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Procedural Pain Heart Rate Responses in Massaged Preterm Infants

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Abstract

Heart rate (HR) responses to the removal of a monitoring lead were assessed in 56 preterm infants who received moderate pressure, light pressure or no massage therapy. The infants who received moderate pressure massage therapy exhibited lower increases in HR suggesting an attenuated pain response. The heart rate of infants who received moderate pressure massage also returned to baseline faster than the heart rate of the other two groups, suggesting a faster recovery rate.

Preterm infants are repeatedly exposed to painful procedures (Simons, van Dijk, Anand et al., 2003), and repeated exposure to pain during early infancy can affect the development of the nervous system (Grunau, 2000). Although analgesics have been recommended for severe pain in neonates (Anand, 2001), non-pharmacological interventions are being explored for managing the mild to moderate pain associated with routine procedures (Leslie & Marlow, 2006). Phlebotomists typically rub the infant's heel prior to a heel lance procedure, for example, but massaging of that kind is rarely used with other preterm infant care procedures. Here, we report serendipitous findings on responses to a mildly painful/ stressful procedure (surgical tape removal) on a sample of preterm infants randomly assigned to receive moderate pressure massage therapy versus light pressure massage therapy or a standard care control group.

Methods

Participants

The participants were a subsample of infants from an ongoing study assessing the mechanisms underlying weight gain in preterm infants following massage therapy. Medically stable preterm infants recruited from a Neonatal Intensive Care Unit were randomly assigned to a moderate pressure, light pressure or no massage therapy group. The sample was comprised of 56 infants distributed 57% male and 59% Hispanic, 30% African American and 11% Caucasian. Their mean birthweight was 1212 grams (range 560-2105 grams), their mean gestational age at birth was 29.8 weeks (range 22-35 weeks) and their corrected gestational age at study entry was 34.7 weeks (range 29.8-40.1 weeks). The groups did not differ on these background variables (see table 1).

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Procedure

Massage therapy was provided at approximately the same time of day for all infants (one hour after their mid-morning feeding) by therapists trained on the protocol. The moderate pressure massage therapy consisted of the 15-minute protocol used in many preterm infant weight gain studies (Field, Diego & Hernandez-Reif, 2007). The light pressure massage therapy followed the same protocol as the moderate pressure massage therapy protocol with the exception that light pressure stroking (e.g., no skin color change in a Caucasian baby or indentations in skin for all infants) was used during the first and last five-minute periods of the protocol. The middle five-minute period of kinesthetic stimulation was the same for both groups. The light pressure massage procedure served as a stimulation placebo. Therapists were blind to the hypotheses of this study.

Fifteen minutes prior to the start of the 15-minute treatment period, three disposable silver chloride electrodes were placed across the preterm infant's chest and back to assess EKG, and a temperature probe was attached to the infant's right outer calf using a 1.27cm by 6cm strip of surgical tape (3M, Transpore). Exactly fifteen minutes after the treatment period (1.5Hrs after feeding), with the infant lying supine, the surgical tape used to attach the temperature probe was removed using one smooth continuous movement that lasted approximately 2-seconds. An electrocardiogram recording (EKG) was collected from each infant across the 120-seconds prior to and the 120-seconds following the removal of the surgical tape. A single researcher blind to the infants' treatment group removed the surgical tape for all infants.

EKG data were collected using a UFI Model SRS2004/d-SP Electro-physiology Acquisition System. The EKG signal was filtered between 1Hz and 100Hz, amplified using a gain of 2,000 and sampled at a rate of 1000Hz. Following manual artifact correction, heart rate in beats per minute was calculated from the inter beat intervals of the EKG and used to derive the following dependent variables for each infant: 1) Mean heart rate across the 120-second baseline period ($HR_{Baseline}$); 2) Mean heart rate across the 120-second period following surgical tape removal (HR_{Post}); 3) Maximum heart rate exhibited following surgical tape removal (HR_{max}); and 4) The time lag for heart rate to return to the 95% confidence interval threshold for baseline heart rate following the surgical tape removal ($HR_{recovery}$).

Results

The heart rate of 100% of the infants who participated in this study crossed the 95% confidence interval threshold (mean increase, 11.8 beats per minute, range 6-18 beats per minute) within 5-seconds of the removal of the surgical tape (Mean lag time 3.5 seconds, range 2-5 seconds) (Figure 1). Analyses of variance and effect size (partial η^2) computations followed by post hoc Bonferroni corrected t-tests revealed that preterm infants who received moderate pressure massage therapy 15-minutes prior to surgical tape removal exhibited (Figure 1, Table 1): 1) lower heart rates following the surgical tape removal (HR_{post}), $F(2, 53) = 4.30$, $p = .019$, partial $\eta^2 = .14$, than infants in the control group ($p < .05$); 2) lower HR_{max} values, $F(2, 53) = 7.64$, $p = .001$, partial $\eta^2 = .22$ than infants in the light massage ($p < .05$) or the control group ($p < .05$); and 3) faster $HR_{recovery}$ times, $F(2, 53) = 12.42$, $p < .001$, partial $\eta^2 = .32$, than preterm infants in the light pressure massage ($p < .05$) or control group ($p < .05$). The groups did not differ in their baseline heart rate, $F(2, 53) = 1.86$, $p = .17$, partial $\eta^2 = .07$.

Discussion

Preterm infants exhibited a marked increase in heart rate within 5 seconds of the removal of a surgical tape used to attach a temperature electrode to their right leg, suggesting that this procedure was mildly painful/ stressful. The application and removal of monitoring leads is a

routine procedure that has been identified as potentially painful for preterm neonates (Anand, 2001).

Preterm infants who received 15-minutes of moderate pressure massage therapy 15 minutes prior to the removal of the surgical tape exhibited less of an increase in heart rate than infants who did not receive massage therapy or who received light pressure massage therapy and lower heart rates following the surgical tape removal than infants in the control group. These findings suggest that moderate pressure massage can help attenuate preterm infants' responses to this mildly painful procedure. The heart rate of preterm infants who received moderate pressure massage returned to baseline 27-seconds faster than the heart rate of the other two groups, suggesting a faster recovery rate. Consistent with our findings, other forms of tactile stimulation, including non-nutritive sucking (Carbajal, Chauvet, Couderc, Olivier-Martin, 1999; Stevens, Johnston, Franck et al., 1999) and kangaroo care (Johnston, Stevens, Pinelli et al., 2003; Gray, Watt & Blass, 2000), have been effective in reducing the pain associated with routine procedures administered to preterm infants. The stimulation of pressure receptors may attenuate pain and/or help recovery from a painful stimulus. Future research should explore whether moderate pressure massage is effective in reducing pain associated with other common medical procedures by assessing not only heart rate responses but also stress hormone (cortisol) and behavioral responses.

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Figure 1. Mean heart rate (in beats per minute) collected 120 seconds prior to and 120 seconds following the removal of a surgical tape from infants randomly assigned to a moderate pressure massage, light pressure massage and standard care control group.

Table 1

Demographic characteristics (Standard deviations in parentheses under means).

	Massage Group		
	Moderate Pressure (N = 20)	Light Pressure (N = 16)*	No Massage (N= 20)
Birthweight	1220.04 (314.01)	1165.38 (230.08)	1277.41 (352.42)
Gestational Age at Birth	29.64 (2.48)	29.96 (1.97)	29.51 (2.47)
Gestational Age at Study Entry	34.48 (2.22)	35.03 (2.41)	34.32 (1.72)
Gender			
Male	55%	60%	56%
Female	45%	40%	44%
Race			
Hispanic	60%	62%	55%
African American	30%	25%	35%
Caucasian	10%	13%	10%

* This sample is smaller because we stopped recruiting preterm infants into the light pressure massage therapy group due to ethical considerations when we discovered that these infants gained significantly less weight than infant receiving moderate pressure, massage and they also showed tachygastria following the light pressure massage.

Table 2

Means (and standard deviations in parentheses) for 1) mean baseline heart rate (in beats per minute), HR_{Baseline} ; 2) mean heart rate following surgical tape removal, HR_{Post} ; 3) the difference between mean heart rate at baseline and the maximum heart rate exhibited after surgical tape removal (HR_{max}); and 4) the time (in seconds) that it took for heart rate to return to the baseline 95% confidence interval (HR_{recovery}).

	Massage Group		
	Moderate Pressure (N = 20)	Light Pressure (N = 16)*	No Massage (N = 20)
HR_{Baseline} (BPM)	150.57 (3.13)	149.78 (2.69)	151.70 (3.22)
HR_{Post} (BPM)	154.19 ^a (5.44)	157.41 (4.57)	158.87 (5.28)
HR_{max} (BPM)	10.03 ^b (3.06)	12.33 (1.71)	13.23 (2.59)
HR_{recovery} (Secs)	55.50 ^b (20.89)	84.38 (20.97)	83.00 (18.95)

^a Different than the control group;

^b Different than the control and light massage group.