Early Clamping Versus Stripping of Cord: Comparative Study of Electrocardiogram in Neonatal Period*

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In 1949, McCausland, Holmes, and Schumann reported that 38 per cent of 1198 of diplomates from the American Board of Obstetrics and Gynecology stripped the cord at least some of the time. A year earlier some fear had been voiced of the possible danger of expressing tissue juices or particles into the blood, but the procedure was subsequently accepted as safe (McCausland, Holmes, and Schumann, 1950). Data are not available on how many diplomates are now stripping the cord, though there is no apparent reason why this procedure should have fallen into disfavour.

Studies comparing the effects of stripping and immediate clamping of the cord differ considerably in technique and not unexpectedly in results. However, significant differences in blood volume (Whipple, Sisson, and Lund, 1957), erythrocyte count (McCausland *et al.*, 1949; Siddall, Crissey, and Knapp, 1952; Colozzi, 1954), plasma volume (Usher, Shephard, and Lind, 1963), haemoglobin (Siddall *et al.*, 1952; Siddall and Richardson, 1953; Colozzi, 1954; Lanzkowsky, 1960), haematocrit (Usher *et al.*, 1963), and erythrocyte volume (Usher *et al.*, 1963) have been reported, some of these differences still being present on the 7th day of life.

Comparison of the electrocardiographic effects of these procedures has not been made, though the characteristics of the electrocardiogram during the first week of life in 31 infants whose cords were clamped within 4 seconds after delivery have been reported. The findings in these infants were also compared with findings in infants with late clamping of the cord (3–5 minutes). Early clamped infants had significantly shorter intervals (P duration, P–R segment, P–R, QRS, Q–Tc), lower amplitude

deflections (PII, QV6, RV6, SV6), and earlier inversion of TV1 than late clamped infants (Walsh, 1968b).

To assess these differences further, serial tracings of these early clamped infants were compared with those of a few infants with stripped cords.

SUBJECTS AND METHODS

After delivery onto a tray about 20 cm. below the mother's perineum, the cord was vigorously stripped 10 times for 5 minutes in 6 infants, one of whom was an identical twin (birthweight 2340 g., length 46 cm., gestation 39 weeks). The infant became quite cyanotic after this procedure and was transferred to the nursery for observation a few hours later. Her twin sister (birthweight 2420 g., length 46 cm.) was delivered 7 minutes later and the cord was clamped late, i.e. after cessation of pulsations.

Birthweight of the other 5 infants ranged from 2630–5710 g., length from 47.5–55 cm., and gestational age from 38–42 weeks. Three were boys. The mothers were either para 1 or 2. Their ages ranged from 22–32 years. One received no analgesia or anaesthesia while the others were given intermittent nitrous oxide and oxygen or trichloroethylene for a short time before and during delivery.

Electrocardiograms were recorded with a 4-channel jet writer at a paper speed of 100 mm./sec. at mean ages of 8 minutes, 2 hours 40 minutes, 22 hours, and 6 days. A magnification of 5× was used for making measurements.

There were 31 infants with early clamping of the cord, i.e. clamping within 4 seconds of delivery of the feet. They were the products of spontaneous singleton delivery in cephalic presentation with minimal or no maternal analgesia or anaesthesia. Electrocardiograms were recorded with the same instrument at mean ages of 10 minutes, 3 hours, 25 hours, and 6 days, and measurements were made in the same manner. Data on these infants have been reported elsewhere (Walsh, 1968a, b).

Received July 12, 1968.

* Supported by grants from the National Institutes of Health, American Heart Association, and Association for Aid to Crippled Children.

FIG. 1.—Serial electrocardiographic findings in 31 infants with immediate clamping of the cord (light lines) and in 6 infants with vigorous stripping of the cord (heavy lines) during the first week of life. Mean (—, —), SE (x), and SD (X) are shown. Note higher P amplitude (Pamp), longer P-R and Q-Tc intervals particularly on the first day of life in infants with stripping. ● Individual values in infants with stripping; ⊙ 45-minute old infant not included in mean.

RESULTS

Heart rate, electrocardiographic intervals (P duration, P-R segment, Macruz index (P duration/P-R segment), P-R, QRS, Q-Tc), and deflections (PII, QV1, V6, RV1, V6, SV1, V6, R/SV1, V6, TV1, V6) were compared in infants with early clamping (EC) and stripping (SC) of the cord. No differences in mean and distribution of values were noted in heart rate, P-R segment, QRS interval, SV1, V6, and QV6 during the first week of life.

On the other hand, P duration, Macruz index, P-R, and Q-Tc intervals were longer in SC than in EC infants. Differences in duration of the P wave and P-R interval were more marked at 10 minutes (mean and S.E. (msec.) P dur.: SC 81 ± 5.1 , EC 58 ± 1.6 ; P-R int.: SC 125 ± 6.45 , EC 97 ± 2.5) and at 3 hours of age (P dur.: SC 71 ± 7.9 , EC 58 ± 1.7 ; P-R int.: SC 116 ± 7.3 , EC 100 ± 2.2), while the Macruz index was greater throughout the week. Thus, mean values in stripped cord infants at 10 minutes and 6 days were 1.95 and 1.38 as compared to 1.63 and 1.01 in early clamped infants. Two stripped cord infants at 3 hours of age had ratios of 2.5 and 2.7, which were greater than in any of the 31 early clamped infants of comparable

age (maximum 2.3). The greater ratio was probably due to relative prolongation of P wave duration without corresponding increase in duration of the P-R segment. The Q-Tc interval was longer in some infants at 3 hours of age (SC 444 ± 16.5 , EC 409 ± 6.0) (Fig. 1).

Moreover, differences in P wave amplitude, R/S ratio, and direction of T waves in V1 and V6 were also noted. Thus, P wave amplitude was not only higher initially in stripped cord infants (mean and S.E. (mV) stripped cord 0.175 ± 0.03 , early clamped 0.10 ± 0.008), but the difference increased at the end of the week (stripped cord 0.20 ± 0.022 , early clamped 0.075 ± 0.007) and all values either equalled or exceeded the maximum (0.15 mV) recorded in early clamped infants (Fig. 1). The R/S ratio in V1 and V6 was lower in stripped than in clamped infants. The difference was greater in V1 and on the first day of life. Fig. 2 shows the median and quartiles (o) of the 31 early clamped infants and the median and individual values (●) of the stripped cord infants during the week. At 10 minutes old, all 4 values in the latter infants were either equal to or less than the 25 per cent quartile of 1.29 in the early clamped infants; at 3 hours, 3 of 6 stripped cord

FIG. 2.—R/S and T in leads V1 and V6 in 31 infants with immediate clamping of the cord (light lines) and in 6 infants with stripping of the cord (heavy lines) during the first week of life. The median (—) and quartiles (○) are shown in early clamped infants and median (—) and individual values (●) in stripped cord infants for the R/S; the mean, SE, and SD are shown for the T wave. Note lower R/S ratios and delayed inversion of TV1 in infants with stripping.

infants had values below the minimum (0.60) in early clamped infants. This was due to a lower amplitude R wave in both leads, particularly at 3 hours old in the stripped cord (RV1: SC (mean) 13.7, EC 22.3 ± 1.4 ; RV6: SC 3.8, EC 8.5 ± 0.8), though this was still evident at 6 days (RV1: SC 13.7, EC 19.3 ± 1.0 ; RV6: SC 7.2, EC 8.2 ± 0.7). Differences in amplitude of T waves were noted at 2 days old when the mean amplitude of the T wave was more positive in V1 (SC 3.6 ± 1.15 , EC -0.4 ± 0.4) and more negative in V6 in SC than in EC infants (SC 0.25 ± 0.6 , EC 1.4 ± 0.2). The tracings obtained on the identical twins show some of these features (Fig. 3).

DISCUSSION

There is a considerable difference in blood volume between infants whose cords are clamped within 4 seconds of delivery and infants whose cords are vigorously stripped 10 times for 5 minutes. This has been shown by Usher *et al.* (1963) who found at 30 minutes of age that the mean blood volume was 78 ml./kg. in infants with early clamping (within 22 seconds of delivery) and 100.9 ml./kg. in infants with the cord stripped 10 times for 5 minutes ($p < 0.001$). If both clamping and blood volume determinations had been done earlier, the difference undoubtedly would have been greater. No significant difference in volume of transfusion was found between infants with delayed clamping at 5 minutes and infants with stripping. However, the more

rapid the increase in blood volume, the more severe the effects, and vigorous stripping of the cord must significantly accelerate transfer of blood. It is therefore not surprising that the infants in the present study were more cyanotic, more irritable, and tachypnoeic than a large group of late clamped infants studied in this laboratory. The difference was particularly noteworthy in the identical twins, one of whom had stripping and the other late clamping of the cord. As about 50 per cent of identical twins have electrocardiograms of close similarity (Wise, Comeau, and White, 1939), it is of interest that the tracings of these infants were alike, apart from certain features that appear to be more characteristic of a larger and more rapid placental transfusion at this age.

This study further confirms earlier findings that the amount of the transfusion received at birth significantly influences the neonatal electrocardiogram. In contrast to infants with immediate clamping of the cord, i.e. within 4 seconds of delivery, vigorous stripping of the cord results in increased amplitude and duration of the P wave, increased duration of the P-R and Q-T intervals, lower amplitude R waves in leads from the right and left praecordium, with consequently lower R/S ratios and delayed inversion of T waves in V1. These differences are particularly striking on the first day of life, but in the case of the P wave amplitude and R/S ratio in V1 persist until the end of the week.

FIG. 3.—(a) Tracing recorded in twin A at 2 hours after stripping the cord. (b) Tracing recorded in twin B at 3½ hours after late clamping of the cord. Note high amplitude P, slightly longer P duration, low amplitude R waves in precardial leads, and isoelectric T waves in twin A.

In normal newborn infants aged 27 hours or less, taller P waves and upright T waves in right precardial leads are associated with higher pulmonary arterial pressure, while an R/S ratio less than 1 in right precardial leads is present only in infants with a left-to-right shunt through the ductus arteriosus (Emmanouilides, Moss, and Adams, 1965). Moreover, late clamped infants have higher atrial pressures during the first hour, higher pulmonary arterial pressure during the first 9 hours, and higher systemic pressures for as long as 24 hours after birth than early clamped infants (Arcilla *et al.*, 1966). In accord with the findings reported here, these authors were also unable to find any difference in heart rate between these two groups, while Arcilla and Lind (1965) noted that the S1–S2/ $\sqrt{R-R}$ interval was significantly longer during the first 3 hours of life in late clamped infants.

Experimental production of hypervolaemia in erythroblastotic infants shows that addition of approximately 25 per cent of estimated total blood volume has little effect on heart rate, but causes increases in right heart filling pressure (10 mm. Hg above initial value), systemic pressure (20–25%), and pulmonary artery pressure (100%—but determined in only 2 cases (Wallgren, Barr, and Rudhe, 1964)). Though the results of vigorous stripping of the cord may not be identical with those from experimental studies in infants aged 11 hours or more with erythroblastosis, it seems likely that stripping the cord induces acute expansion of the blood volume, and that the foramen ovale and ductus arteriosus act as escape outlets and prevent acute right ventricular overload. Though this mechanism averts more serious consequences, the electrocardiographic findings are compatible with a delay in fall of pulmonary artery pressure and closure of the ductus arteriosus.

CONCLUSION

Comparison is made of serial electrocardiograms of 31 infants with early clamping of the cord and 6 infants with vigorous stripping of the cord. Infants with stripping have considerably longer electrocardiographic intervals, higher amplitude P waves, lower R/S ratios in V1 and V6, and delayed inversion of the T wave in V1. Possible genesis of these findings is discussed.

I am indebted to Professor John Lind for having stripped the cords and for his help and advice in other aspects of this study. The technical assistance of Mrs. Siv Lundqvist and Mrs. Noella Bickham is gratefully acknowledged.

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