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The Relationship between Sucking Pressure and Respiration during Nutritive Sucking of Normal Newborn Infants

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ABSTRACT

The sucking pressure of 11 low-risk, full-term neonates was observed ultrasonographically with measurement of sucking pressure and monitoring of respiration during nutritive sucking. The development of sucking pressure was closely related to sequential peristaltic movements of the tongue and sequential changes in the volume of the space formed by the tongue, palate, and nipple. We found that sucking pressure develop both during inspiration and expiration with similar frequencies. These findings indicate that sequential tongue movements and the generation of sucking pressure are independent of the respiratory phase during nutritive sucking in neonates.

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Key words : sucking pressure, respiration, ultrasonography

INTRODUCTION

Neonates drinking milk suck 80 to 90 times per minutes and simultaneously breath 40 to 50 times. However, to our knowledge no previous studies have investigated whether sucking pressure for milk swallowing is dependent on respiration. In the present study, to clarify the relationship between the sucking pressure and respiration during nutritive sucking, we used ultrasound, a special device for directly measuring sucking pressure, and a respiratory monitor to noninvasively examine intraoral structures, the sucking pressure pattern, and respiration simultaneously and in real time.

SUBJECTS AND METHODS

The subjects were 11 full-term, breast-fed newborns (7 boys and 4 girls) with a mean gestational age of 40.4±3.1 weeks. Mean birth weight was 3033±243 g. All newborns, except for one boy (born by cesarean section owing to cephalopelvic disproportion), had been delivered transvaginally and Apgar score of at least 8 after 1 minutes. Examinations 6 days after birth revealed no abnormalities.

Real-time ultrasound examination was performed during bottle-fed nutritive sucking in the sagittal planes from the submental aspect with a TOSHIBA SSA-250A apparatus (TOSHIBA Corp., Tokyo) with a mechanical sector scanner and a 5-MHz sector probe. A special device for directly measuring sucking pressure was attached to a type K silicon rubber nipple (Pigeon Corp., Tokyo) and was connected to transducer by a silicon rubber tube that did not flatten with sucking. A respiration pick-up (model 45257, Nihon Denki Sanei, Tokyo) was held in front of the nasal cavity. The transducer and the respiration pick-up were connected to the ultrasound apparatus

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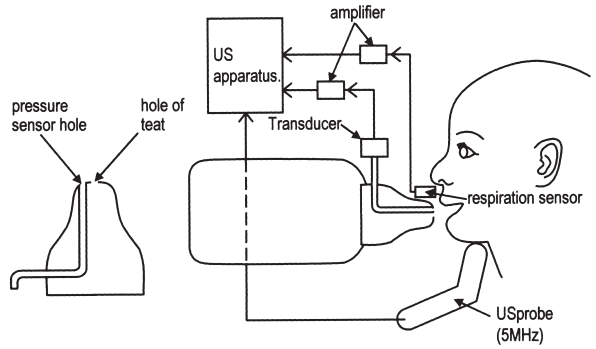

Fig. 1. The schematic view of the system of this study.

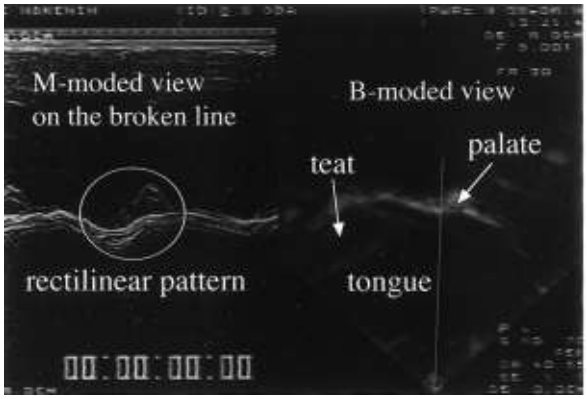

Fig. 2. The rectilinear pattern on M-mode ultrasonography which indicated sequential changes in the volume of the space formed by the tongue, palate, and nipple during nutritive sucking.

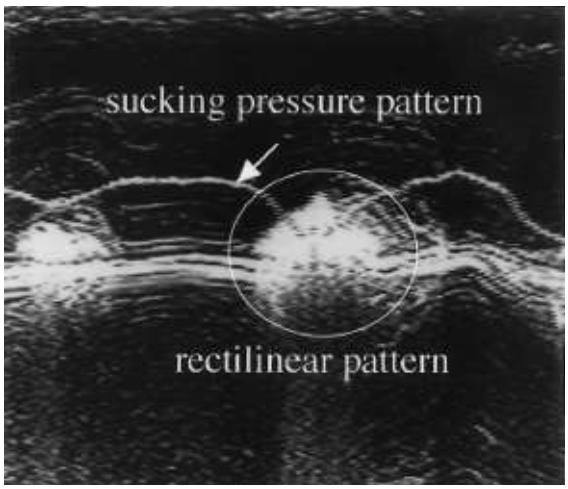

Fig. 3. The relationship between sucking pressure patterns and the rectilinear pattern.

via an amplifier (model 3671-B, Nihon Denki Sanei, Tokyo), and sequential changes in sucking pressure patterns and respiration curves were displayed with real time ultrasonograms (Fig. 1).

This study was approved by the appropriate hospital ethics committee, and the mothers of the subjects gave their consent after having been informed of the purpose and the method of this study.

RESULTS

The following findings were observed in each of the subjects.

1. Peristaltic movements of the tongue were observed on B-mode ultrasonography. First, the anterior portion of tongue pressed the nipple upward, then the medial portion pressed the nipple when the anterior portion moved downward. The posterior portion moved upward, made contact with the palate, and then moved downward and separated from palate.

On M-mode ultrasonography, sequential changes in the distance between the posterior portion of the tongue and the palate appeared as repeated rectilinear patterns on a line including the posterior portion of the tongue and the palate (Fig. 2).

2. Sucking pressure developed and increased shortly before the appearance of the rectilinear pattern when the tongue was in contact with the palate; sucking pressure became weaker shortly after the appearance of the rectilinear pattern when the tongue was separated from the palate and the distance between the tongue and the palate became increased (Fig. 3).

3. Sucking pressure was generated simultaneously with both inspiration and expiration (Fig. 4-a, 4-b, and 4-c). During 5 minutes observation, the mean frequency of sucking was 88.2 per minute and that of respiration was 43.6 per minute. The mean frequencies of the generation of the sucking pressure occurring with inspiration (14.5 per minute) and with expiration (12.2 per minute) did not differ significantly (Student's t-test).

DISCUSSION

Some textbooks of physiology and anatomy state that newborns and young infants can swallow milk during respiration because the larynx is in a higher

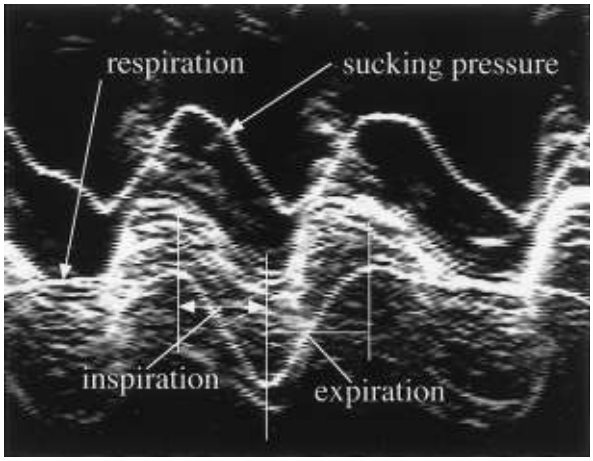

Fig. 4-a. Patterns of inspiration and expiration.

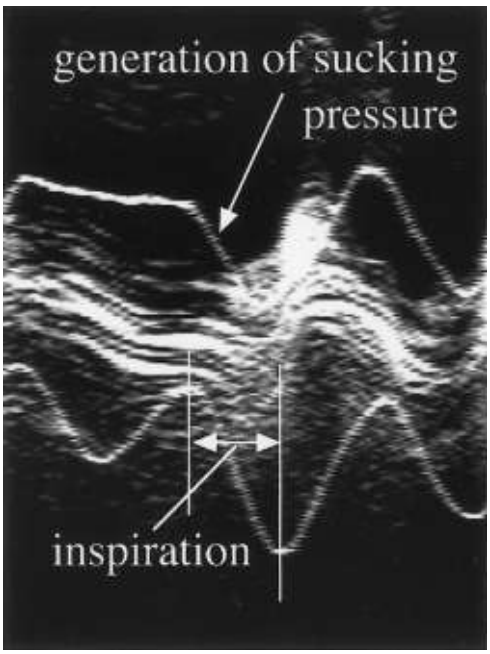

Fig. 4-b. Sucking pressure developed during inspiration.

position than in adults and milk flow and air flow do not interfere with each other in the parynx4. However, these statements are based on the frequent and simultaneous sucking and respiration that can be observed during nutritive sucking by newborns and young infants but is not based on detailed investigations of sucking and respiration. In the present study we simultaneously observed sequential changes in intraoral structures, sucking pressure patterns, and respiratory patterns.

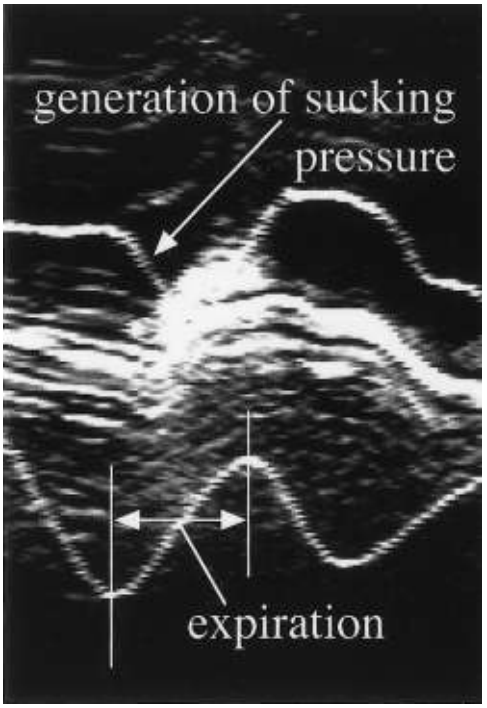

Fig. 4-c. Sucking pressure developed during expiration.

We found that sucking pressure was generated at the same time as respiration and was generated at similar frequencies during inspiration and expiration. These findings indicate that sucking pressure can be generated without any influence from respiration. Further analysis should be done to clarify the relationship between sucking and swallowing in newborns and young infants and to confirm the belief that newborns and young infants can swallow milk during respiration.

References

1. Eishima K. The analysis of sucking behavior in newborn infants. Early Hum Dev 1991 ; 27 : 163-73.
2. Bosma JF, Hepburn LG, Josell SD, Baker K. Ultrasound demonstration of tongue motion during suckle feeding. Dev Med Child Neurol 1990 ; 32 : 223-9.
3. Hayashi Y, Hoashi E, Nara T. Ultrasonographic analysis of sucking behavior of newborn infants : the driving force of sucking pressure. Early Hum Dev 1997 ; 49 : 33-8.
4. Arvedson JC, Brodsky LB. Pediatric swallowing and feeding. San Diego : Singular Publishing Group, 1993.