below 7					
Yes	12 (0.9)	11 (0.6)	5 (0.7)	2 (1.1)	0.557
No	1356 (99.1)	1719 (99.4)	736 (99.3)	176 (98.9)	
Umbilical artery pH below 7.15					
Yes	160 (11.7)	173 (10.0)	60 (8.1)	9 (5.1)	
No	1208 (88.3)	1557 (90.0)	681 (91.9)	169 (94.9)	<0.001
Blood loss in mL	402.6 (284.3)	401.0 (342.4)	377.8 (302.7)	386.8 (296.1)	0.317

Values are in mean (SD) or n (%).

parity, with rates of 30.8%, 10.5%, 4.3%, and 2.8% for parity 1, 2, 3, and 4, respectively. While the spontaneous occurring tears P1+2, V, and L occurred almost equally distributed in parity 1 (P1+2: 36.4%, V: 31.4%, and L: 27.0%), the dominant spontaneous tear in the higher parity groups was P1+2 with 44.8–46.9% vs. 5.1–14.5% for V and 2.8–10.5% for L. The overall rate of high-grade perineal tears (P3+4) in our cohort was 1.0%, with rates of 2.0% in parity 1, 0.6% in parity 2, 0.4% in parity 3, and 0% in parity 4.

Distribution of tear patterns by parity

With the seven single tear types, we found 28 different unique combinations (tear patterns) in our cohort. As parity increased, the counts of tear patterns markedly decreased. Thus, we decided to focus the further analysis on the ten most frequent tear patterns with respect to an aggregated ranking of parity 1–4. Thus, the number of women included in the further analysis slightly decreased to 1265 in parity 1, 1674 in parity 2, 729 in parity 3, and 176 in parity 4. Nevertheless, these top ten tear patterns still reflected 92.5% of the whole 28 tear patterns for parity 1, 96.8% for parity 2, 98.5% for parity 3, and 98.9% for parity 4. The top ten tear patterns consisted of intact perineum (I), episiotomy (E), episiotomy+vaginal tear (EV), low-grade perineal tear (P1+2), low-grade perineal tear+vaginal tear (P1+2V), low-grade perineal tear+labial tear (P1+2L), low-grade perineal tear+vaginal tear+labial tear (P1+2VL), vaginal tear (V), labial tear (L), vaginal

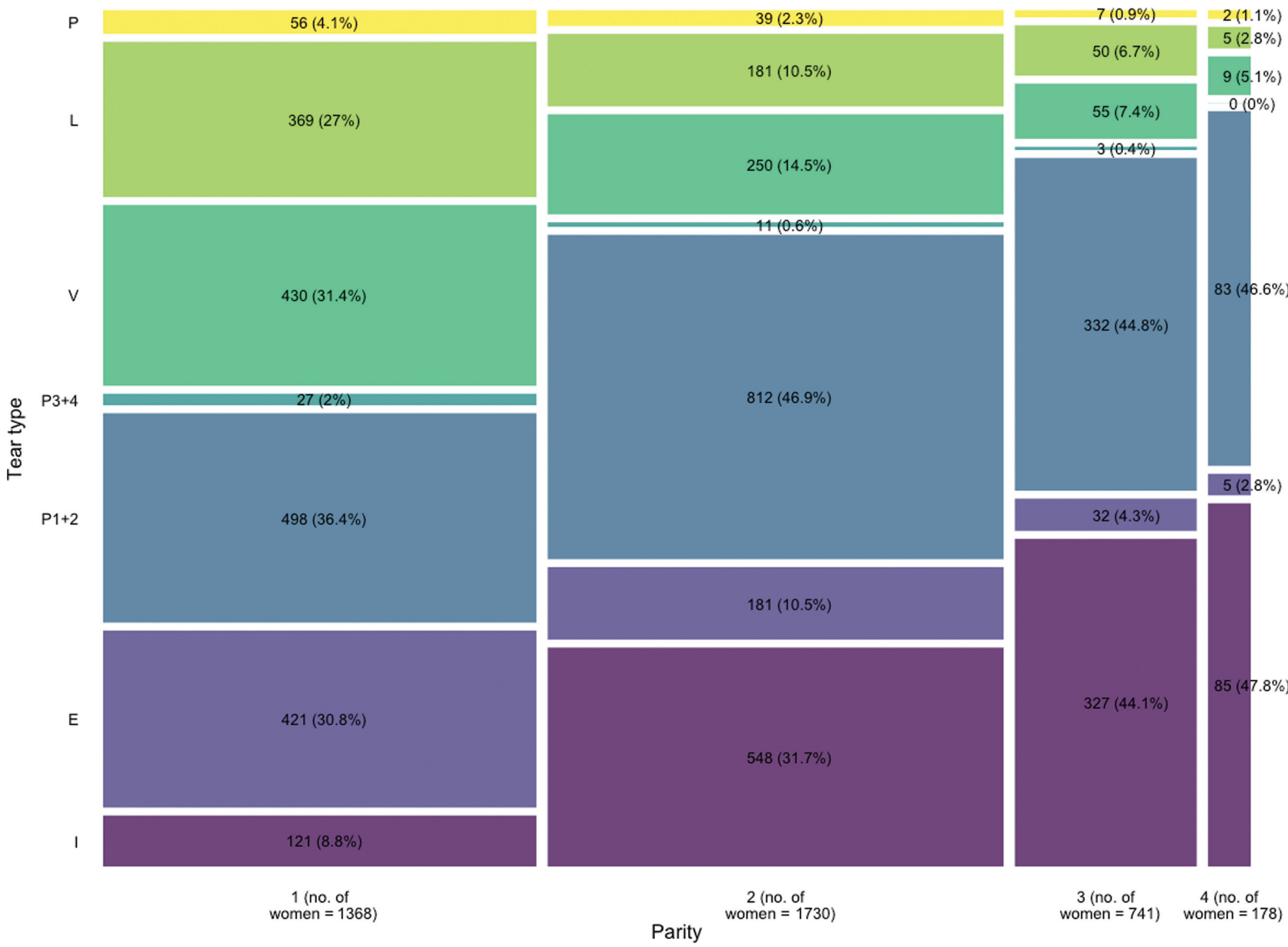

Figure 1: Distribution of the seven single tear types by parity in absolute numbers of tear types and percentage of women.

tear + labial tear (VL). The distribution of these top ten tear patterns per parity group is presented in Figure 2.

From the ten most frequent tear patterns, five were single tear types (I, E, P1 + 2, V, L), and the other five consisted of tear combinations (EV, P1 + 2V, P1 + 2L, P1 + 2VL, VL). Paraclitoral tears (P) and high-grade perineal tears (P3 + 4) were not part of the ten most frequent tear patterns. The single tear types E and P1 + 2 in summation account for 41–44% of the tear patterns in all the four parity groups. The frequencies of the other tear patterns, excluding “intact,” decreased with increasing parity.

Change in tear patterns in subsequent births

For the assessment of the change in birth tear patterns between subsequent births, we considered only women with subsequent births in our institution for this analysis. The number of women with births in parity 1 and parity 2 was 1199, with births in parity 2 and parity 3 was 587, and in parity 3 and parity 4 was 158 women. Tear patterns changed with increasing parity, as shown in Figure 3A for parity 1 to parity 2, Figure 3B for parity 2 to parity 3, and Figure 3C for parity 3 to parity 4.

The observed tear pattern distribution for parity 2 given the sustained tear patterns in parity 1 are shown in Figure 3A. For example, women who gave birth intact in their first birth will have the chance to be intact again in 74% in the subsequent birth and will almost never sustain an episiotomy. After having had an episiotomy with or without a vaginal tear in the first birth, 46% of women sustained a P1 + 2 lesion in the second birth and 59% suffered from a P1 + 2 lesion combined with any kind of other tear type. Besides, after having had an episiotomy with or without a vaginal tear in the first birth, 20–30% had another episiotomy with or without a vaginal tear. Having had a perineal lesion in form of P1 + 2, P1 + 2L, or P1 + 2VL in the first birth was most frequently followed by another perineal lesion in its different combinations in 52–73% of subsequent birth. After just having had a vaginal tear,

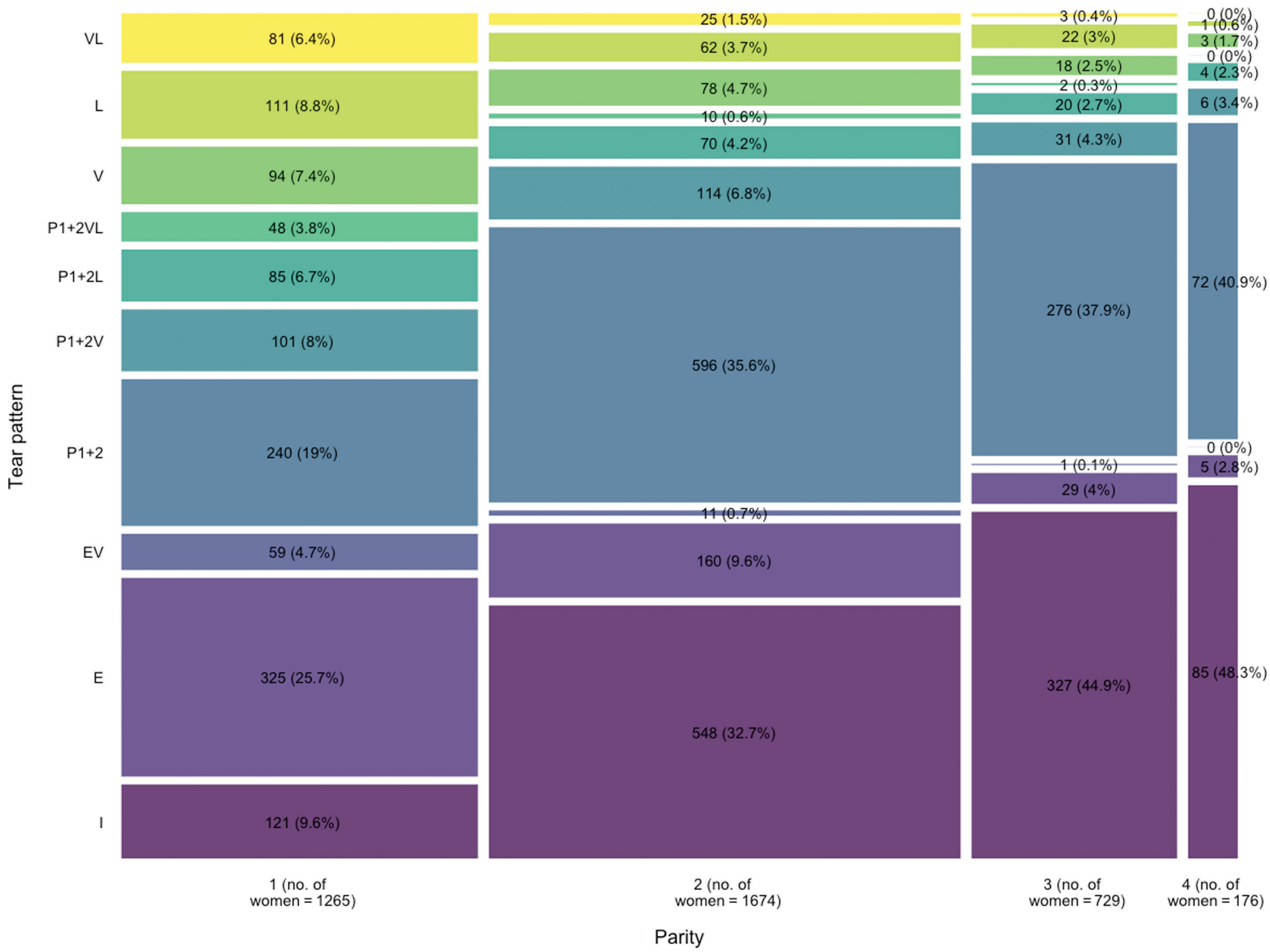

Figure 2: Distribution of the ten most frequent tear patterns by parity 1–4.

labial tear, or their combinations, the rate of birth without any tears in the subsequent birth was 58–71%.

In Figure 3B, the tear pattern distribution for parity 3 given the pattern in parity 2 is shown. One can observe that almost 87% of women who were intact in their parity 2 were also intact in their parity 3. In about 25% frequency, a woman of parity 3 sustained an episiotomy cut if she had an episiotomy for her parity 2. In addition, a low-grade perineal tear seemed to predispose the women of our study for another low-grade perineal tear in a frequency of 33–75% for the women in parity 3. In accordance to Figure 3A, after just having had a vaginal tear, labial tear, or their combinations in the second birth, the rate of no tears in the third birth was quite high, with 40–79%.

As can be seen in Figure 3C, having been intact in parity 3 seemed to predispose women in our study to being intact in their parity 4 in 80%. Having had an episiotomy aligns especially with a P1+2 tear with or without a vaginal or labial tear in 40–60%, followed by another episiotomy in 20% of the cases. After the experience of a P1+2 in an isolated or combined form in parity 3, 73–100% women sustained another low-grade perineal tear in their parity 4.

In summary, being intact in one birth was repeated in 74–87% of women in the subsequent births. It is markedly observed that tears of higher parity mainly appeared at the perineum in form of low-grade tears or tear patterns. Other tear patterns appeared less frequently in higher parities. The recurrence rate of perineal lesions ranged from 33% to 75%, whereas a woman with an episiotomy in a previous birth had a risk of 20–30% for another episiotomy in the subsequent birth.

Association of tear patterns with maternal, fetal and obstetrical impact factors

The associations of the different tear patterns with maternal, fetal, and obstetrical impact factors are illustrated in

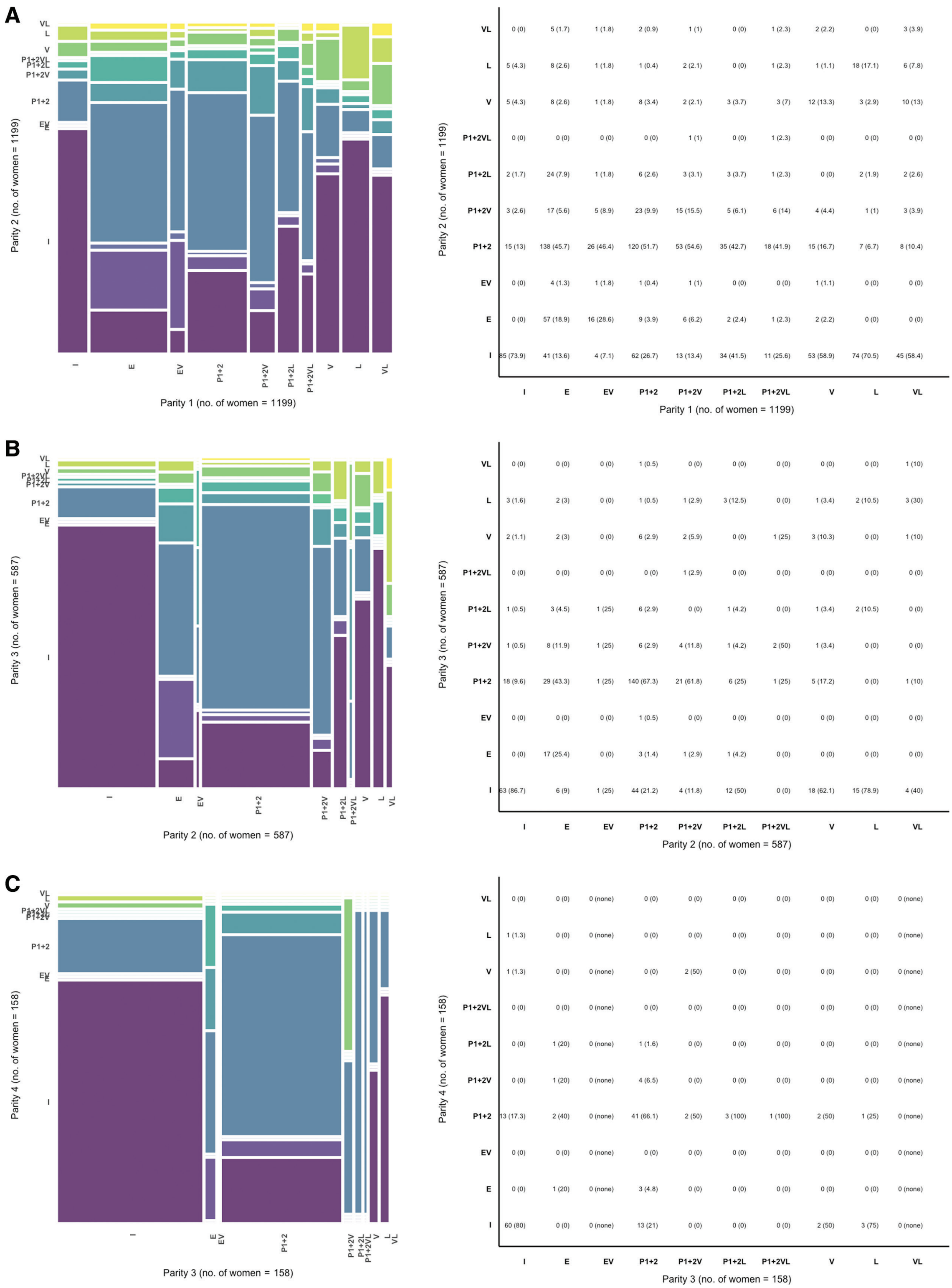

Figure 3: Change in tear pattern distribution.
(A) From parity 1 to parity 2. (B) From parity 2 to parity 3. (C) From parity 3 to parity 4.

Figures 4 and 5. In the figures, the conditional means or counts of the different impact factors are shown across parity 1–4.

For maternal age, no clear trends could be recognized. Only women with EV in parity 3 had a markedly higher mean age. No clear trends could be seen for

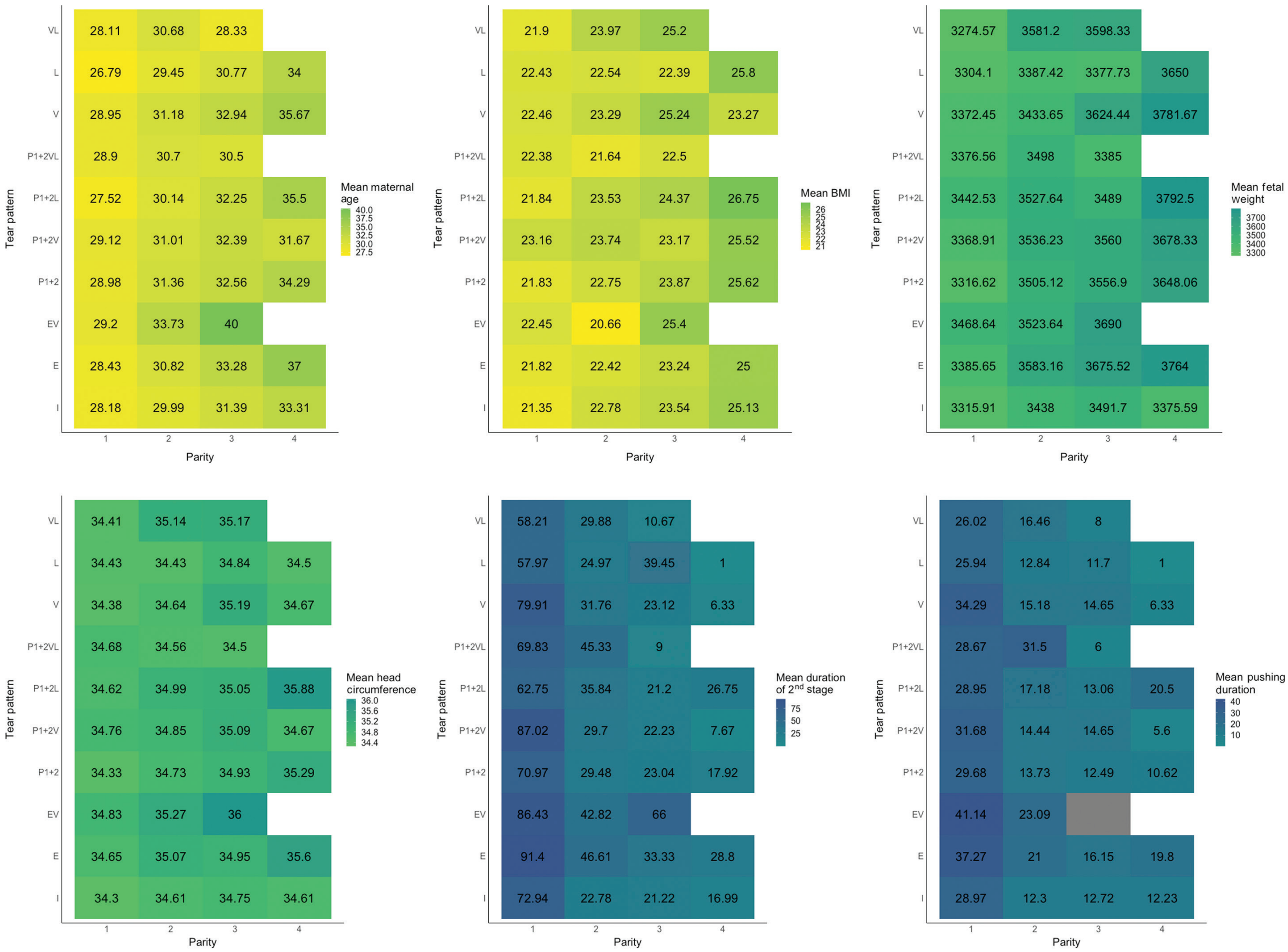

Figure 4: Association of the different continuous impact factors with tear patterns, represented by conditional means across parity 1–4.

maternal BMI. With increasing fetal weight and head circumference, there was a trend to more episiotomies, P1+2, P1+2 combined with other tears, vaginal tears, or vaginal tears combined with other tears in the higher parity groups, especially with parity 3 and 4. A longer duration of the second stage and the pushing phase in women of parity 1 was more likely associated with E, EV, and P1+2V. Furthermore, women in parity 2 with longer durations of the second stage and the pushing phase were observed to sustain E, EV, P1+2L, and P1+2VL at higher frequency. For parity 3 and 4, no trends could be found here.

For ethnicity, the different analgesic procedures and for the fetal positions, there are no marked trends observed regarding tear patterns. With vacuum-assisted births and spontaneous births with Kristeller, the dominant tear patterns were E, EV, and P1+2 compared to spontaneous births, where the tear patterns were more diverse. In cases with abnormal fetal heart tracing, there was a high frequency of E, especially in lower parity groups.

Discussion

Distribution of tear types and tear patterns by parity and their change in subsequent births

The distribution of the different single birth tear types is in accordance with the current literature [1–11, 15–17]. The distribution of tears presented in the literature differs between different studies. This might be mainly explained by different obstetrical management strategies, for example, like the presence of an episiotomy or none [18, 19]. As we have higher rates of episiotomies in our parity 1 group compared to the other parity groups, this definitely had an influence on the distribution of the different tear patterns between the groups. The lower rate of episiotomies in the higher parity groups might be a reason that higher rates of P1+2 were found in those groups, with a P1+2 rate of 36% in parity 1 and 45–47% in parity 2–4.

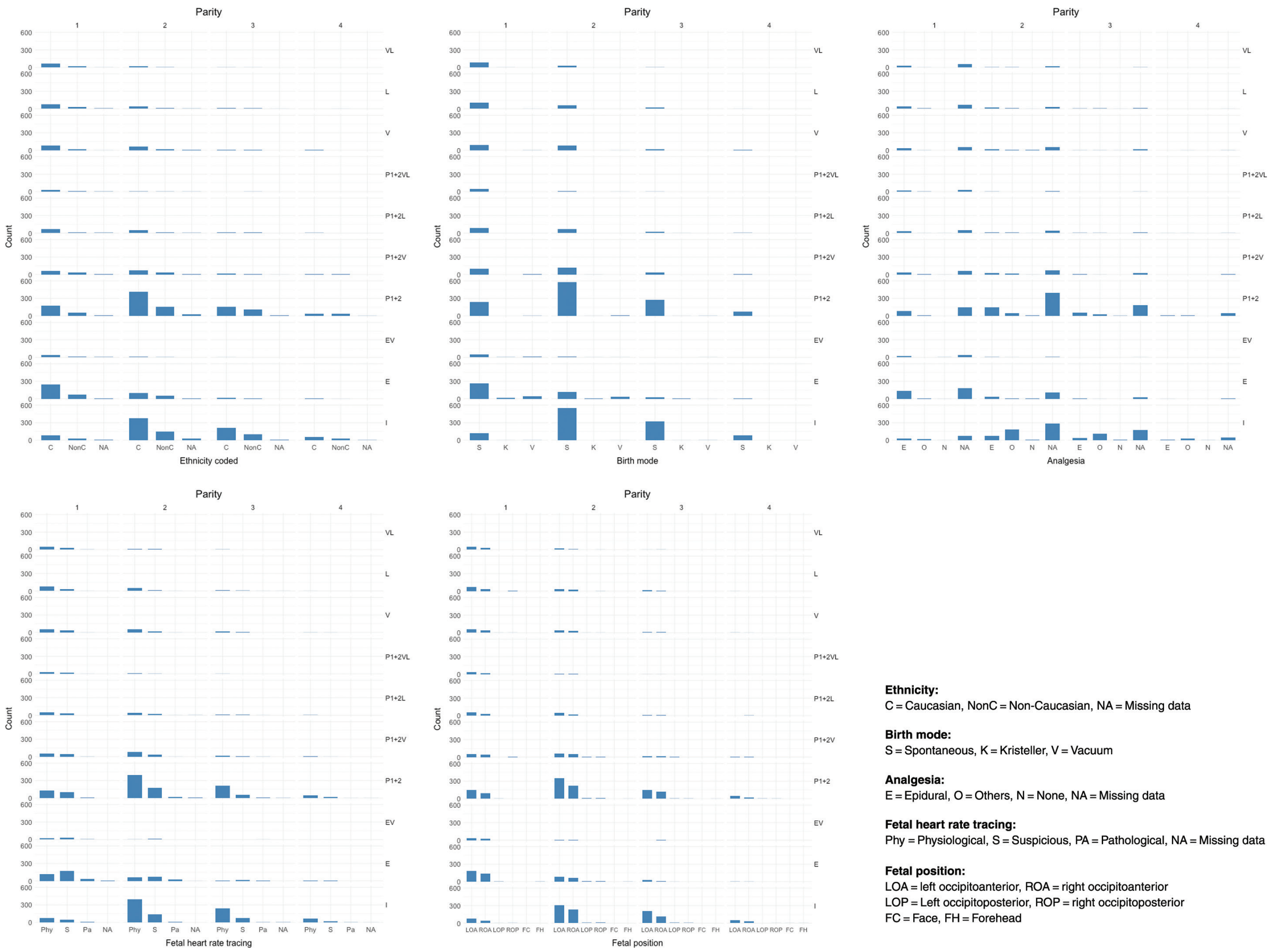

Figure 5: Association of the different categorical impact factors with tear patterns, represented by conditional counts across parity 1–4.

The higher rate of episiotomies in parity 1 could probably be explained by the higher rate of vacuum-assisted births and births with Kristeller in that group. This was accompanied by a higher rate of pathological fetal heart tracing as a possible reason for the vacuum and a higher rate of lower umbilical cord pH as a consequence.

However, combinations of the different birth tears (tear patterns) have not yet been assessed in the literature, and therefore, no information regarding their incidence is available. We are the first to present birth tears in such a manner, so there are no comparisons to other studies. We showed that women who had given birth intact in one birth had a high chance of 74–87% of being intact again in their subsequent birth, which might encourage such women for another vaginal birth. The recurrence rate of low-grade perineal lesions ranged from 33% to 75%, whereas a woman with an episiotomy in a previous birth had a risk of 20–30% for another episiotomy in the subsequent birth. Additionally, if tears appeared in higher parities, these tears mainly appeared at the perineum in the form of low-grade tears or tear patterns. Other tear patterns appeared less frequently in higher parities.

Association of tear patterns with maternal, fetal, and obstetrical impact factors

The expected evidence of significant differences in the characteristics of the different parity groups in our study cohort aligns with clinical experience and from current publications. With higher parity, for example, it is apparent that as maternal age increases, maternal BMI frequently increases along with increasing fetal weight and head circumference. However, it has to be considered that some of the impact factors are not even approximately independent. For example, a fetus with a higher weight has a higher head circumference. This circumference will be even greater in relation to the birth canal if the fetus is positioned occipito-posterior. This might lead to a longer second stage of labor with a longer pushing phase and more likely to an epidural analgesia, a vacuum, or Kristeller-assisted birth with abnormal fetal heart tracing and an episiotomy at the end. Therefore, a multivariate regression approach, for example, for which all of the impact factors need to be approximately independent, would have to be implemented with great care. Moreover, the large number of possible tear patterns that would be the outcome of such a model implies the necessity to estimate a large number of parameters while some of the patterns are observed very infrequently or even not at all, especially in higher parities. We therefore decided to provide a detailed description of the available data without attempting a modeling step and without formal inference on associations. With this strategy, we could illustrate a tendency of the association of some of the different impact factors with the tear patterns but could not demonstrate clear causal correlations. Probably, the individual tissue and anatomical conditions of every woman might be more important variables, for example the ability of tissue to stretch or the ratio of fetal size to the size of the birth canal [16, 20]. Regarding the size of the fetus in relation to the size of the birth canal, it is additionally important to keep in mind that the fetal head circumference measured before or after birth does not resemble the true circumference during birth. We know that the head circumference during the descent through the birth canal changes by molding of the bones and dependent on the flexion or deflexion of the head.

A strength of the study is that our study shares a new insight on the impact of previous birth tears on subsequent birth tear patterns, which has not yet been evaluated before. This new information can be integrated in counseling women regarding their expected tears in subsequent births and might help in the decision-process regarding birth mode in the future. Another strength of our study is that all births took place in the same center with a standardized obstetrical management and a very detailed documentation system.

A limitation is the retrospective character of the study and indeed the problem of adjusting for possible impact factors because of the low birth counts for some of the variables and tear patterns. Especially in the higher parity groups, there were too few cases for evaluation of that many variables. The plots in Figures 4 and 5 have to be interpreted with caution since the conditional means are calculated for different numbers of observations in each tile. Missing values of impact factors may contribute to this issue in addition to low frequencies for some of the tear patterns. In addition, apart from the missing impact factors “maternal anatomy and tissue condition” and “biomechanics of the birth canal,” another important impact variable needs investigation, that is, the technique of perineal support. We know from preexisting publications that the correct technique of perineal support and fetal extraction is a component of different distribution of tears and is an important part of reducing birth trauma, especially of high-grade perineal tears [11, 21–25].

Conclusion

Our results show that birth tear patterns do differ between births of different parities and are associated to sustained tear patterns of previous births. Furthermore, we demonstrated some tendency in the association of tear patterns to possible impact factors. However, the sustained tears of a previous birth seem to have more impact on the tear patterns in a subsequent birth than other impact factors. Hence, individual tissue and anatomical conditions of every woman, the relation of the fetus to the size of the birth canal, and the biomechanical adaptations of the components are in our view important variables to include in further research about the influence of impact factors on tear occurrence.

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