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# Parental oxytocin responses during skin-to-skin contact in pre-term infants

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ABSTRACT

*Objective:* Maternal skin-to-skin contact (M-SSC) has been found to reduce adverse consequences of prematurity, however, its neurobiological mechanisms have been unknown. The purpose of the study was to examine oxytocin mechanism in modulating parental stress and anxiety during M-SSC and P-SSC (paternal SSC) with their pre-term infants.

*Methods:* Twenty-eight stable pre-term infants and their parents (triads) were recruited in a 2-day cross-over study and 26 mothers and 19 fathers completed the study protocol. Each triad was randomly assigned to one of the two sequences: M-SSC was conducted on day-1 and P-SSC on day-2; and P-SSC on day-1 and M-SSC on day-2. Parents' saliva samples for oxytocin and cortisol assays and visual analog anxiety levels were collected pre-SSC, 30-min during-SSC, and 30-min post-SSC.

*Results:* Both maternal and paternal oxytocin levels were significantly increased during-SSC from baseline. Maternal oxytocin dropped post-M-SSC, but paternal oxytocin continued to be maintained at a higher level during post-P-SSC. Both maternal and paternal cortisol levels significantly decreased during-SSC from baseline. Maternal cortisol continuously dropped post-M-SSC, but paternal cortisol increased post-P-SSC. Both mothers' and fathers' anxiety levels decreased during-SSC from baseline, and then increased post-SSC. Mother–father dyads also showed correlated or synchronized stress and anxiety responses in the NICU.

*Conclusion:* M-SSC and P-SSC activated the oxytocin release and reduced stress and anxiety responses in mothers and fathers of pre-term infants.

*Practice implications:* SSC plays a positive role in early post-partum period and patterns of maternal and paternal bio-behavioral responses to SSC with pre-term infants might be different.



## 1. Introduction

Half a million premature births occur each year in the United States [1]. Pre-term birth is itself a source of stress for parents, with high levels of stress negatively impact parenting behaviors and parenting competence [2]. Furthermore, the placement of a pre-term baby in the NICU, may add to parents' stress in an unfamiliar environment. Physical separation from the newborn is known to increase maternal stress and anxiety [3], and it may have similar effects on the father, but, little is known about paternal stress and anxiety when the newborn is premature.

Skin-to-skin contact (SSC, or Kangaroo Care), has been shown to reduce parental stress and anxiety, but the bio-behavioral mechanism involved are still not well known [4]. Oxytocin (OT) release has been suggested as one of the mediators for these effects and it seems to be critical for optimal parenting of pre-term infants [5]. OT is a mammalian neuropeptide which was originally thought to be a female hormone because of its important roles in birth and lactation. However, the function of the oxytocinergic system has been recently found to play a key role in attachment bond formation and parenting across all mammalian species in both females and males [6]. OT is produced primarily in the supraoptic nucleus and paraventricular nucleus (PVN) of the hypothalamus and is released within the brain both from parvocellular neurons originating in the PVN and from dendrites of magnocellular PVN neurons [5]. OT fibers reach the amygdala, the

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nucleus tractus solitarius, the locus ceruleus, and the vagal motor nucleus of the brain stem to modulate attachment, parenting behaviors, physiologic stability, emotion, anxiety and stress [5]. The oxytocinergic system supports parent–infant interactions by a bio-behavioral feedback loop involving OT: maternal–infant contact and touch stimulates the expression of OT, while the release of OT, in turn, leads to the promotion of increased maternal–infant proximity [7].

Parent–infant touch activates the oxytocinergic system, resulting in release of OT in both animals [8] and humans [9]. SSC between mothers and newborns, a form of parent–infant touch, is hypothesized to activate the oxytocinergic system in both the infant and parent, reducing stress and anxiety. The pain and stress reducing effects of maternal SSC (M-SSC) have frequently been measured in infants [10], but have been studied less in parents, with some indirect evidence of reduction of maternal stress [11], but the effects of paternal SSC (P-SSC) on fathers' stress are largely unknown. The specific aims of this study were to: 1) determine differences in the levels of OT, salivary cortisol, and self-reported anxiety scale before, during, and after M-SSC and P-SSC with hospitalized newborn pre-term infants; and 2) establish relationships between maternal and paternal levels of OT, stress, and anxiety scale during the different phases of SSC.

## 2. Methods

### 2.1. Study design, setting, and participants

A randomized cross-over design was used over a 2-day study period. The mother–father–infant triad was assigned to one of the two study sequences: the M-SSC condition was conducted on day-1 and the P-SSC occurred on day-2; and P-SSC on day-1 and M-SSC on day-2. The order of the sequences for each triad was determined randomly by a computer-program using simple random assignment.

The study was conducted in a level IV NICU in Connecticut. Infant–mother–father triads were recruited using a convenience sampling approach. Inclusion criteria were: male and female stable pre-term infants who were 30 0/7–34 6/7 weeks gestational age at birth and 3–10 days old post-natal age; cared for in an incubator; and either NPO or on bolus feeds to control for feeding effects on cortisol levels. Exclusion criteria were: infants who were intubated and receiving mechanical ventilation; had known congenital anomalies; had severe periventricular/intraventricular hemorrhage (≥ Grade III); or had undergone minor or major surgery. Parents had to be 18 years and older without a history of depression so that the influences on OT [12] and cortisol levels [13] were minimized. Parents' history of depression were based on self-report and maternal medical record.

Power analysis was conducted to determine the sample size. Previous study suggested medium effect sizes for maternal and paternal changes in OT during highly affectionate or stimulatory contact with their infants [14]. A sample of 27 subjects can provide 80% levels of power for M-SSC/P-SSC, to detect such effects when applying one-sided tests at the 5% level of statistical significance.

### 2.2. Study conditions and procedures

The study protocol was approved by the institutional review boards of the participating hospital and university. The research nurse in the NICU identified eligible infants daily, approached potential parents, and obtained consent from both mother and father. The infant–mother–father triad was then randomized to one of the two study sequences i.e., M-SSC on day-1 or P-SSC on day-1 and data collection were done during the same time frame each day.

Sampling time of the day is an important consideration in assessing cortisol and OT levels. For adults, both cortisol and OT may display diurnal patterns of highest in the morning and lowest at midnight [15], therefore, establishing consistency in sampling times was important to reduce "noise" from circadian variation [15]. Study procedures and data collection occurred in the early afternoon on each study day. Based on the individual infant's feeding schedule, the period of 1 to 3 pm is about 1 h following the previous feeding and 1 h before the next feeding, and about 1 h after parents' lunch. Mothers' breast milk pumping was another consideration, therefore, the selection of this time can control for diurnal changes and feeding/eating influences on OT and cortisol responses. Each study condition, M-SSC or P-SSC included three study phases: pre-SSC, during-SSC, and post-SSC. The procedures of each study phase were as follows and shown in Table 1.

#### 2.2.1. Pre-SSC phase (10 min)

The mother or father was asked to arrive at the NICU at least 10 min before SSC and rest in a chair for several minutes. Then his/her saliva sample was collected first, after which he/she was asked to self-rate his/her own anxiety level on a validated visual-analog scale. The infant remained in the incubator during this study phase.

#### 2.2.2. During-SSC phase (30 min)

The mother or father was instructed to hold the infant skin-to-skin for a 30-min period. A 30-min SSC was selected because previous studies have shown that 30 min of SSC is effective in reducing infants' stress and pain response as well as parental stress [16]. 1) *M-SSC condition*: The mother was instructed to dress in a hospital gown opened in the front and move to the La Fuma recliner chair with a footrest especially used for SSC. After she was seated, the chair was reclined. The infant was transferred by the researcher from the incubator into SSC position using a standard transfer technique [17]. The diaper-clad infant was placed on the mother's chest, skin-to-skin and chest-to-chest, in a prone and upright position at an incline of 30–40°. The infant was covered across the back with a blanket and with the mother's cover gown. If the father was present, the father was asked to sit on a chair near the mother–infant pair. A folding screen was placed around the family to ensure their privacy. During the last 5 min of the 30-min M-SSC, maternal saliva was collected, and then the mother was asked to self-rate her anxiety measurement. 2) *P-SSC condition*: The data collection procedure during P-SSC condition was the same as M-SSC, except that the father was holding the infant throughout the SSC. The father's saliva sample and anxiety measurements were similarly obtained during the last 5 min of P-SSC.

#### 2.2.3. Post-SSC phase (30 min)

The infant was transferred back to his/her incubator after 30 min of SSC. The mother or father was asked to dress-back and sit at the side of the incubator within their designated private area for another 30 min. During the last 5 min of the 30-min post-SSC, the mother's or father's saliva was collected, and then they were asked to self-rate their anxiety level.

#### 2.2.4. Saliva collection procedure

Saliva samples from parents were collected using a standard unstimulated passive drool method. Because several components can confound salivary cortisol measurement, the parents were instructed not to eat, drink alcohol, smoke, or exercise 1 h before the data collection. When the mother or father arrived at the NICU, the parent was required to rinse her/his mouth thoroughly with water to remove any food particles. Before saliva collection, any contaminating components in the mouth were visually checked by the study coordinator. To standardize collection for each sample, the parent was asked to reserve saliva in her/his mouth without swallowing for 1 to 2 min. After saliva reservation, with head tilted forward, the parent used a 2-inch plastic drinking straw to expectorate saliva into two pre-chilled 2 mL Cryovials (Salimetrics, State College, PA), which were suspended in a cup of ice throughout the collection process. The Cryovials were then transferred and stored in the −80 °C freezer until assay.