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ORIGINAL ARTICLE

New approach to the evaluation of perineal measurements to predict the likelihood of the need for an episiotomy

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Abstract

Introduction and hypothesis Episiotomy is performed selectively during vaginal delivery. Among the maternal anthropometric factors for episiotomy, the length of the perineal body (pb) and genital hiatus (gh) defined as per the POP-Q system have been studied. The objective of our study was to compare two perineal measurements (defined as per the POP-Q system and the anogenital distance [AGD] concept) to determine which of these can predict the likelihood of an episiotomy being performed.

Methods An observational prospective cohort study was designed. Anthropometric data (pb, gh, symphysis–coccyx distance, distance between ischial tuberosities, AGDaf [anus–fourchette], and AGDac [anus–clitoris]), duration of the second stage of labor, and neonatal biometric data were collected from 119 women included in this study. Statistical analysis was performed using Student's *t* test for unpaired data, Mann–Whitney, and Chi-squared tests. Receiver operating characteristic (ROC) curves were generated to compare AGDaf, AGDac, and "gh + pb" with the presence of episiotomy.

Results A shorter "gh + pb" length and AGDac were risk factors for episiotomy. Compared with AGDac, gh + pb was a slightly better predictor in ROC curve analysis. Furthermore, a longer duration of second-stage labor was evident in the episiotomy group.

Conclusions This study introduces measures of AGD as risk factors for episiotomy. We propose that "gh + pb" length <77 mm and AGDac <93 mm may predict the likelihood of requiring episiotomy and may be useful for diminishing subjectivity in the decision to perform an episiotomy.

Keywords Episiotomy · Perineum · Anogenital distance · Vaginal delivery

Introduction

Episiotomy is defined as surgical enlargement of the posterior aspect of the vagina with an incision to the perineum during the last part of the second stage of labor. The incision is performed using scissors or a scalpel and is typically midline or mediolateral in location. Episiotomy is performed to enlarge the birth outlet and facilitate delivery of the fetus.

Episiotomy is now performed on an individual basis. Episiotomy is considered when the clinical circumstances place the patient at a high risk of a third- or fourth-degree laceration and obstetric anal sphincter injuries (OASIS) [1] or when the fetal heart tracing is of concern and the hastening of vaginal delivery is warranted [2]. A mediolateral episiotomy (performed 60° from the midline) is associated with a lower risk of third- and fourth-degree lacerations than a midline episiotomy [3]. The decision to perform an episiotomy is heavily dependent on the opinion of the delivering clinician and is based on the clinical scenario at the time of delivery.

Efforts have been directed toward identifying factors, both maternal and fetal, that predict the likelihood of an episiotomy being performed. Among maternal factors, the anthropometry of the external genitalia has been extensively studied. Some perineal measurements have been standardized by the International Continence Society (ICS). The ICS established the Pelvic Organ Prolapse Quantification (POP-Q) system as

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a precise and reproducible technique for describing pelvic organ position and anthropometric measurements of the perineum. Within this classification system, there are two measures of interest for this study: the perineal body (pb), which is the distance between the posterior margin of the genital hiatus, and the mid-anal opening, or genital hiatus (gh), which refers to the length of the gh measured from the center of urethral meatus to the posterior midline hymen or failing the leading edge of the nucleus of the perineum. Short perineal length is associated with higher rates of episiotomy, spontaneous perinatal tears, operative vaginal delivery, and OASIS [4, 5]. Cut-off points for a short perineum vary over a wide range, from under 25 mm to under 40 mm [4, 6, 7]. In the referenced reports, the authors consider the perineal lengths according to the pb definition of the POP-Q system. Khunda and co-workers [8] found that gh, pb, and gh plus pb were strongly associated with the hiatal area on ultrasound in non-pregnant women.

From another perspective, the anogenital distance (AGD), which is the distance between the external genitals and the anus, is a sexual dimorphism (first described in placental mammals [9, 10] and later in humans) and is longer in males than in females. AGD reflects the amount of androgen that a female fetus has been exposed to during intrauterine development [11]. AGD is an anthropometric measurement that, based on current knowledge [12], may be stable across the lifespan of an individual. Recent studies have described and characterized AGD in adult women and have provided evidence of an association between the length of AGD and reproductive function, including hormone-dependent gynecological pathological conditions, such as endometriosis or polycystic ovary syndrome (PCOS) [13, 14]. In patients with or without pelvic floor organ prolapse, variations in AGD measurements have been described [15].

The objective of our study was to compare the two perineal measurements (defined by the POP-Q system and AGD concept) to determine whether these lengths could predict the likelihood of an episiotomy being performed. Our hypothesis is that women with a shortened AGD may be at a higher risk of episiotomy and then it could be taken into account to plan the delivery. Moreover, it could be possible to reduce the subjectivity in the decision to perform an episiotomy if systematic objective measurements of perineal anthropometry were performed. Our secondary objectives were to analyze additional anthropometric measurements of women, newborn infants, and labor as episiotomy risk factors.

Materials and methods

Study population

An observational prospective cohort study was conducted between March 2016 and March 2017. The study was approved by the local ethics committee for clinical research (No TI.16–11) and women signed informed consent forms to participate in the study. The study initially included 155 participants with singleton or twin pregnancies, with the first fetus exhibiting cephalic presentation, who were admitted for labor and delivery at the Department of Obstetrics and Gynecology of Santa Lucia University Hospital (Cartagena, Murcia), Spain. Of 155 participants included, 36 women underwent urgent (intrapartum) cesarean section delivery; therefore, a total of 119 participants with vaginal deliveries were ultimately included in our study. All women were Caucasian, and pregnant women undergoing elective or scheduled cesarean section were excluded. First- and second-degree lacerations or higher-degree tears were not considered for this study, Cases were considered women with an episiotomy ($n = 32$), and control women were those without an episiotomy ($n = 87$). The decision to perform episiotomy was based on the clinical scenario at the time of delivery. There were no specific situations in which an episiotomy was essential.

Data collection

We collected the following data regarding the women's medical history: antepartum and clinical data (age, height, weight, body mass index [BMI]) at the beginning and end of each pregnancy; data regarding gestational age; data regarding a history of high blood pressure, pregestational and gestational diabetes, and other pathological conditions during pregnancy; and data pertaining to obstetric history, episiotomy during previous deliveries, previous cesarean delivery, and the type of labor onset, whether spontaneous or induced. According to the protocol of our service, in cases requiring induction of labor, if the Bishop score (targeting cervical conditions) was less than 7, then cervical ripening with an intravaginal device for the release of dinoprostone was carried out before induction with oxytocin. If the Bishop score was greater than 7, then direct induction was carried out with intravenous infusion of oxytocin.

We also collected data on the duration of the second stage of labor, neonatal weight and length, cranial circumference, several pelvic measurements, the symphysis–coccyx distance, and the distance between ischial tuberosities. For each woman, the AGD was measured in two ways. First, the anus–clitoris AGD (AGDac) was measured from the surface of the clitoris to above the upper edge of the anus (Fig. 1, point 1 to point 3). Second, the anus–fourchette AGD (AGDaf) was measured from the posterior fourchette to the upper edge of the anus (Fig. 1, point 2 to point 3). All measurements were performed using a stainless steel digital caliper (VWR® International, West Chester, PA, USA). Patients were in a lithotomy position, with the thighs at an angle of 45° to the examination table. The same examiner performed each of these measurements three times, and the average for each

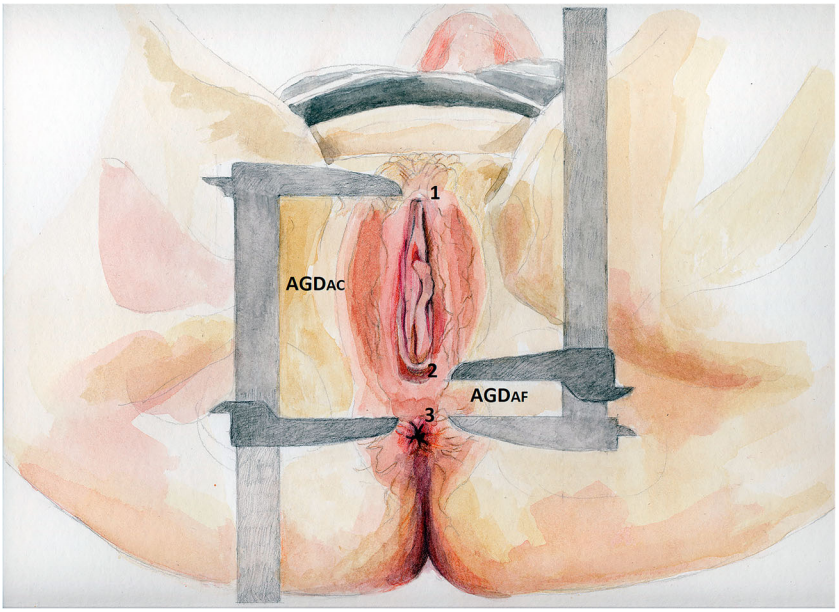

Fig. 1 Benchmarks for two AGD measurements: *AGDac*, from the surface of the anterior clitoris to the upper edge of the anus (point 1 to point 3), and *AGDaf*, from the posterior fourchette to the upper edge of the anus (point 2 to point 3) [14]

AGD was used as the estimate. Other measurements included the lengths of the gh and pb (defined as per the parameters of the POP-Q classification and Fig. 2), and these measurements were performed three times.

Anthropometric distance measurement was performed for each patient upon admission, before delivery at the beginning of the second stage of labor, to precede complete cervical dilatation, avoiding conditioning of the perineal measurements by compression of the fetal head over the domed perineum.

All deliveries (except for the operative vaginal deliveries) were carried out by the midwives of the center following the criteria of the clinical guide to care for regular delivery published by the Spanish Ministry of Health. In each case, the episiotomy was mediolateral.

Statistical analyses

To detect a difference of at least 5 mm in the AGDac between the two groups for size calculation with a standard deviation of

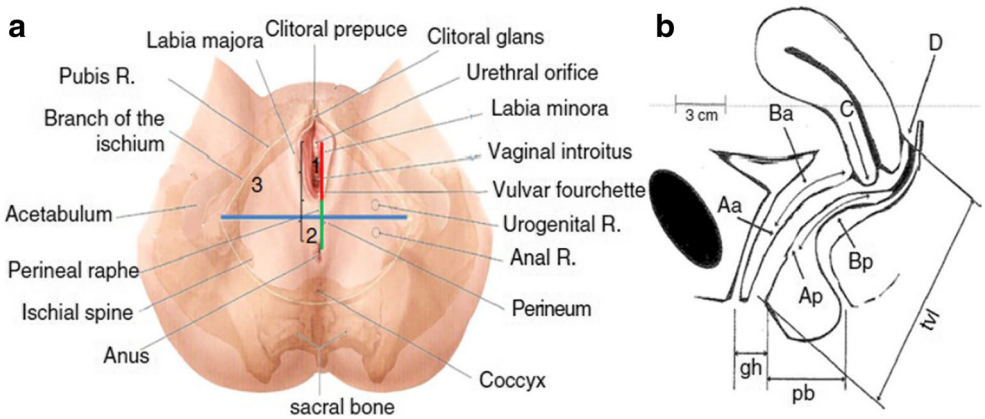

Fig. 2 **a** Measurement of genital hiatus length (*1*) and perineal body (*2*). Source: taken from Prometheus Atlas of Anatomy [16], with permission . **b** Definition of the length of the genital hiatus (*gh*) according to the POP-Q: from the center of the urethral meatus to the posterior midline hymen or the leading edge of the nucleus of the perineum (identified by palpation of the levator ani and not by the skin fold of the fourchette). Perineal body length (*pb*) according to the POP-Q: from the posterior margin of the urogenital hiatus or from the central node of the perineum to the center of the anus. *Aa* point located in the midline of the anterior vaginal wall 3 cm proximal to the external urethral meatus, *Ba* point that represents the distal-most (i.e., most dependent) position of any part of the upper anterior vaginal wall from the vaginal cuff or anterior vaginal fornix to *Aa*, *C* point that represents either the distal-most (i.e., most dependent) edge of the cervix or the leading edge of the vaginal cuff, *D* point that represents the location of the posterior fornix (or pouch of Douglas) in a woman who still has a cervix, *Bp* point that represents the distal-most (i.e., most dependent) position of any part of the upper posterior vaginal wall from the vaginal cuff or posterior vaginal fornix to *Ap*, *Ap* point located in the midline of the posterior vaginal wall 3 cm proximal to the hymen, *tvl* total vaginal length. Source: taken from Bump et al. [17] with permission

approximately 9.4 mm, an α-risk of 0.05 and 80% statistical power to detect differences, if any, 26 cases and 78 controls were required, and we surpassed the number of patients required in each group. Unpaired Student's *t* tests and Mann–Whitney *U* tests were performed for comparisons of continuous variables between cases (women with episiotomy) and controls (women without episiotomy). Chi-squared test was used for categorical variables. To evaluate the discriminating abilities of AGD and "gh + pb" to predict episiotomy, ROC curves were generated using a maximum likelihood estimation to fit a binomial ROC curve to continuously distributed data. ROC curves were generated by comparing AGD measurements (AGDaf and AGDac) and "gh + pb" with the presence of episiotomy. To calculate sensitivity, specificity, and the positive and negative likelihood ratios, AGD measurements were dichotomized by using optimal cut-off points based on the maximum Youden Index (J) value [18]. To take into account the influence of other covariates, ANCOVA models were carried out to assess whether differences between cases and controls with regard to AGD and "gh + pb" measurements remained after adjustment by age, duration of the second stage of labor, parity, instrumentation, and spontaneous rate in vaginal deliveries. ROC curves with AGD and "gh + pb" measurements adjusted by age, BMI, duration of the second stage of labor, parity, and instrumentation rate were also compared. All tests were two-tailed, and the level of statistical significance was set at 0.05. Statistical package IBM SPSS19.0 (IBM Corporation, Armonk, NY, USA) and EPIDAT 3.1 (Xunta de Galicia-OPS/OMS, Spain) were used for statistical analysis.

Results

Overall, in our study, 47.7% of women were nulliparous. Of the multiparous patients, 61% had undergone at least one episiotomy during a previous delivery, and 39% had a previous delivery without episiotomy. Nearly 35% of women delivered after labor induction, and 65% of deliveries began spontaneously. In the comparison between the episiotomy ($n = 32$; 26.9%) and non-episiotomy groups ($n = 87$; 73.1%; Table 1), AGDac and gh + pb measurements were significantly shorter and the duration of the second stage of labor was significantly longer in the episiotomy group. Significant differences were also noted in maternal pregestational age, nulliparity rate, and instrumental versus spontaneous vaginal deliveries between women with and those without episiotomy. No differences between the two groups were evident regarding other variables; namely, neonatal length and weight, cephalic circumference, coccyx–symphysis distance, inter-schismatic distance, perineal body length, AGDaf or maternal conditions (e.g., high blood pressure [controls: 6.8% vs cases: 12.5%: *p* value: 0.33], pregestational [1.1% vs 2%: *p* value: 0.54] or gestational diabetes [3.4% vs 6.2%: *p* value: 0.50]).

In the representation of the two variables, namely, AGDac and gh + pb, in ROC curves (Fig. 3), an area under the curve of 0.62 [0.504–0.737] with a sensitivity and specificity of 0.55 and 0.70 respectively was calculated for the first variable with an optimal predicted probability cut-off of 93 mm (AGDac), and an area under the curve of 0.63 [0.51–0.75] with a sensitivity and specificity of 0.72 and 0.60 respectively was calculated for the second variable with an optimal cut-off of 77 mm (gh + pb). The latter was slightly better than the former. Similar results were obtained regarding ROC curves, or AGD and gh + pb measurements between cases and controls after controlling for potentially important covariates. For example, adjusted mean values for AGDac in cases and controls were 92.4 vs 98.0 mm respectively; for gh + pb they were 77.0 vs 81.7 mm respectively, and significant differences remained. Overall, in our study population, the predictive capacity of these measurements to distinguish between women with a need for an episiotomy and those without are still modest.

Discussion

We found that shorter lengths of "gh + pb" and its "'counterpart" AGDac are risk factors for episiotomy. The sum of the gh and pb lengths in addition to the innovative measurement of AGDac were significantly shorter in the episiotomy group than in the non-episiotomy group. Our results are consistent with the fact that the size or area of the levator hiatus may influence the need to perform an episiotomy. The area of the levator hiatus (determined by MRI or 3D ultrasound) can be estimated clinically [8, 19]. The closest clinically measurable equivalent to the levator hiatus size is the gh (or urogenital hiatus); that is, the distance from the center of the external urethral meatus to the center of the fourchette. Delancey and Hurd [19] noted that the anteroposterior diameter corresponds to the distance between the pubic symphysis and the palpable margin of the firm, dense connective tissue of the pb (not the perineal skin). Using 3D ultrasound, Khunda and co-workers [8] found that the clinical correlation with the size of the levator hiatus was better for "gh + pb" than for "gh" alone in non-pregnant women. If this correspondence works, from a clinical perspective, it would much easier to measure a linear distance with a ruler than an area (which would require an ultrasound with a three-dimensional probe). It is also interesting to point out that this correlation is higher with the sum of "gh + pb" than with "gh" only, as it might have been thought a priori. We also found that AGDac correlates better with the sum of "gh + pb" than with "gh" only, but in pregnant women. To our knowledge, this area has not been analyzed as a risk factor for episiotomy. We did not measure the area of the levator ani because an ultrasound with a three-dimensional probe was not available at that moment. For

Table 1 Descriptive characteristics of the study population

Characteristic	Cases (episiotomy) $n = 32$	Controls (no episiotomy) $n = 87$	p value
Maternal pregestational age (years), mean (SD)	33.5 (5.5)	30.4 (6.1)	0.02
Maternal pregestational height (cm), mean (SD)	163 (6.3)	164 (7.6)	0.66
Maternal pregestational weight (kg), mean (SD)	68.1 (12.4)	72.6 (15.2)	0.13
Maternal pregestational BMI, mean (SD)	25.7 (4.3)	27.1 (5.6)	0.23
Gestational age at delivery (weeks), mean (SD)	39.6 (1.4)	39.3 (1.6)	0.29
Second stage of labor time (min), mean (SD)	79.8 (59.2)	43.5 (43.5)	0.003
Neonatal weight (g), mean (SD)	3217 (479)	3,399 (525)	0.09
Neonatal length (cm), mean (SD)	49.3 (2.0)	49.7 (1.9)	0.38
Cephalic circumference (mm), mean (SD)	346 (15.7)	349 (13.9)	0.27
Symphysis–coccyx distance (mm), mean (SD)	154 (13.3)	155 (12.5)	0.70
AGDac (mm), mean (SD)	93.1 (9.4)	97.8 (10.2)	0.03
AGDaf (mm, mean (SD))	35.9 (6.9)	34.9 (7.4)	0.51
gh + pb (mm), mean (SD)	77.0 (10.8)	81.9 (9.8)	0.02
Pb (mm), mean (SD)	45.4 (8.1)	44.9 (7.8)	0.76
Distance between the ischial tuberosities (mm), mean (SD)	144 (9.4)	144 (9.4)	0.93
Nulliparity (%)	62.5	25.3	0.001
Previous cesarean section (%)	12.5	8.0	0.46
Previous episiotomy (%)	47.1	66.7	0.13
Induction rate (%)	31.2	48.3	0.10
Instrumental deliveries (%)	75.0	9.2	0.001
Spontaneous vaginal deliveries (%)	25.0	90.8	0.001

SD standard deviation, *AGDac* anus–clitoris anogenital distance, *AGDaf* anus–fourchette anogenital distance

example, Cassadó Garriga et al. [20] evaluated the area of the levator only using ultrasound (without visual exploration of the patient) after delivery with or without episiotomy.

To compare and discuss our findings, we reviewed the literature, but found comparison difficult because of the substantial variability among the objectives of the studies retrieved. These

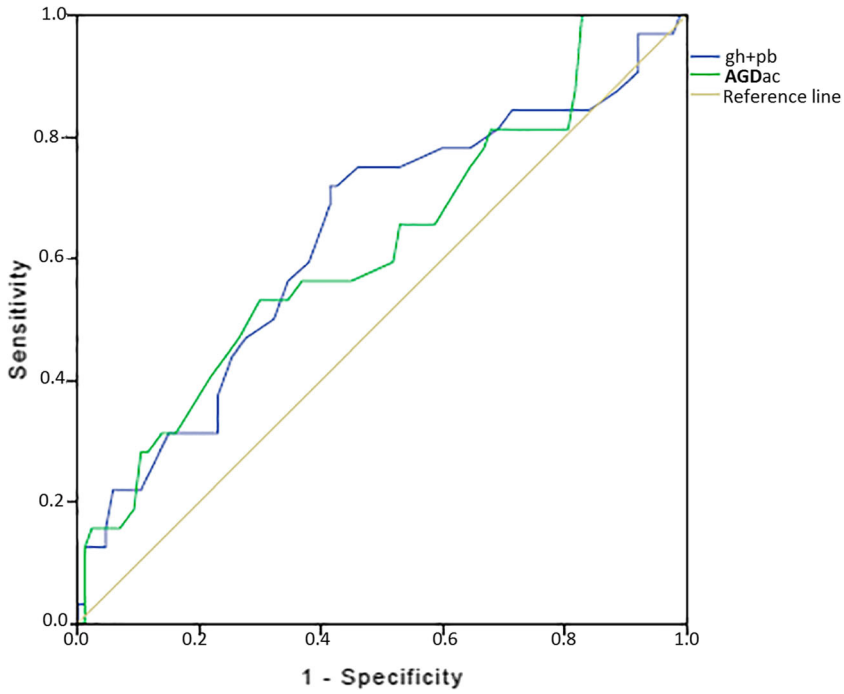

Fig. 3 Analysis of sensitivity in the receiver operating characteristic curves of the variables genital hiatus (*gh*) + perineal body (*pb*) and anus–clitoris anogenital distance (*AGDac*)

studies correlate the measurements of the perineum not only with the risk of episiotomy, but also with other outcomes, such as the risk of perineal tear, OASIS, instrumental delivery, and pelvic organ prolapse in the future. Another problem involves the different methods used to introduce these perineal measures, with a clear lack of standardization. Although most of the parameters used were the pb and gh described according to the ICS, other index forms, such as the anal position index [4] (the pb/distance between the fourchette and the inferior margin of the coccyx), were also used. Moreover, the anal position index does not correlate with AGD measurements.

This study introduces measures of AGD as risk factors for episiotomy. We found only one article [21] in which AGD was measured in pregnant women. In this article, the median AGDaf was 40.3 ± 10.7 mm, which is relatively high compared with 34.86 mm in our study population. In this case, ethnicity may explain the AGD differences. The other problem is the lack of consensus on normal and shortened perineal measurements as we observed wide ranges in the published data. No standard measure exists to measure the perineum or studies on measures that are considered normal. Dua et al. [22] reported the mean pb length in 1,000 women. Mean perineal length was 3.7 ± 0.9 cm in Caucasian women and 3.6 ± 0.9 cm in in Asian women [22]. Some authors, including Verghese et al. [3] found an average pb length of 3.9 ± 0.7 cm. Other authors have reported different mean values for pb: Nager and Helliwell [23], pb = 4.3 cm; Rizk and Thomas [4], pb = 4.6 ± 0.9 cm; Rizk et al. [24], pb = 4.1 ± 0.7 cm; and Aytan et al. [7], pb = 3.98 ± 0.54 cm. Our mean pb value was 4.5 cm in Caucasian women. Differences in ethnicity and the labor stage in which these measurements were performed may explain the variations in pb values.

Our findings are consistent with those of Eid et al. [21], who did not find significant differences between episiotomy and non-episiotomy groups regarding the gh or pb length. Additionally, Deering et al. [6] did not report differences in the pb measurements in terms of the episiotomy rate. Moreover, the length of the gh has not been studied in relation to posterior perineal injury, although this measurement is inversely associated with the length of the perineum [4]. These authors also reported that women with a short perineum (pb < 4 cm) had significantly higher rates of episiotomy and perineal tears. We did not observe statistical differences in pb, although we used a standard approach proposed by the ICS, as used by Rizk et al. [24]. We could not compare our findings with those of others because to our knowledge, no studies have explored the gh + pb length or the AGD as risk factors for episiotomy.

We also found that the duration of the second stage of labor was a risk factor for episiotomy. Rizk et al. [24] found a correlation between a longer second stage of labor and a short perineum, but the authors did not observe a correlation with the episiotomy risk. Deering et al. [6] found no statistically significant difference between the duration of second-stage labor and the pb length or episiotomy rate. This difference may be due to restriction of the study population to women attempting their first vaginal deliveries. Sheiner et al. [25] and Lane et al. [26] found that a prolonged second stage (>40 min) and low parity were independent risk factors for perineal tears, but not for episiotomy. In the study by Lane et al. [26], a prolonged second stage >99 min and a pb length ≤ 3.5 cm were associated with an increased risk of third- and fourth-degree lacerations in primigravid patients.

Multiple studies have compared perineal measures with the risk of lacerations. Eid et al. [21] found an increased risk of significant lacerations in patients with a shortened pb (<3.5 cm). The authors suggest that episiotomy should be reserved for cases in which the perineal length is initially short (<3.5 cm). Primigravid women with short perinea were more likely to experience third-degree perineal tears during delivery ($p = 0.03$) [19]. Other authors have associated women with a pb < 3 cm with a significantly higher rate of ultrasound-diagnosed anal sphincter tears. Deering et al. [6] also found that a pb ≤ 2.5 cm was associated with a significantly higher likelihood of third- or fourth-degree lacerations. This risk remained after controlling for both operative vaginal delivery and episiotomy. In some studies, episiotomy was the most important determinant of perineal lacerations and anal sphincter tears [23]. Other studies concluded the opposite, showing that episiotomy does not increase the risk of a perineal tear [27, 28]. In our study population, we also failed to see this relationship, despite an episiotomy rate of 26.9%. Pb length (≤3.5 cm) also correlated with a higher incidence of operative vaginal delivery [4]. Some authors [5] suggest that in women with perineal lengths ≤3 cm, mediolateral episiotomy may be preferable to midline episiotomy owing to an elevated risk of third- and fourth-degree perineal lacerations.

We did not identify any newborn parameters as risk factors for episiotomy. Komorowski et al. [29] correlated newborn weight, cranial circumference and cranial presentation position with perineal trauma but not with episiotomy. Drusany Starič et al. [28] found an association between the cephalic perimeter and OASIS. Other authors did not identify neonatal weight as a risk factor for perineal tears [6].

One of the strengths of the study is that the measures were performed during the first phase of labor before the decision to perform episiotomy was determined. All measurements were routinely performed by the same investigator and deliveries were facilitated by the midwives on staff. One of the limitations of this study is that we had a heterogeneous population in terms of pregnancies (singleton versus twin) parity and previous episiotomies; that could restrict the external validity of our work. In future studies, a homogeneous group of nulliparous women could be more convenient to increase external validity. Another limitation is that we did not compare the reproducibility of the two proposed measurement methods (measures defined according to the POP-Q protocol) and the distances

defined by the AGD concept. In a preliminary investigation, we compared pb and AGDaf measurements and found worse reproducibility for pb than for AGDaf [15]. More work is required to define which measures have the best reproducibility. First- and second-degree lacerations or higher-degree tears were not considered for this study, and these associations should be evaluated in future studies. Lastly, our study population was relatively small; however, although a relatively small sample size is typically a source of type II error, this was not observed in our study, as significant relationships were identified.

We conclude that the decision to perform an episiotomy is heavily dependent on the opinion of the delivering clinician and is based on the clinical scenario at the time of delivery. Few studies have clearly identified risk factors associated with the practice of episiotomy. We suggest that the joint measurement of gh + pb and AGDac are new approaches to measuring the perineum and that these measures constitute risk factors for episiotomy. We propose that gh + pb length shorter than 77 mm and an AGDac shorter than 93 mm may be risk factors for episiotomy and useful for diminishing subjectivity in the decision to perform an episiotomy. However, given the results of ROC curves, the predictive capacity is limited, and more studies are required to confirm and expand our findings.

Compliance with ethical standards

Conflicts of interest None.

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