Acta Genet Med Gemellol 40: 373-381 (1991)

Received 16 May 1991
Final 16 September 1991

Discordant Twins: Acid-Base Status

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Abstract. A prospective study was undertaken to determine the effect of twin birth-weight discordancy on Apgar scores and umbilical blood acid-base parameters. Using the paired t-test, small but statistically significant differences were seen in these parameters favoring the heavier twin over its lighter sibling. These differences were also affected by birth order, with the first-born being favored.

Key words: Twins, Birth weight, Umbilical blood gas

INTRODUCTION

Twin birth-weight discordancy has been associated with substantial risk for the lighter twin. A birth-weight difference of $\geq$ 15% has been shown by various investigators to be associated with increased perinatal compromise for the smaller twin [3,11]. Perinatal mortality has been found to be greater in the lighter twin of a discordant pair [6,7]. Several studies have indicated that the lower birth-weight twin of a discordant pair has a slower rate of development than its larger stibling [2,4,9,14]. It has even been reported that the larger twin has better social behavior than the smaller one [10].

In our previous twin pregnancy studies [13,16], significant differences at birth in twin blood-gas parameters favoring the first-born twin were noted. It was also observed that neither gestational age, presentation nor route of delivery had any effect on these differences. This study was undertaken to determine the effect of another clinical variable, weight discordancy, on twin blood-gas parameter differences.

MATERIALS AND METHODS

A prospective study of all twin births was initiated in 1979, resulting in the present study of 183 sets. The degree of discordancy (birth-weight difference between the lighter and

heavier twin) was computed for all twin pairs using the larger twins as 100%. The twin sets were then divided into a concordant group, with a birth-weight difference (BWD) of $< 15\%$, a discordant group with a BWD $\geq 15\%$, as well as an additional group of still greater discordancy, BWD $\geq 20\%$. In each of the groups, the heavier twin was compared with the lighter twin for weight and Apgar score at 1 and 5 minutes, as determined by a pediatrician not involved in the study. A comparison was also made for umbilical venous and arterial blood parameters obtained after cord clamping with delivery of the twins. Blood was drawn with a 21-gauge needle and plastic syringe. The samples were analyzed immediately, or placed in vacuum tubes in an ice bath, and analyzed within 20 minutes of being obtained so that no significant effect of delay occurred. Blood samples were analyzed for pH, pO_2, pCO_2, bicarbonate, and base excess with a Corning 165 analyzer, and for lactic acid concentration with an enzymatic electrochemical method previously described by our laboratory [1]. Statistical analysis was carried out by the paired t-test with $\alpha < 0.05$ considered statistically significant.

RESULTS

A comparison of Apgar scores at 1 and 5 minutes and umbilical venous and arterial blood parameters as a function of birth order in the concordant group (BWD $< 15\%$) shows statistically significant differences favoring the first-born in the 1-minute Apgar score, umbilical venous and arterial pO_2, pCO_2 and bicarbonate, as well as in the umbilical vein pH, and arterial base excess (Table 1). In the discordant group (BWD $\geq$ 15%), the same trend in favor of the first-born, twin A, was evident with statistically significant differences noted in the 1- and 5-minute Apgar scores, umbilical venous and arterial pO_2 and the umbilical arterial pCO_2 (Table 1). At still higher levels of discordancy (BWD $\geq 20\%$) again all the parameters favored the first-born with statistically significant differences achieved in the 1- and 5-minute Apgar scores, umbilical venous pO_2 and umbilical arterial pCO_2, bicarbonate, and base excess (Table 2).

In the analysis of discordant twin pairs by birth order (Tables 1 and 2), the number of lighter first-born is approximately equal to the number of heavier first-born (23 lighter and 23 heavier first-born in the 15% discordancy group, and 11 lighter and 13 heavier first-born in the 20% discordancy group). Therefore, in the discordant twin pairs the average weight of the twins born first is not significantly different from the average weight of the twins born second. As a result, the effects of birth-weight discordancy may be masked, and the twin differences noted may primarily reflect birth order effects.

To segregate the impact of birth-weight discordancy from birth-order effects on twin Apgar scores and acid-base differences, the discordant and concordant groups were further subdivided into those cases in which the lighter twin was the first-born and those in which it was the second-born. For the discordant twin pairs (BWD $\geq 15\%$) when the lighter twin was the first-born, no significant differences were evident between the twin siblings. However, for those cases in which the lighter twin was the second-born, statistically significant differences in favor the heavier first-born were seen in the 1- and 5-minute Apgar scores, umbilical venous and arterial pH, pO_2, pCO_2 and Bicarbonate (Table 3). Similar results were seen when twins of even greater discordancy, BWD $\geq 20\%$,

Table 1 - Concordant (BWD < 15%) and discordant twins (BWD ≥ 15%): Comparison of Apgar scores and acid-base factors for first born (twin A) and second born (twin B)

Parameter	No. of sets	Twin A		Twin B		p[a]
		Mean	SD	Mean	SD	
Concordant twins						
BWD < 15% (Mean 7.3%, SD 4.1%)						
Weight (g)	137	2484	592	2464	572	
1-min Apgar score	136	7.6	1.6	7.3	2.0	<.05
5-min Apgar score	136	8.7	0.9	8.6	1.2	
Umbilical venous						
pH	132	7.33	0.07	7.32	0.07	<.01
pO_2 (mm Hg)	129	29.7	8.0	25.2	8.4	<.001
pCO_2 (mm Hg)	129	39.1	8.7	42.4	8.8	<.001
Bicarbonate	80	20.6	3.2	21.3	2.9	<.05
Base excess	87	−4.8	3.6	−4.7	3.2	
Lactate (mmol/l)	77	2.67	1.56	2.72	1.39	
Umbilical arterial						
pH	121	7.28	0.07	7.27	0.06	
pO_2 (mm Hg)	113	20.1	7.3	16.0	6.3	<.001
pCO_2 (mm Hg)	115	43.2	10.7	48.2	12.0	<.001
Bicarbonate	74	20.1	5.7	22.2	4.8	<.001
Base excess	81	−6.0	4.8	−5.1	3.6	<.05
Lactate (mmol/l)	70	2.59	1.24	2.75	1.42	
Discordant twins						
BWD ≥ 15% (Mean 22.1%, SD 6.4%)						
Weight (g)	46	2308	615	2308	686	
1-min Apgar score	46	7.5	1.9	6.3	2.5	<.01
5-min Apgar score	46	8.7	0.8	8.1	1.6	<.01
Umbilical venous						
pH	45	7.32	0.05	7.30	0.07	
pO_2 (mm Hg)	41	30.8	7.8	25.4	6.9	<.01
pCO_2 (mm Hg)	43	39.2	7.3	42.3	10.6	
Bicarbonate	24	20.6	4.7	22.0	5.0	
Base excess	26	−4.4	4.4	−3.6	4.1	
Lactate (mmol/l)	23	2.47	1.00	2.81	1.65	
Umbilical arterial						
pH	37	7.28	0.06	7.26	0.07	
pO_2 (mm Hg)	33	19.8	6.8	16.2	6.7	<.05
pCO_2 (mm Hg)	34	44.2	12.0	50.7	12.0	<.01
Bicarbonate	21	21.4	6.3	23.6	6.2	
Base excess	24	−4.8	6.0	−3.1	5.5	
Lactate (mmol/l)	20	2.46	0.94	2.69	1.08	

[a] Blanks indicate nonsignificant p values.

https://doi.org/10.1017/S0001566000003561 Published online by Cambridge University Press

Table 2 - Discordant twins with BWD ≥ 20%. Comparison of Apgar scores and acid-base factors for first born (twin A) and second born (twin B)

Parameter	No. of sets	Twin A		Twin B		p[a]
		Mean	SD	Mean	SD	
Discordant twins						
BWD≥20% (Mean 27.2%, SD 5.4%)						
Weight (g)	24	2164	587	2130	652	
1-min Apgar score	24	7.1	2.1	5.8	2.7	<.05
5-min Apgar score	24	8.6	0.6	7.8	2.02	<.05
Umbilical venous						
pH	24	7.30	0.05	7.29	0.08	
pO_2 (mm Hg)	22	31.2	7.7	24.0	6.1	<.01
pCO_2 (mm Hg)	24	38.6	8.5	42.9	10.5	
Bicarbonate	11	19.1	5.3	21.5	5.4	
Base excess	13	−5.6	4.6	−3.9	3.9	
Lactate (mmol/l)	13	2.64	1.00	3.12	1.91	
Umbilical arterial						
pH	19	7.26	0.07	7.25	0.05	
pO_2 (mm Hg)	18	20.4	7.3	16.5	8.0	
pCO_2 (mm Hg)	18	43.8	12.4	52.1	9.6	<.01
Bicarbonate	9	19.9	7.1	24.7	3.9	<.05
Base excess	11	−6.8	6.7	−2.3	3.3	<.05
Lactate (mmol/l)	10	2.75	0.87	2.81	1.01	

[a] Blanks indicate nonsignificant p values.

were analyzed (Table 4). Again, in those cases in which the lighter twin was the first-born, no significant differences were evident between the twin siblings. However, when the lighter twin was the second-born, statistically significant differences in favor of the heavier first-born were seen in the 5-minute Apgar score, umbilical venous pO_2 and arterial pH, PO_2, pCO_2 and bicarbonate.

In the concordant twin group where the weights of the twin pairs are comparable, significant differences in the umbilical venous and arterial blood parameters in favor of the first-born were noted, regardless of whether it was the slightly heavier or lighter twin of the pair (Table 5).

DISCUSSION

The present study indicates that twin birth-weight discordancy, together with birth order, have a combined impact on the differences in umbilical blood gas acid-base parameters and Apgar scores between twin siblings at birth. The birth-order effects

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Table 3 - Discordant Twins (BWD ≥ 15%). Comparison of Apgar scores and acid-base factors: Cases for twin A the lighter twin, and cases for twin A the heavier twin

Parameter	No. of sets	Twin A		Twin B		p[a]
		Mean	SD	Mean	SD	
Twin A lighter and Twin B heavier						
BWD≥15% (Mean 22.0%, SD 6.6%)						
Weight (g)	23	2043	596	2627	739	<.001
1-min Apgar score	23	7.0	2.0	6.0	2.4	
5-min Apgar score	23	8.6	1.0	8.0	1.9	
Umbilical venous						
pH	23	7.30	0.05	7.29	0.08	
pO_2 (mm Hg)	21	28.8	8.4	26.1	7.4	
pCO_2 (mm Hg)	21	41.6	7.5	42.6	11.2	
Bicarbonate	12	22.0	5.2	22.2	6.4	
Base excess	13	−3.5	5.0	−3.0	5.3	
Lactate (mmol/l)	13	2.64	1.02	3.05	1.86	
Umbilical arterial						
pH	19	7.25	0.07	7.26	0.07	
pO_2 (mm Hg)	16	17.6	7.3	16.8	6.8	
pCO_2 (mm Hg)	16	45.2	15.0	49.2	13.8	
Bicarbonate	11	21.1	8.5	23.9	8.2	
Base excess	12	−5.8	8.2	−2.6	7.5	
Lactate (mmol/l)	10	2.58	1.13	2.69	0.83	
Twin A heavier and Twin B lighter						
BWD≥15% (Mean 22.8%, SD 6.5%)						
Weight (g)	23	2574	520	1990	451	<.001
1-min Apgar score	23	7.9	1.6	6.5	2.6	<.05
5-min Apgar score	23	8.9	0.5	8.3	1.2	<.05
Umbilical venous						
pH	22	7.34	0.04	7.31	0.06	<.01
pO_2 (mm Hg)	20	33.0	6.6	24.6	6.5	<.001
pCO_2 (mm Hg)	22	36.9	6.5	42.0	10.2	<.05
Bicarbonate	12	19.2	3.8	21.7	3.3	<.05
Base excess	13	−5.3	3.8	−4.3	2.5	
Lactate (mmol/l)	10	2.24	0.91	2.51	1.36	
Umbilical arterial						
pH	18	7.30	0.04	7.26	0.06	<.005
pO_2 (mm Hg)	17	21.8	5.9	15.6	6.8	<.01
pCO_2 (mm Hg)	18	43.3	8.9	52.0	10.3	<.001
Bicarbonate	10	21.8	3.0	23.4	3.4	<.05
Base excess	12	−3.8	2.5	−3.7	2.6	
Lactate (mmol/l)	10	2.33	0.75	2.70	1.34	

[a] Blanks indicate nonsignificant p values.

https://doi.org/10.1017/S0001566000003561 Published online by Cambridge University Press

Table 4 - Discordant twins (BWD ≥ 20%). Comparison of Apgar scores and acid-base factors: Cases for twin A the lighter twin, and cases for twin A the heavier twin

Parameter	No. of sets	Twin A		Twin B		p[a]
		Mean	SD	Mean	SD	
Twin A lighter and Twin B heavier BWD≥20% (Mean 27.4%, SD 6.0%)						
Weight (g)	11	1806	404	2521	674	<.001
1-min Apgar score	11	6.7	2.2	5.9	2.8	
5-min Apgar score	11	8.5	0.7	7.7	2.6	
Umbilical venous						
pH	11	7.29	0.06	7.27	0.10	
pO_2 (mm Hg)	11	29.2	7.4	25.0	6.8	
pCO_2 (mm Hg)	11	41.0	9.2	44.2	11.7	
Bicarbonate	5	20.6	6.2	20.9	6.9	
Base excess	6	–4.6	5.5	–3.5	5.1	
Lactate (mmol/l)	8	2.99	1.02	3.47	2.24	
Umbilical arterial						
pH	9	7.22	0.08	7.26	0.05	
pO_2 (mm Hg)	8	17.9	7.4	18.6	9.1	
pCO_2 (mm Hg)	8	44.8	16.5	50.3	9.4	
Bicarbonate	5	18.2	9.4	24.1	5.3	
Base excess	6	–9.2	8.6	–2.0	4.5	
Lactate (mmol/l)	6	2.99	0.95	2.94	0.90	
Twin A heavier and Twin B lighter BWD≥15% (Mean 22.8%, SD 6.5%)						
Weight (g)	13	2466	554	1800	422	<.001
1-min Apgar score	13	7.5	2.1	5.8	2.8	
5-min Apgar score	13	8.7	0.6	7.8	1.4	<.05
Umbilical venous						
pH	13	7.32	0.03	7.30	0.06	
pO_2 (mm Hg)	11	33.3	7.8	22.9	5.5	<.01
pCO_2 (mm Hg)	13	36.6	7.7	41.8	9.8	
Bicarbonate	6	17.8	4.5	22.0	4.5	
Base excess	7	–6.5	4.0	–4.2	3.0	
Lactate (mmol/l)	5	2.10	0.71	2.56	1.23	
Umbilical arterial						
pH	10	7.29	0.04	7.24	0.06	<.05
pO_2 (mm Hg)	10	22.5	6.9	14.8	7.0	<.05
pCO_2 (mm Hg)	10	43.0	8.7	53.5	10.1	<.01
Bicarbonate	4	22.1	2.4	25.6	1.3	<.05
Base excess	5	–4.0	2.0	–2.7	1.4	
Lactate (mmol/l)	4	2.39	0.71	2.61	1.28	

[a] Blanks indicate nonsignificant p values.

https://doi.org/10.1017/S0001566000003561 Published online by Cambridge University Press

Table 5 - Concordant twins (BWD < 15%). Comparison of Apgar scores and acid-base factors: Cases for twin A lighter than twin B, and cases for twin A heavier than twin B

Parameter	No. of sets	Twin A		Twin B		p[a]
		Mean	SD	Mean	SD	
Twin A lighter than Twin B						
BWD < 15% (Mean 7.2%, SD 4.3%)						
Weight (g)	62	2329	534	2513	581	<.001
1-min Apgar score	61	7.4	1.7	7.1	2.4	
5-min Apgar score	61	8.6	1.0	8.4	1.5	
Umbilical venous						
pH	59	7.32	0.08	7.31	0.08	
pO_2 (mm Hg)	57	28.6	8.4	24.9	8.5	<.005
pCO_2 (mm Hg)	57	39.0	9.5	43.3	10.0	<.01
Bicarbonate	39	20.5	3.6	21.3	2.7	
Base excess	41	−4.8	3.8	−4.7	3.2	
Lactate (mmol/l)	31	2.88	1.71	2.94	1.48	
Umbilical arterial						
pH	54	7.27	0.07	7.26	0.07	
pO_2 (mm Hg)	49	18.8	7.0	16.2	6.8	<.05
pCO_2 (mm Hg)	51	42.6	12.0	47.7	14.4	<.005
Bicarbonate	35	20.3	6.3	22.2	5.5	<.05
Base excess	36	−6.5	5.2	−5.5	3.2	
Lactate (mmol/l)	29	2.67	1.38	2.87	1.67	
Twin A heavier than Twin B						
BWD < 15% (Mean 7.2%, SD 4.1%)						
Weight (g)	75	2612	609	2424	565	<.001
1-min Apgar score	75	7.8	1.6	7.4	1.8	<.05
5-min Apgar score	75	8.8	1.0	8.7	0.8	
Umbilical venous						
pH	73	7.34	0.06	7.32	0.06	<.005
pO_2 (mm Hg)	72	30.6	7.6	25.5	8.4	<.001
pCO_2 (mm Hg)	72	39.1	8.1	41.6	7.8	<.005
Bicarbonate	41	20.7	2.8	21.2	3.1	
Base excess	46	−4.7	3.4	−4.7	3.3	
Lactate (mmol/l)	46	2.54	1.46	2.56	1.32	
Umbilical arterial						
pH	67	7.29	0.07	7.28	0.06	
pO_2 (mm Hg)	64	21.2	7.4	15.9	5.9	<.001
pCO_2 (mm Hg)	64	43.6	9.5	48.5	9.6	<.001
Bicarbonate	39	20.0	5.2	22.2	4.1	<.005
Base excess	45	−5.6	4.4	−4.8	3.8	
Lactate (mmol/l)	41	2.54	1.14	2.66	1.22	

[a] Blanks indicate nonsignificant p values.

https://doi.org/10.1017/S0001566000003561 Published online by Cambridge University Press

favors the first-born, and the weight discordancy favors the heavier twin. Therefore, these effects are additive when the first-born is the heavier twin, and tend to cancel when the first-born is the lighter twin. As a result, in discordant twin pairs, only the heavier first-born shows a small, but statistically significant, favored acid-base status.

As we postulated in our previous report [16], the birth-order effects may be caused by the reduced uterine size after-delivery of the first twin, which may result in decreased intervillous blood flow, and less respiratory exchange between the second fetus, still in utero, and its placenta. Additionally, placental function or perfusion might be affected by clamping the umbilical cord of the first twin, as shown in singleton pregnancies [12].

The cause of the negative effect of weight discordancy on the lighter twin is not clear. It has been postulated that the observed differences in discordant twin pairs may be due to "intrauterine impoverishment" for the lower birth-weight twin, due to a reduction in nutrients and oxygen flow from the maternal supply line [4,8]. A higher incidence of neonatal hypoglycemia in the smaller twin of the discordant pair supports this concept of unequal nourishment [6,15]. This inequality of maternal supply to the lighter twin may be due to factors such as preexisting differences in blood flow to the placental implantation site, disproportionate sharing of the placental mass, or as has been suggested, placental crowding [5].

CONCLUSIONS

This study demonstrates that discordant twins exhibit Apgar score and umbilical blood-gas acid-base differences which favor the heavier twin of a discordant pair. Birth order also affects these differences, with the first-born being favored. These two effects are additive when the first-born is the heavier twin, and tend to cancel when the first-born is the lighter twin. The relationship, if any, of these small differences with the noted dissimilarities in the developmental pattern of discordant twins requires further study.

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