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Review article

Fetal monitoring in term breech labor – A review

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Introduction

There has been considerable debate about the mode of delivery in breech presentation at term in response to a large randomized study (the Term Breech Trial) finding that mortality and short-term morbidity were increased among those selected for vaginal delivery [1]. Inadequate fetal surveillance in breech labor has been reported as a contributing factor to adverse outcomes [2,3]. However, elective cesarean delivery is not necessarily advantageous to the long-term outcome [4], and several recent observational studies recommend vaginal delivery after careful selection and close monitoring during labor [5–20]. This is also reflected in the revised recommendations of the Cochrane Library [21] no longer strictly favoring elective cesarean delivery. In contrast to the conclusion of the Term Breech Trial [1], several national guidelines [5,22–24] recommend vaginal breech delivery at term for selected cases.

Irrespective of the mode of delivery, a term breech presentation is associated with increased risk of perinatal morbidity and mortality [25], which has been estimated as being three times higher than for comparable infants with vertex presentation [26]. This is partly due to an increased frequency of malformations, antenatal deaths, and also fetal growth restriction. This last factor in combination with an increased risk of cord prolapse and cord compression, places the breech fetus at an increased risk of intrapartum asphyxia. Therefore, most guidelines for vaginal breech birth highlight the necessity of electronic fetal monitoring with cardiotocography (CTG) during labor.

However, correct interpretation of the monitored fetal heart rate (FHR) as well as decision making, is challenging generally, [27] but especially so in vaginal breech birth— a controlled Danish audit found insufficient surveillance and an inadequate response to FHR abnormalities to be the most frequent issues in term breech deliveries with adverse outcomes [2].

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Despite having been in use for more than four decades, there has been little research into different aspects of electronic fetal monitoring in breech presentation. The aim of this study was to review the current knowledge about fetal surveillance during term breech labor, including the use of CTG and its adjunctive technologies to assess the associated neonatal outcome, and to suggest areas of future research.

Material and methods

We searched EMBASE, MEDLINE, AMED, CINAHL, and the Cochrane Library over the period from 1946 to 2017 using the search terms presented in Appendix S1. The initial search was performed on October 21, 2016, and its final update was performed on June 26, 2017. Studies were not excluded based on language, methodology, or quality assessment. The database search was complemented by comprehensively checking the references cited in the reports, which identified further studies that were relevant to this review. The first author (M.C.J.) reviewed the titles and abstracts of the publications and identified citations fulfilling the following predetermined selection criteria: breech presentation, singleton pregnancy, term delivery, and fetal monitoring forming part of the management procedure. Full-text versions of the selected citations were reviewed for eligibility. Doubts about eligibility were discussed with one of the co-authors (J.K.), and decisions were made through consensus.

Results

The systematic search identified 550 abstracts. Of those, 495 were excluded due specified criteria (Fig. 1) Appendix S1 and S2. A total of 83 full-text articles were assessed and 13 finally included [5,13,15,19,283031323334353637] (Fig. 1). In addition a further 28 studies were identified after scrutinizing the reference lists of these 13 publications, and 22 of those included in the review [1,6–12,14,16–18,37,394041424344454647]. Although these studies were related to fetal monitoring, corresponding keywords were lacking from the articles and so they were not identified in the systematic search.

All the included studies differed in the mode of surveillance, surveillance method, and adjunctive methods. Out of the total of 35 studies where electronic fetal monitoring formed part of the intrapartum management (Table 1) [1,5–19,28–30,32–36,38,40–45], the use of CTG guidelines during term breech labor was described in detail for only nine [5,10,13,15,16,19,35,36,45].

There were only two randomized controlled studies while the remaining studies were observational and differed in study design, and patient populations.

We therefore systematized the results into the following clinically important issues: CTG classification systems, adjunctive technologies, changes in FHR specific to breech labor, and outcome related to the fetal monitoring technique.

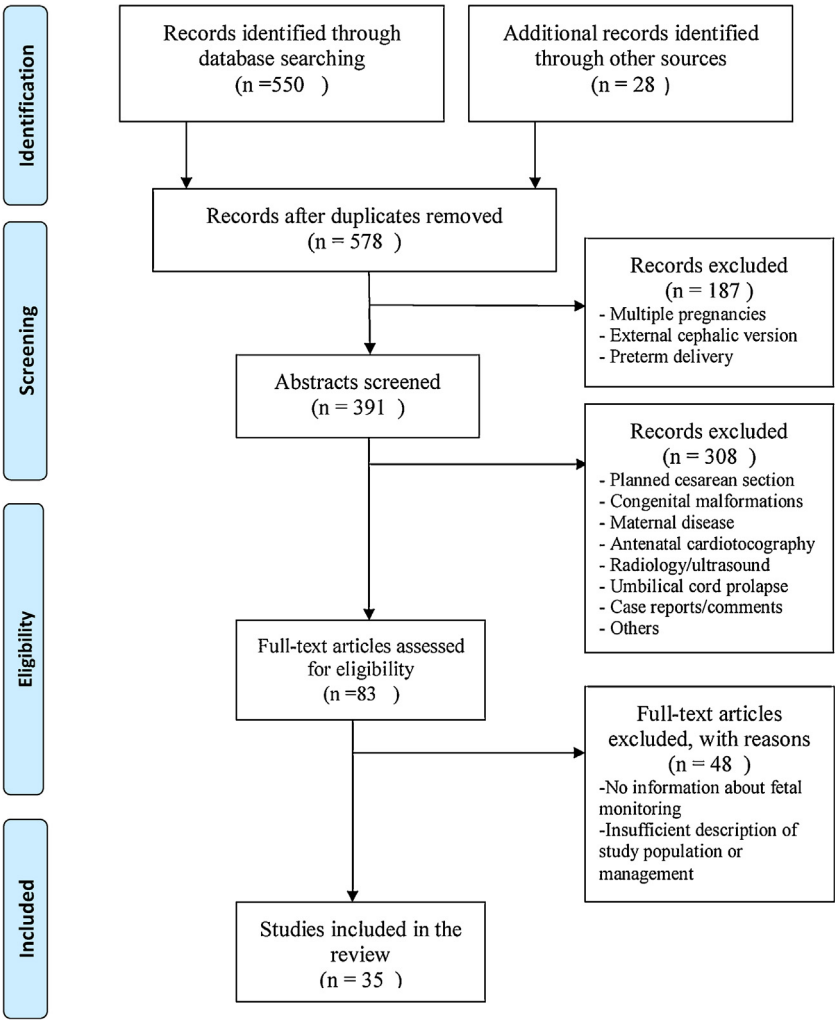

Fig. 1. Flow chart for searching, selecting, and including studies.

Table 1
Summary of included studies with information on general characteristics, features of fetal monitoring, and neonatal outcomes.

	Year		Study design	Total breech presentations	Selected for vaginal delivery	Actual vaginal delivery	Selection criteria - vaginal delivery	
							Fetal biometry	Pelvimetry
Goffinet [5] (PREMODA)	2006	Prosepective	Observational	8105	2526	1796 (71.1%)	+	+
Ulander (37)	2004	Retrospective	Case-control	2910	1270	1127 (88,74%)	+	+
Hannah [1] (TBT)	2000	Prospective	RCT	2083	1045	591 (56.6%)	-	-
Albrectsen [28]	1997	Retrospective	Case-control	1212	811	639 (78.8%)	+	+
Michel [6]	2011	Retrospective	Before-and-after	1133	422	354 (83.9%)	+	+
Herbst [38]	2001	Retrospective	Case-control	1050	699	603 (86.3%)	+	+
Uotila [7]	2005	Retrospective ?	Cohort	986	590	455 (77.1%)	+	+
Fleming [29]	1983	Retrospective	Observational	953	691	560 (81%)	+	+
Krupitz [39]	2005	Retrospective	Observational	882	382	284 (74,3%)	+	+
Toivonen [8]	2012	Retrospective	Cohort	751	254	174 (68.5%)	+	+
Hopkins [9]	2007	Retrospective	Cohort	725	214	138 (64.5%)	+	+
Hellsten [10]	2002	Retrospective	Intended-mode-of-delivery	711	445	371 (83.4%)	+	+
Irion [40]	1998	Retrospective	Cohort	705	385	269 (69.9%)	+	-
Giuliani [11]	2002	Retrospective	Observational	699		481	+	-
Alarab [12]	2004	Retrospective	case-control	641	298	146 (49%)	+	-
Kessler [13]	2014	Prospective	Observational	625	433	336 (78%)	+	+
Sibony [14]	2002	Retrospective	Cohort	610	514	407	+	+
Belfrage [41]	2002	Retrospective	Case-control	575	448	376	+	+
Vistad [15]	2013	Prosepctive	Registration study	568	289	185	+	+
Socol [42]	1987	Retrospective	Case-control	449		139	-	-
Mahomed [43]	1990	Retrospective ?	Case-control	395	218	168 (77,1%)	+	-
Andreasen [16]	2010	Retrospective	Observational	385/348	235/214	133 (56,6%)/126 (59%)	+	+
Donnai [30]	1975	Prosepctive (?)	Observational	317	138	130 (94,2%)	-	+
Kumari [17]	2004	Retrospective	Observational	250	128	98 (51,2%)	+	+
Roumen [44]	1990	Retrospective	Observational	247	234	196 (83,8%)	+	-
Barlöv [31]	1986	Prospective	Observational	226	125	102 (81,6%)	-	+
Mahomed [32]	1987	Retrospective	Observational	213	144	88 (61,1%)	-	+
Maier [20]	2011	Prosepctive	Observational	211	85	46 (54,1%)	+	-
Hill [33]	1976	Prosepctive	Case-control	186	145	127 (87,6%)	-	-
Doyle [18]	2005	Retrospective	Cohort	150	-	41	+	+
Toivonen [19]	2016	Retrospective ?	Case-control	108	108	84 (77,8%)	-	-
Gimovsky [34]	1983	Prosepctive	RCT	105	70	31 (44,3%)	-	+
Ohel [35]	1987	Prosepective	Observational	35	35	35	+	+
Daniel [45]	1998	Prosepctive	Control (??)	30	30		+	-
Eilen [36]	1984	Prosepctive	Observational	27	27	19 (70,4%)	-	+

Intrapartum managment defined in methods				Perinatal outcome		
CTG during labor	CTG guideline	Labor progression	Compared with	Apgar score <7 5 min	Arterial Cord pH< 7	Recommended mode of delivery
Continuous	National French guidelines	+	Planned CS	37/2526 (1,47%)		Vaginal
Intermittent		+	Planned CS	2/91		Vaginal
Intermittent	-	+	Planned CS	31/1042 (3%)	13/503 (2,6%)	CS
Intermittent	-	-	Vaginal cephalic	6/610 (1%)		Vaginal
Continuous	-	+	Breech	1/567 (0,2%) 3/566(0,5%)	4/529 (0.8%)	Vaginal
Continuous	-	-	Planned CS	25/699 (3,6%)		CS
Continuous	-	+	Planned CS	12/590 (2%)		Vaginal
Continuous	-	-	Planned CS			Vaginal
Continuous			Planned CS			Vaginal
Continuous	-	-	Planned CS	4/254 (1,6%)		Vaginal
Continuous	-	-	Planned CS		12/173 (6.9%)	Vaginal
Continuous	FIGO	-	Planned CS	10/445 (2,2%)	7/344 (2%)	Vaginal
Continuous	-		Planned CS	6/385 (1,6%)	7/385 (1,81%)	Vaginal
Continuous	-	-		3/481 (0,6%)	7/465 (1,5%)	Vaginal
Continuous	-	+	Planned CS	2/146 (0,7%)		Vaginal
Continuous	Modified FIGO	+	STAN/CTG	19/433 (4,3%)	12/351 (2,8%)	Vaginal

Table 1 (*Continued*)

Intrapartum managment defined in methods			Perinatal outcome			
CTG during labor	CTG guideline	Labor progression	Compared with	Apgar score <7 5 min	Arterial Cord pH< 7	Recommended mode of delivery
Continuous	-	+	Vaginal cephalic	0/514		Vaginal
Continuous	-	-	Vaginal cephalic	19/448(4,2%)	14/318 (4,4%)	CS
Continuous	Modified FIGO	-	Planned CS	7/289 (2,4%)	5/130 (3,8%)	Vaginal
Continuous	-	-	Vaginal cephalic			Vaginal
Intermittent	-	+	Planned CS	42/ 395 (10,6%)		-
Continuous	Modified FIGO	-	Planned CS	6/214 (2,8)		Vaginal
intermittent	Tripton And Shelly?	+	Planned CS			Vaginal
Continuous	-	+	Planned CS			Vaginal
Continuous	-	+	Vaginal cephalic	2/234 (0,86%)		Vaginal
Continuous	-	-		1/102		Vaginal
Continuous	-	+				Vaginal
Intermittent	-	-	Planned CS	2/85 (2,4%)		Vaginal
Continuous	-	+				Vaginal
Intermittent	-	-				Vaginal
Intermittent	FIGO	-	Vaginal cephalic	4/108 (3,7%)	2/108 (1,9%)	?
Continuous	-	+	Planned CS	2/70 (37%)		Vaginal
Continous	-	-		2/30 (6,7%)		Vaginal
Intermittent?	Cunningham	+	Vaginal cephalic	0/30		Vaginal
Continuous	Hammeracher and Fisher	-	Vaginal cephalic			Vaginal

CTG classification

All CTG classifications used for monitoring breech labor assessed the baseline FHR and variability as well as the presence or absence of accelerations and decelerations. Five of the nine studies [10,13,15,16,19] used classification systems based on the International Federation of Gynecology and Obstetrics (FIGO) guidelines [47] published in 1987, which categorized CTG findings into normal, suspicious, or pathological. In this system, the baseline FHR and its variability and the type of decelerations are categorized separately into reassuring, nonreassuring, or abnormal. A CTG with reassuring findings was classified as normal, while the presence of a nonreassuring variable was considered a suspicious CTG. In the presence of at least one abnormal or two nonreassuring features, the CTG finding was classified as pathological. The normal range for the baseline FHR was defined as within the range of 110–150 bpm (beats per minute).

A modified FIGO guideline is recommended for the clinical use of ST-interval analysis (STAN) of the fetal electrocardiogram (ECG) as an adjunct to CTG [13,15,48]. This guideline introduced the separate classification category preterminal CTG (i.e., the absence of variability and reactivity) for identifying fetuses at high risk of hypoxia with a need for immediate intervention. CTG abnormalities other than preterminal CTG are assessed in conjunction with the occurrence of changes in the ST interval to determine whether or not to intervene.

The PREMODA study [5] used the French national guidelines for intrapartum fetal monitoring [49]. The CTG findings were divided into four categories according to the presumed risk of acidosis. Different from the FIGO classification, the normal range of the baseline FHR was defined as 100–160 bpm. Further, a nonreassuring CTG is subdivided according to the risk of acidosis defined by different shapes of variable decelerations. The loss of initial and/or secondary acceleration, prolonged secondary acceleration, slow return to baseline FHR, biphasic appearance, return to lower baseline FHR, or absent variability were all features defining atypical variable decelerations associated with an increased risk of acidosis.

Other studies with small samples used various other CTG classifications. Ohel et al. [35] interpreted the CTG findings according to Krebs et al. [50] and classified FHR patterns according to the baseline FHR changes, with the severity increasing in the following order: normocardia, transitory bradycardia, tachycardia, persistent bradycardia, and progressive bradycardia. Each category was further subdivided depending on the association with decelerations.

Daniel et al. [45] used a classification from the 19th edition of Williams' Obstetrics [51] where a division was made between mild variable decelerations (lasting <30 seconds or FHR = 70–120 bpm for <60 seconds) and moderate variable decelerations (FHR < 70 bpm for 30–60 seconds or FHR = 70–120 bpm for >60 seconds). Eilen et al. [36] used the Hammeracher and Fisher scoring system [52] where the CTG findings were assessed according to short- and long-term variability, baseline heart rate, decelerations, and accelerations.

Adjunctive technologies to CTG

We identified studies on two adjunctive methods to CTG: STAN and fetal blood sampling. STAN is based on the automated analysis of the fetal ECG and the detection of changes in the ST interval caused by intrapartum hypoxia. To enable ECG analysis, an electrode is attached to the presenting part of the fetus after rupture of the membranes. Only one of the randomized trials included breech presentations ($N = 55$), among which 30 were monitored with STAN [53].

Table 2
Summary of studies describing specific variables of fetal heart rate (FHR) patterns during breech labor.

Author, year	Presentation		Baseline		Variability	Decelerations	
	Cephalic	Breech	Tachycardia	Bradycardia	Decreased	Variable	Late
Teteris, 1970 [46][a]	28	15	+	+	?	+	-
Krebs, 1982 [57]	922	40	?	?	+	?	+
Eilen, 1984 [36][b]	121	27	+	+	?	+	?
Ohel, 1998 [35]	50	35	-	-	-	+	?
Daniel, 1998 [45]	60	30	?	?	?	+	?
Kessler, 2015 [13]	5577	433	?	?	+	?	?
Toivonen, 2012 [19]	108	108	?	-	+	-	+

"+" and "– indicate increases and decreases, respectively, in the specific FHR variable in breech presentation.
"?" signifies lack of reported data for the study.
Breech compared with cephalic presentation from previous studies: [a] Ullery et al. [60] and [b] Fleischer et al. [58].

The prospective observational study of Kessler et al. published in 2015 [13] demonstrated the clinical feasibility of STAN monitoring in breech presentation. Despite a higher frequency of ECG signal disturbance and QRS abnormalities in breech compared to vertex presentation, automated ST-interval analysis could be clinically utilized in most cases [54]. Fetuses in breech presentation were shown to have a lower risk of a baseline T/QRS increase during labor compared to those with vertex presentation [13].

Fetal blood sampling (FBS) during labor is another adjunctive method used together with CTG for intrapartum monitoring. For this purpose a capillary blood sample is obtained either from the fetal scalp or from the buttocks [33,55]. The data from small observational studies are insufficient for establishing robust reference ranges for pH. Repetitive FBS during the second stage of labor irrespective of CTG changes revealed a significant decrease in pH by the time the breech had reached the perineum. Immediate delivery was recommended if the pH was lower than 7.15 [55]. A later study that included 186 deliveries from gestational week 32 onwards encouraged breech labor with combined CTG and FBS, but emphasized that the safety margin is smaller in breech than in vertex presentation when the pH is <7.25 [33].

We found no studies on fetal blood sampling with lactate measurement, fetal vibroacoustic stimulation or fetal pulse oximetry during breech labor.

Heart-rate changes specific to breech labor

In total, seven studies involving 688 parturients were identified that described FHR patterns specific to breech delivery (Table 2) [13,19,35,36,46,56,57]. All but two studies presented data on both 1st and 2nd stage of labor. The description of FHR changes focused on the second stage of labor, without a differential characterization depending on stage of labor. FHR patterns of decreased variability and late decelerations during the last hour prior to delivery were more common in breech labor than in vertex deliveries [19,52]. In line with this, interventions due to preterminal CTG were more common in breech than in vertex presentation [13]. Variable decelerations occurred in 77% [35], 33% [36,58], and 38% [59] of the cases of breech presentation. Teteris et al. demonstrated that the terminal bradycardia during expulsion in term breech deliveries lasted on average 110 seconds, compared with 69 seconds for vertex presentations [46,60]. They also observed that mild tachycardia (150–170 bpm) occurred frequently during the late first stage of breech labor.

Outcome relative to fetal monitoring technique

The 5-min Apgar score was reported in seven studies ($N = 2361$ cases) with intermittent fetal monitoring [1,19,20,28,31,37,43,45] and in 18 studies ($N = 8993$ cases) with continuous fetal monitoring [5–8,10–16,34,35,38,40,41,44]. A 5 min Apgar score of <7 was more common in breech neonates with a protocol of intermittent monitoring ($N = 87$ cases; 3.68%, 95% confidence interval [CI] = 3.00–4.52%) than with continuous electronic monitoring ($N = 161$ cases; 1.79%, 95% CI = 1.54–2.09%).

Umbilical cord acid-base data were reported in two studies with intermittent monitoring ($N = 611$ cases) and in eight studies with continuous monitoring ($N = 2695$ cases), with results available for 74% (range 45–100%) of the neonates. The frequency of acidosis did not differ significantly between intermittent monitoring ($N = 15$ cases; 2.45%, 95% CI = 1.49–4.01%) [1,19,31] and continuous monitoring ($N = 68$ cases; 2.52%, 95% CI = 2.00–3.19%) [6,9–11,13,15,40,41].

The PREMODA study, recommending continuous fetal monitoring with CTG, found that the neonatal risk of combined neonatal outcome as not higher in planned vaginal delivery compared to planned elective cesarean section [5].

Using the FIGO guidelines, Hellsten et al. [10] and Toivonen et al. [19] found that the risks of a low 1-min Apgar score and a low umbilical cord arterial pH were higher in the planned vaginal delivery group, but with no intergroup difference in the risk of metabolic acidosis.

Kessler et al. evaluated the neonatal outcome of pregnancies with breech presentation selected for vaginal delivery and monitored with STAN [13]. The risk of cord metabolic acidosis, perinatal mortality, and moderate or severe neonatal encephalopathy did not differ significantly between breech and vertex deliveries, but the study was not powered to detect differences in mortality. Vistad et al. reported that neonatal morbidity defined as Apgar score <7 after 5 minutes and transfer to the neonatal intensive care unit within four days, occurred significantly more frequently in the vaginal-breech-delivery group than in the planned-breech-cesarean-section group [15].

Discussion

Breech presentation has been recognized as a risk factor for intrapartum hypoxia and therefore considered an indication for intrapartum monitoring for decades. This review shows that most of the published research on fetal monitoring during breech labor is inadequate. Most of the observational studies ($N = 26$, 74,5%) in which electronic fetal monitoring formed part of the intrapartum management, lacked information on the CTG classification system and the guidelines for intervention (Table 1). The remaining nine studies (25.7%) mentioned six specific CTG classification systems, which demonstrates the lack of an evidence-based consensus for interpreting the FHR during labor (Table 1).

A new consensus FIGO guideline for CTG interpretation and classification was published recently [61], but it did not document any new scientific evidence for a more favorable maternal and neonatal outcome compared to the previous guidelines. The threshold for

intervention upon the occurrence of fetal distress—in particular with the use of adjunctive technologies (FBS and STAN)—will depend on the CTG classification system used, and any revised guidelines need to be thoroughly tested before they are introduced into clinical practice. Even the few studies describing the CTG pattern in breech labor were incomplete regarding the description of all FHR parameters, the duration of FHR abnormalities, and their temporal occurrence during labor (Table 2).

Thus, the FHR patterns that develop during the first and second stages of breech labor are not yet fully understood. The application of a longitudinal analysis of FHR patterns during labor that focuses on critical periods for fetal monitoring (i.e., the onset of the recording, the late first stage, and the time of active pushing) [62] may provide new insight into fetal adaptations to hypoxic challenges during breech labor.

In breech delivery the neonate is at an increased risk of cord acidemia [13,19,34,45], but cord acid-base data were only reported for 10 studies, representing 11.4% of all breech deliveries included in this review. It has been suggested that the severity of hypoxia related to FHR decelerations is more severe in breech than in vertex fetuses, presumably due to a greater degree of cord compression [58]. A recent case–control study identified both breech presentation and variable decelerations as risk factors for acidemia [19], but the interrelationship between these risk factors was not explored.

The use of STAN as an adjunctive method reduced the need for fetal blood sampling and the frequency of vaginal operative deliveries [63]. However, breech neonates had a higher risk of morbidity even when the guidelines were rigorously applied in high-risk deliveries [13]. None of the observational studies using the STAN methodology [13,15,53] have explored specific FHR abnormalities related to ST-interval changes in breech presentation. It is possible that the current STAN clinical guidelines need to be refined for breech presentation as a specific risk condition.

Only one randomized controlled trial of the use of fetal blood sampling as an adjunctive monitoring modality in breech labor has been published. It did not demonstrate improved neonatal outcomes compared to CTG alone [64]. Finally, the current guidelines for intervention based on fetal lactate measurements have not been tested for fetuses in breech presentation.

The use of electronic fetal monitoring in low-risk vertex births decreases the frequency of neonatal seizures, but any effect on the rate of mortality or cerebral palsy remains to be proven [65,66]. Nevertheless, the monitoring intensity could impact the outcome given that the rates of neonatal morbidity and mortality were fourfold higher in the Term Breech Trial [1], in which only 33% of the participants were monitored continuously, compared to the PREMODA study, in which all of the participants were monitored continuously [5]. Our finding that the frequency of a low Apgar score was higher in intermittent than in continuous fetal monitoring supports the recommendation of intensive monitoring found in many current guidelines [7,23,24,67,68]. The lack of influence of the monitoring intensity on the frequency of cord acidosis at delivery could be due to small sample size, in contrast to universal assessments of the Apgar score.

Conclusion

This review has demonstrated the inadequacy of the current knowledge about specific FHR patterns during breech labor and their relationship to intrapartum hypoxia. Future research should aim at providing a systematic description of FHR patterns during breech labor and the refined application of adjunctive technologies.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ejogrb.2019.05.009.

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