Acceleration Patterns of the Fetal Heart Rate before and during Labour

H. J. ODENDAAL, H. A. SANDENBERGH

SUMMARY

In infants in whom accelerations of the fetal heart rate were present during the first stage of labour, the incidence of low Apgar scores was significantly less than in those in whom accelerations were not present. Absence of acceleration patterns during the contraction stress test (CST) was associated with a lower birth weight. In patients in whom acceleration patterns were observed during a positive CST, fetal distress occurred in the minority of subsequent labours. When accelerations as well as late decelerations are observed during a CST, the possibility of a false positive test should be excluded.

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Acceleration patterns are among the periodic fetal heart rate changes which occur most frequently. At first the significance of these patterns was doubtful, but recent reports[1,2] indicate an association with favourable fetal prognosis. Late decelerations observed during the contraction stress test (CST) indicate placental respiratory insufficiency and therefore fetal distress.[3,4] The presence of accelerations during the CST, on the other hand, reflects fetal well-being. The significance of acceleration patterns observed during a positive CST seems to be controversial and was therefore examined.

PATIENTS AND METHODS

In the first part of this study, the influence of acceleration patterns, as observed during labour, was studied with special reference to the fetal outcome. Fetal heart rates were monitored with a spiral scalp electrode, and uterine contractions were measured either internally or externally. A Hewlett-Packard Model 8020A cardiotocograph was used for these recordings. After all recordings of poor quality had been excluded, 948 were examined for the presence of acceleration patterns, defined as transient spurts of increase in fetal heart rate of at least 10 beats per minute (Fig. 1). Apgar scores in infants in whom no acceleration patterns were seen were compared with those in a group in whom accelerations were observed. Apart from the exclusion of poor recordings and the presence or absence of acceleration patterns, patients were chosen at random.

Department of Obstetrics and Gynaecology, University of Stellenbosch and Tygerberg Hospital, Parowvallei, CP

H. J. ODENDAAL, F.C.O.G. (S.A.), M.MED. (O.&G.), M.R.C.O.G., M.D.

H. A. SANDENBERGH, M.B. CH.B.

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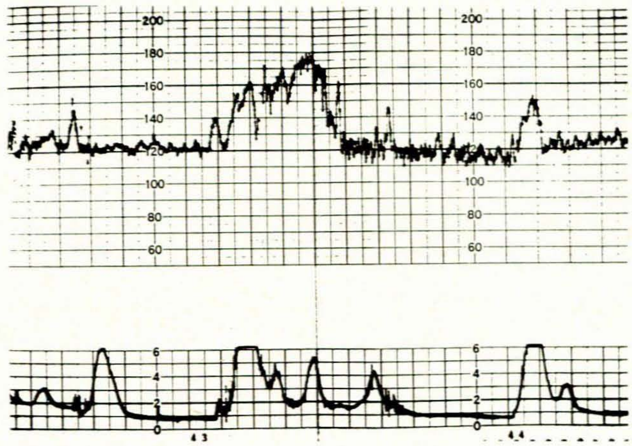

Fig. 1. Cardiotocograph demonstrating accelerations of the fetal heart rate during labour.

In the second part of the study, acceleration patterns, as observed during the CST, were examined. The test technique has been described in an earlier study.[5] Recordings of good quality, demonstrating uterine contractions each lasting 45 seconds or more, and occurring every 2 - 3 minutes, were a prerequisite for interpretation. The patient's most recent CST only was examined. There were 564 patients with negative CSTs, of which 120 did not demonstrate acceleration patterns, i.e. they were smooth CSTs. Gestational ages at the time of the CST and at birth, as well as the 5-minute Apgar scores and birth weights of the two groups, were compared. Infants of patients who knew the date of their last menstrual period were examined for growth retardation. Growth curves in use at Tygerberg Hospital were used for this purpose[6] and infants below the 10th percentile were regarded as being small for gestational age. The incidence of acceleration patterns and smooth CSTs in these infants was then examined.

Finally, 57 patients with positive CSTs were studied. Patients in whom acceleration patterns were observed during the CST were studied in greater detail, as well as those with small-for-gestational-age infants. Infants weighing 2 800 g or more were not regarded as being growth-retarded, even though the duration of pregnancy was sometimes unknown. Growth charts compiled at Tygerberg Hospital have demonstrated that it is highly unlikely for infants weighing 2 800 g or more to be growth-retarded.

RESULTS

Acceleration patterns occurred in 638 patients during labour, while 310 patients did not demonstrate this

TABLE I. INCIDENCE OF LOW 5-MINUTE APGAR SCORES

FHR pattern during labour	Apgar (1 - 6)	Apgar (7 - 10)	Total
Acceleration pattern absent	**48 (15%)**	**262 (85%)**	**310 (33%)**
Acceleration pattern present	**30 (5%)**	**608 (95%)**	**638 (67%)**
Total	**78**	**870**	**948**

FHR = fetal heart rate; χ^2 (1 degree of freedom) = 32,1; $P<0,0001$.

pattern at any stage. When acceleration patterns were present the incidence of low 5-minute Apgar scores (1 - 6) was 5%. In the absence of any acceleration pattern during labour, 15% of infants born had low Apgar scores (Table I). This difference is statistically highly significant ($P<0,0001$).

The duration of pregnancy at the time of the CST was known in 332 patients. The mean duration was 37 weeks in patients with smooth CSTs and 38 weeks in those with acceleration patterns (Table II). The mean duration of pregnancy at birth was 39,33 and 39,93 weeks, respectively. Five-minute Apgar scores were 9,22 and 9,36, respectively. None of these differences was statistically significant. Mean birth weight in the group with acceleration patterns was 3 022 g as against 2 794 g in the group with smooth CSTs. This difference is statistically significant. As the frequency distribution was not normal, the χ^2 test was also done. The same results were seen in all the parameters compared. Small-for-gestational-age infants were associated with 13% of acceleration pattern CSTs and with 20% of smooth CSTs (Table III). Statistically this difference is not significant ($P>0,05$).

TABLE II. COMPARISON BETWEEN ACCELERATION AND SMOOTH FHR PATTERNS

	Acceleration pattern CST	Smooth pattern CST
Duration of pregnancy at CST		
Number of patients	**255**	**77**
Mean (wks)	**38**	**37**
SD (wks)	**3,93**	**4,25**
t	**1,92**	
P	**>0,05**	
Duration of pregnancy at birth		
Number of patients	**283**	**76**
Mean (wks)	**39,93**	**39,33**
SD (wks)	**3,46**	**3,27**
t	**1,37**	
P	**>0,05**	
5-minute Apgar score		
Number of patients	**436**	**117**
Mean	**9,36**	**9,22**
SD	**1,43**	**1,57**
t	**0,94**	
P	**>0,05**	
Birth weight		
Number of patients	**444**	**120**
Mean (g)	**3 022,84**	**2 794,14**
SD (g)	**663,96**	**844,74**
t	**3,15**	
P	**<0,01**	

FHR = fetal heart rate; CST = contraction stress test; SD = standard deviation.

The incidence of acceleration patterns in 57 patients with positive CSTs was 21%, but in those with negative CSTs it was 79% (Table IV). The difference is statistically significant ($P<0,01$).

TABLE IV. INCIDENCE OF ACCELERATION PATTERNS IN POSITIVE AND NEGATIVE CSTs

	Smooth pattern	Acceleration pattern	Total
Negative CST	**120 (21%)**	**444 (79%)**	**564 (91%)**
Positive CST	**45 (79%)**	**12 (21%)**	**57 (9%)**
Total	**165**	**456**	**621**

CST = contraction stress test; χ^2 (1 degree of freedom) = 88,3; $P<0,0001$.

Growth retardation was found in 16 infants with positive CSTs. Five infants of unknown gestational age weighed less than 2 800 g. They could, therefore, not be categorized into different weight-for-age groups. Growth was retarded in 17% (2 out of 12) of infants in whom acceleration patterns were seen, and in 35% (14 out of 40) of those in whom smooth patterns were observed.

The acceleration patterns observed in 12 patients during a positive CST were analysed further. In 6 patients delivery was by caesarean section, and in 4 of these it

TABLE III. ASSOCIATION BETWEEN ACCELERATION PATTERN AND GROWTH RETARDATION

Contraction stress test	Infants appropriate for gestational age	Infants small for gestational age	Total
Acceleration pattern	**247 (87%)**	**36 (13%)**	**283 (79%)**
Smooth pattern	**61 (80%)**	**15 (20%)**	**76 (21%)**
Total	**308**	**51**	**359**

χ^2 (1 degree of freedom) = 2,4; $P>0,05$.

TABLE V. CLINICAL DETAILS OF PATIENTS WITH A POSITIVE CST AND ACCELERATION PATTERNS

Indications for CST	Parity	Gestational age (wks)	Primary CS	Method of delivery	Abnormal FHR pattern during labour	Birth weight (g)	Apgar scores	SGA	Possible reason for wrong interpretation
Pre-eclampsia	1	40	No	Normal	No	3 108	10, 10, 10	No	Accelerations
Post-term	0	42	No	Forceps	No	4 660	8, 9, 10	No	Supine hypotension
Poor weight gain	4	39	No	Normal	No	2 990	10, 10, 10	No	Overstimulation
Pre-eclampsia	2	?	No	Vacuum extraction	No	3 680	10, 10, 10	No	No reason
Chronic nephritis	1	?	No	Normal	No	2 910	10, 10, 10	No	Poor recording
Post-term	3	43	No	CS	Yes	2 180	10, 10, 10	Yes	No reason
Post-term	3	43	Yes	CS	—	2 680	10, 10, 10	Yes	No reason
Poor weight gain	1	40	No	Normal	No	3 160	10, 10, 10	No	Accelerations
Hydramnios	0	38	No	CS	Yes	4 300	4, 7, 10	No	
Pre-eclampsia	0	42	Yes	CS	—	2 700	10, 10, 10	No	Overstimulation
Post-term	0	41	Yes	CS	—	3 910	9, 10, 10	No	No reason
Poor weight gain	1	42	Yes	CS	—	3 760	8, 9, 10	No	Overstimulation

CST = contraction stress test; CS = caesarean section; FHR = fetal herat rate; SGA = small for gestational age.

was primary (Table V). Labour was induced in 8 patients. In only 2 of these did fetal distress develop and require caesarean section. Careful analysis of the CSTs with acceleration patterns demonstrated that uterine overstimulation could have caused late deceleration patterns in 4 patients. In 2 patients acceleration patterns could have been interpreted as late decelerations. Supine hypotension and a poor recording could have caused an erroneous interpretation in another 2 patients. No reason for late decelerations, other than placental insufficiency, could be detected in 4 patients.

DISCUSSION

In one of the few articles regarding acceleration patterns of the heart rate as observed during the CST, Lee and Baggish[1] observed that it is a reflection of fetal well-being. They regard partial cord compression, peripheral nerve stimulation and fetal activity as the most important physiological causes of fetal heart rate acceleration. Sadovsky *et al.*[7] found that fetal movements *in utero* indicate a favourable fetal prognosis and that a reduction of fetal movements could be secondary to fetal anoxia. Pearson and Weaver[8] and Pedlow[9] also regard fetal activity as an assurance of well-being.

The favourable prognosis of acceleration patterns during labour was demonstrated during this study; the incidence of low Apgar scores was reduced when acceleration patterns had been present up to the end of the first stage. With acceleration and smooth pattern CSTs, it was found that the two groups did not differ in gestational age at the time of the test or at delivery, nor did the mean Apgar scores differ. Mean birth weight in the smooth pattern group was significantly lower, but not enough to increase the overall incidence of small for gestational age infants significantly. It is noteworthy that Sadovsky *et al.*[7] found that almost half of the infants with the 'movements alarm signal' were small for dates.

Acceleration patterns are seldom demonstrated during a positive CST. When they are observed, factors that could cause a false positive CST, such as supine hypotension syndrome or uterine overstimulation, should be excluded. Induction of labour should be carefully evaluated. Performing primary caesarean section for patients with acceleration patterns is to be discouraged, because many of these occur in a false positive CST, and in these cases fetal distress rarely develops during labour.

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