Original Article

Pain related to breastfeeding in seated and side-lying positions: assessment and recommendations for improved guidance

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Abstract

Purpose: To explore the relationship between breastfeeding positions and pain in the upper arms and shoulders.

Subjects and Methods: Twelve subjects with breastfeeding experience participated in an experiment and survey. In the experiment, subjects embraced two dummy infants with different weights, in six different positions, such as the cradle hold and side-lying hold, while electromyography (EMG) and video were recorded at six sites: the right and left forearms, upper arms, and shoulders. The survey asked for responses to 37 items such as sites where pain was felt during breastfeeding, type of hold during breastfeeding, and guidance received from medical institutions or other advisors.

Results: The 11 subjects who provided valid data were analysed. In training and practice with breastfeeding positions at medical institutions, only two subjects had received guidance on the side-lying hold, but 10 had used it. In terms of the positions of the upper arms in each hold, seven patterns were observed for the side-lying hold. Spearman's rank correlation coefficient for left/right location of chronic pain and frequency of breastfeeding with the left/right breast was 0.95 ($p<0.01$). Eight of 10 subjects who had performed the side-lying hold felt short-term pain in the upper arm and shoulder of the breastfeeding side (the bottom side in the lateral decubitus position).

Conclusion: Of six breastfeeding positions, the one most frequently linked to pain was the side-lying hold. It also became clear that uneven breastfeeding with the right and left breasts in the side-lying hold, or the use of a self-taught side-lying hold position, produced short-term pain that was linked to lactation-stage pain. This shows that guidance on the proper use of the side-lying hold is needed. There is also a need for further investigation that distinguishes between different side-lying hold positions, to support teaching of appropriate body positions. Research on breastfeeding positions has the potential to reduce the burden of child-rearing on mothers and contribute to a healthier child-rearing environment.

Keywords: Breastfeeding positioning, EMG, Pains of upper arms and shoulder, Side-lying, After birth and parenting support

Introduction

1 Background

In 1989, UNICEF/WHO published a joint statement on "Protecting, promoting and supporting breast-feeding: the special role of maternity services" (World Health Organization, 1989). In it, they proposed "Ten steps to successful breast feeding", a respected set of guidelines on breastfeeding for mothers (WHO/CHD, 1998). In 1991, the

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WHO/UNICEF started their “Baby Friendly Hospital Initiative (BFHI)”. This is an initiative to certify obstetric facilities that use advanced approaches to promoting breastfeeding. Knowledge and practice of the “Ten steps” also spread in Japan, owing to an initiative by the Japan Breast Feeding Association, which UNICEF had enlisted for the task of surveying for Baby Friendly Hospitals (BFHs) (Japanese Association of Lactation Consultants, 2016). Japan’s Ministry of Health, Labour, and Welfare also recommended breastfeeding in their “Healthy Parents and Children 21”, and in 2007 they developed a “Support guide for breastfeeding and weaning” (Ministry of Health, Labour, and Welfare, 2007). Hospitals across Japan use the “Ten” as a reference to recommend breastfeeding and provide inpatient mothers with guidance on how best to do it.

Factors regarded as important in breastfeeding include positioning (the way the child is held), and the latch (the way the child attaches to the breast). Breastfeeding positions include the Australian “koala” hold, the cradle hold, the cross-cradle hold, and the football hold; the possible breastfeeding positions become even more diverse if a breastfeeding pillow, breastfeeding chair, or other options are used.

However, mothers who have given birth are often required to feed their new-born infants before they have had time to recover from the fatigue of labour, and often feel tired. Prior research has implicated the breastfeeding positions of mothers as contributing to pain in the arms and shoulders. There are situations where mothers feel pain despite having received guidance on breastfeeding positioning, based on a report (Nakamoto, 2013) on breastfeeding guidance provided to mothers by nurses, which stated that breastfeeding positions that allow the child to be stable and the mother to relax are superior. These pain reports suggest that the guidance on breast feeding positioning may not be optimal. Lactation lasts only around 30 minutes per session, but this becomes a long time as sessions accumulate, and breastfeeding should be done in a position that imposes as little burden as possible on the mother’s body.

2 Prior research on mothers’ fatigue and breastfeeding positions

Figure 1 shows sources of pain for mothers in the perinatal period. A mother's perception of the causes of her health status and feelings of fatigue, first attributed to the effects of labour and delivery, change from 4 months onward to being attributed to child rearing and daily life, as can be seen in a report on perception of health by mothers 6 months after birth, in which an absence of symptoms caused by the effects of childbirth is linked to self-perception of health from 4 months onward (Aoyagi, 2006). Symptoms originating from the stresses of daily life, including child rearing, reportedly appear about 2 months after birth.

In research on the perception of fatigue by mothers, it has been reported that “being sleepy”, “stiff shoulders”, and “wanting to lie down” were prevalent (Kubo, 2010), and that there was a relationship between the subjective symptoms of physical fatigue and the number of breastfeeding sessions (Kawada, 2013). Another report (Koyasu, 2015) concluded that the prevalence of neck and shoulder pain is high after delivery, one of the causes being breastfeeding. Thus, it is possible to infer a relationship between physical pain—in particular, pain around the shoulders—and breastfeeding positioning.

It has been reported that for primiparas, the cradle hold and football hold are equal in terms of comfort (Bency, 2014), and that the Australian hold is comfortable for mothers after caesarean section (Shannon, 2013). In a study of low back pain resulting from the cradle hold,

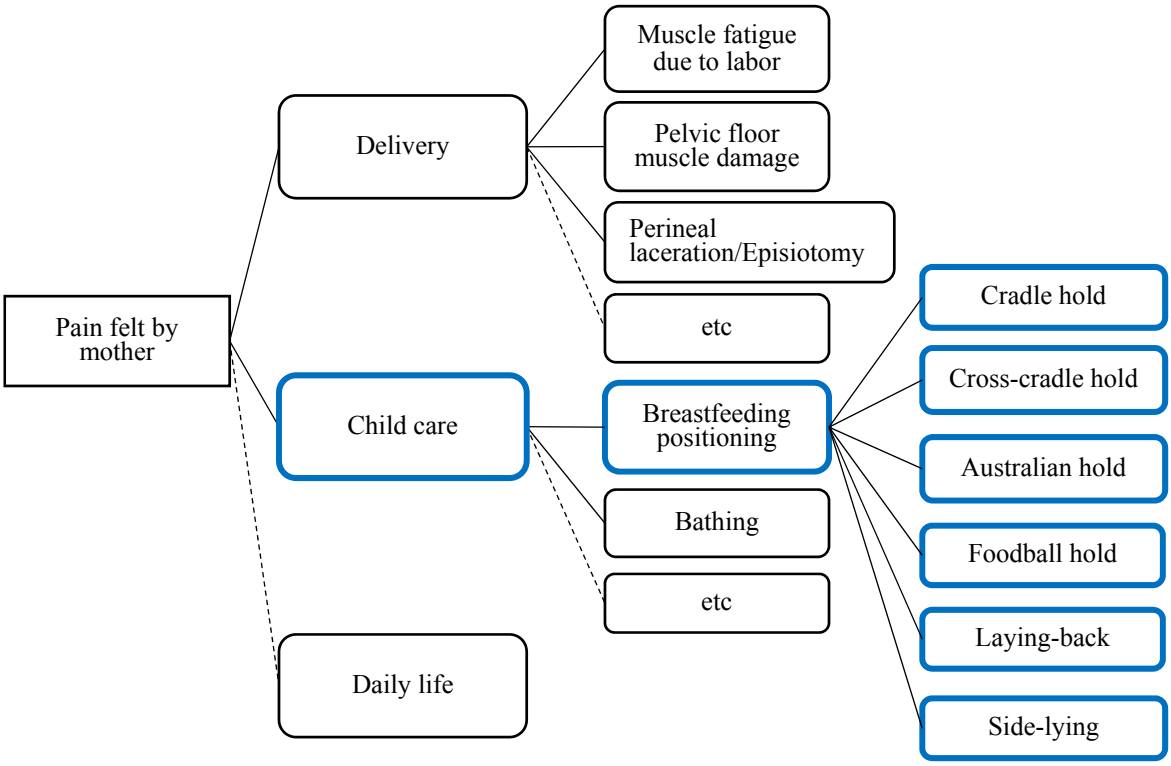


Figure 1: Factors of mother's pain at perinatal period

in which muscle action potentials were recorded near the L3 level, it was reported that breastfeeding while seated in a chair without lumbar support increased back pain (Klinpikul, 2010), but other than that there has been little quantitative study of pain associated with breastfeeding.

3 Objectives

The purpose of the present study was to clarify the reasons why pain occurs in the arms in breastfeeding positions, with an eye to breastfeeding guidance and current practices. "Breastfeeding", in the present study, is the act of feeding lactated milk directly to the child, and excludes the act of giving formula or using a baby bottle to give milk.

This study was conducted with the approval of the Kanagawa Institute of Technology Ethics Committee. (Approval number: 20160825-01)

Methods

1 Subjects

The study included 13 subjects with breastfeeding experience, whose most recent birth was within at most 8 years. Doctors, midwives, and nurses were excluded, to eliminate experts who might have special knowledge of breastfeeding techniques.

2 Data collection methods

Data collection consisted of [1] administration of a survey and [2] experimentation using a dummy.

2-1 Questionnaire survey

During the waiting time for the experiment described in 2-2 below, the subjects filled out a 37-question retrospective questionnaire, in a separate room. Figure 2 on the next page shows the questions. Of these, 11 questions concerned

basic physical and obstetric information, two questions addressed pain in the body through the entire lactation stage, up to 6 months, pain felt during and after breastfeeding in specific holds, and other pains, and 24 questions addressed the details of breastfeeding, included what types of holds were mentioned in guidance from the childbirth facilities, and what holds they actually used.

"Pain" in the present study is pain that is felt daily at 6 months after birth (chronic pain), as well as pain that is felt during or immediately after a session of breastfeeding (short-term pain). The differences between the two were explained clearly. The time point 6 months after birth was chosen in light of a report that most mothers recover from the fatigue of childbirth by 4 months after birth (Hattori, 1997); 6 months is thus when fatigue and symptoms resulting from delivery have disappeared, and is also around the time when a solid food diet is typically started, with a corresponding decrease in breastfeeding.

2-2 Experimentation with models

In this experiment, electromyography (EMG) was used to assess muscle activity. The subjects were given a dummy infant model (Kyoto Kagaku, Paediatric practice model infant, 7-10 months: "Maron-chan"; weight: 5 kg) and a dummy neonate model (KOKEN: Koken Baby, weight: 3 kg) with which to simulate the six basic patterns of breastfeeding positioning (cradle hold, cross-cradle hold, football hold, Australian hold, back-lying hold, and side-lying hold). No instruction was given regarding whether to breastfeed with the left or right breast, and the choice was left to the subjects. The cradle hold, cross-cradle hold, football hold, Australian hold, and back-lying hold were performed once with each of the two dummies, either while seated in a chair or, for the side-lying hold, in a recumbent position, for a total of 12 patterns studied. The holding positions were shown by photographs and simple descriptions included in the questionnaire, and also explained verbally in advance (Figure 3). The chair was a typical dining chair, with a rigid backrest and no elbow rests; we used Aico's MC221W(F18)BU. The

Table 1 Use of upper limbs by breastfeeding positioning and muscle mainly used

Positions	Use of upper limbs	Mainly used muscle	Positions	Use of upper limbs	muscle mainly used
Cradle hold	Bend and raise to own elbow. Support baby's head and buttocks with the forearm.	Biceps brachii Brachioradialis Serratus anterior Pectoralis major Pectoralis minor Rhomboid muscle	football hold	The shoulder joint is positioned slightly backward. Support baby's head and own breast with the forearm and the palm.	Biceps brachii Brachioradialis Trapezius Serratus anterior Pectoralis major Pectoralis minor Rhomboid muscle
Cross-cradle hold	Bend and raise to own elbow. Support baby's head and own breast with the forearm.	Biceps brachii Brachioradialis Serratus anterior Pectoralis major Pectoralis minor	Lying-back	Bend to own elbow. Support baby's buttocks with the forearm.	Biceps brachii Brachioradialis Serratus anterior Pectoralis major Pectoralis minor Rhomboid muscle
Australian hold	Bend and raise to own elbow. Support baby's head and own breast with the forearm.	Biceps brachii Brachioradialis Serratus anterior Pectoralis major Pectoralis minor	side-lying	Raise to own arm,bend to own elbow.	Triceps brachii Biceps brachii Trapezius Serratus anterior Pectoralis major Pectoralis minor

limbs and torsos of the subjects were also imaged by video cameras, from two directions.

2-3 EMG measurement: EMG leads and recording

For the CAPTIV-L7000 EMG recording, surface electrodes were applied at six locations—[1] to [3], on the left and right upper arms—with reference to Table 1, allowing for recording of a maximum of 6 channels. The locations were:

① Forearm (brachioradialis: from the carpus to 2/3 of the distance to the radial side from the elbow)
② Upper arm (biceps: halfway point on the upper arm)
③ Shoulder (trapezius: near the upper scapula over the clavicular midline)

First, the skin near the electrode application sites was pre-treated, and then the surface electrodes (disposable electrode L, Vitrode L-150, with 10 mm lead diameter; NIHON KOHDEN) were applied along the muscle fibre direction, with a distance of 20 mm between electrodes, and measurements were taken. TEA's CAPTIV-L7000 system was used for EMG acquisition, as were their T-sens wireless sensors for EMG measurement. The resulting EMG signals were recorded onto a personal computer at 2048 Hz using a biometric synchronization system CAPTIV L-7000 (TEA), via a T-DAC data receiver unit (TEA).

The analysis software included with the system was then used to find the moving root mean square of every 16 samples from the myopotential signals. This is because when surface electromyography is used as a tool for motion analysis, the moving root mean square or rectification average of a given interval is more reflective of the motion than the detailed shape of each wave of the myopotential signal (Kizuka, 2016). To ensure that muscle activity was in a steady state, for each hold 40 seconds of EMG data were recorded while the body was kept still, and 20 seconds of the data—excluding the 10 seconds immediately after recording started and immediately before recording stopped—were used for analysis.

The resulting data showed the changes in EMG magnitudes at each site for different holds within each subject. For each test, EMG was measured before and after the breast-feeding position was assumed with the dummy, allowing examination of changes in EMG due to the load.

3 Methods of analysis

Two of the original 13 subjects were excluded, one (subject 8) because a faulty electrode channel made proper EMG recording impossible, and one (subject 5) whose daily breastfeeding time was 10 minutes. Because it can be presumed that it will not be related to pain because it is too short as a time to spend breastfeeding in a day. "Pain" in the present study encompassed chronic pain, described in Methods 2-1, as well as pain felt during or immediately after a session of breastfeeding (short-term pain). To examine the relationship between sites where pain was felt and the frequency of breastfeeding with the left and right breasts, we calculated Spearman's rank correlation coefficient, designating a match when pain was felt on the same sites on the left and right, and a non-match otherwise. For

1. Age
2. Height
3. Current weight
4. Weight before pregnancy
5. Birth date
6. Caesarean section or Vaginal delivery
7. Length of labour
8. Birth weight
9. Birth Height
10. Age of elder child
11. How many children do you have?
12. How long per day did you hold your baby apart from feeding time?
13. In which body parts are you currently feeling pain?
14. In which body parts have you felt pain during lactation?
15. Please specify a part on the upper arm and shoulder where you felt pain during breastfeeding
16. When did you feel the pain for the first time? e.g. before pregnancy, after delivery of their child
17. How did you feed your baby? Exclusive breastfeeding or combination feeding.
18. How often did you breastfeed your baby?
19. How long did each feeding last?
20. How did you collect information about breastfeeding technique?
21. Where did you obtain support for breastfeeding?
22. What was your preferred breastfeeding positioning?
23. Did you use cushions to support breastfeeding?
24. How did you position yourself to breastfeed your baby?
25. Where was your upper arm when you sat to breastfeed your baby?
26. Which side of breast was normally offered to breastfeed your baby in sitting position?
27. Where did you sit during breastfeeding, on the floor or in a chair?
28. Did you use the backrest when breastfeeding in sitting position?
29. Where was your upper arm when you breastfed your baby in side-lying position?
30. Which side of breast was normally offered to breastfeed your baby in side-lying position?
31. What is the shape of your breast and nipple?
32. Which breastfeeding position was recommended by medical professionals?
33. How did you position your baby to give him a bottle?
34. Have you ever given your baby a bottle without holding him?
35. Did you use cushions for bottle feeding?
36. How did you position yourself to give your baby a bottle?
37. Where was your upper arm when you gave your baby a bottle?

Figure 2: Questionnaire

1. Cradle hold

2. Cross-cradle hold

3. Football hold

4. Side-lying

5. Australian hold

6. Lying-back

Figure 3: Pictures of Breastfeeding positions

short-term pain, each individual's total number of pain sites in the side-lying hold was recorded, along with the total number of matches between chronic pain and short-term pain. "Matches" were cases in which the responses for chronic pain and short-term pain were the same—either "yes" or "no"—at sites in the forearm, upper arm, or shoulder, on the breastfeeding side or the non-breastfeeding side.

In this study, the "breastfeeding side" refers to the side containing the breast that was used for feeding; the "non-breastfeeding side" refers to the opposite side.

The sums of the ratios for each hold were calculated as percentages. Simple comparisons were made between whether there had been guidance concerning breastfeeding holds from a medical institution or other advisor, and the holds used during breastfeeding as actually practiced in daily life. The positioning of the arms, and the location where the child was supported, were determined on the basis of the video recordings of each hold, and combinations (patterns) were calculated for each subject. EMG data for the side-lying hold was converted to Z-scores for simple comparisons. IBM SPSS Statistics Ver. 24 was used for statistical processing, with $p < 0.05$ set as the level of significance in all cases.

Results

Table 2 describes the 11 subjects from whom valid data was obtained. The subjects' BMIs were within the normal range, and they were regarded as having normal adult women's physiques; there were believed to be no problems caused by physique among the subjects.

1 Teaching and actual practice with holds

Figure 4 shows the guidance on each holding position received from medical institutions or other sources, and the holds that were actually used by the subjects for breastfeeding their infants. Every subject had been given guidance on the cradle hold, and it was the most commonly used. Six subjects had been instructed on the cross-cradle hold, and one person actually used it, while two subjects had been instructed on the side-lying hold, and 10 people actually used it.

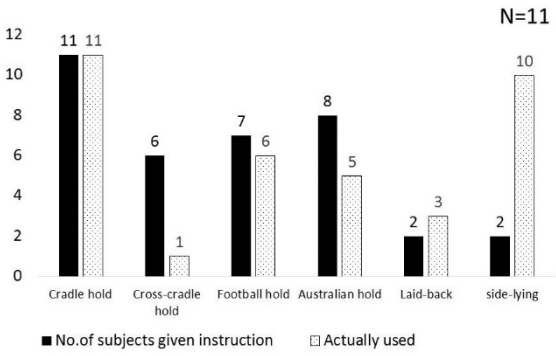


Figure 4: No. of subjects given instruction in breastfeeding position by medical professionals

2 Upper arm positions for each hold

Table 3 shows the positions of the upper arm for each hold. Even for the same hold, arm positioning varied from subject to subject, with one pattern observed for the cradle hold and cross-cradle hold, two patterns for the football hold, three patterns for the Australian hold and the back-lying hold, and seven patterns for the side-lying hold.

3 Chronic pain and the left/right breastfeeding ratio

Figure 5 shows the grand total score for chronic pain. Table 4 shows each subject's sites of pain and left/right breastfeeding ratio. Overall, the subjects tended to feel pain more often on the breastfeeding side. For the side-lying hold, when Spearman's rank

Table 2 Subject characteristics (N = 11)

Age	36.5±2.5
Body form	
Height(cm)	159.5±4.8
Weight(kg)	50.8±4.7
BMI	20.0±4.8
Lactation	
Subject's breastfeeding time per day (min)	
Subject	min
1	200
2	240
3	100
4	100
6	120
7	160
9	200
10	90
11	40
12	120
13	390
Average	160±91.6

correlation coefficient was calculated for the left/right distribution of pain sites and the left/right breastfeeding ratio, the result was 0.95 ($p<0.01$), indicating that pain usually appeared on the breastfeeding side. For holds that used a seated position (cradle hold, cross-cradle hold, Australian hold, football hold, and back-lying hold), the correlation coefficient was 0.06 ($p>0.1$), indicating that there was no significant association between the breastfeeding side and the side on which pain occurred.

4 Short-term pain and EMG in the side-lying hold

Figure 6 shows some of the EMG data for the side-lying hold. This is data from a steady state after the breastfeeding position had been assumed; nothing considered to be noise was used for the data analysis. Figure 7 shows raw EMG data before and after positioning the model in the side-lying hold.

Table 5 shows total scores, by subject, for short-term pain in the side-lying hold. Subject 12 had not performed the side-lying hold. Eight of 10 subjects who had performed the

Table 3: Position of both upper limbs by Breastfeeding positions(Supporting part)

A: baby's head **B**: baby's buttock **C**: baby's back **D**: Own breast **E**:Own head **F**: Along own regio temporalis **G:** Bending to wrap the baby

Subject	Cradle hold		Cross-cradle hold		Australian hold		Football hold		lying-back		side-lying	
	Breast feeding side	Other side	Breast feeding side	Other side	Breast feeding side	Other side	Breast feeding side	Other side	Breast feeding side	Other side	Breast feeding side	Other side
1	A	B	D	A	D	A	C	A	B	B	A	D
2	A	B	D	A	B	A	C	A	B	C	A	B
3	A	B	D	A	A	B	C	A	B	B	E	C
4	A	B	D	A	A	B	A	C	C	B	F	A
6	A	B	D	A	D	A	C	A	B	C	G	A
7	A	B	D	A	B	A	C	A	B	B	A	B
9	A	B	D	A	B	A	A	C	B	B	E	C
10	A	B	D	A	D	A	A	C	C	B	C	G
11	A	B	D	A	A	B	A	C	B	B	B	A
12	A	B	D	A	B	A	C	A	C	B	A	B
13	A	B	D	A	B	A	A	C	B	B	G	A
Total patterns	1		1		3		2		3		7	

Subject 5 was excluded from the study because of Breastfeeding time is 10minute.

Subject 8 was excluded from the study because of equipment problems

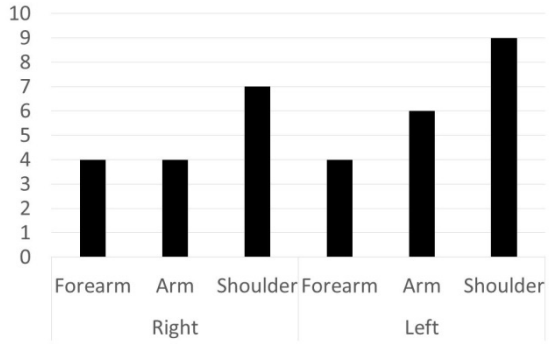


Figure 5: Pain felt during lactation 6 months after delivery (Upper limbs and shoulders)

Figure 6: EMG example in the side-lying position

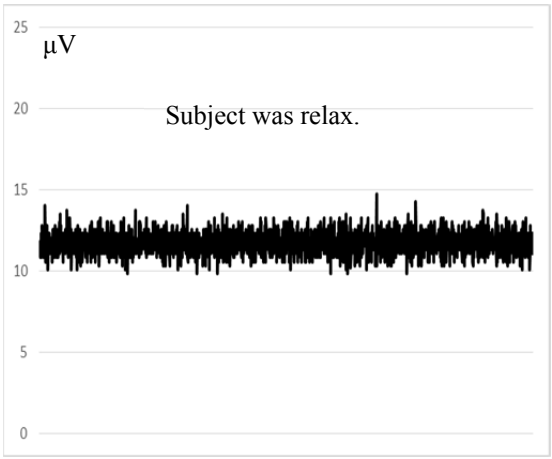
side-lying hold felt short-term pain in the upper arm and shoulder of the breastfeeding side (the bottom side in the lateral decubitus position). Figure 8 shows EMG Z-values for the breastfeeding side and non-breastfeeding side in the side-lying hold. The results show that the breastfeeding side's Z-score tended to be higher.

5 Relationship between chronic pain and short-term

Table 6 shows the level of matching for chronic pain and short-term pain, as defined in the Methods section. The match rate between chronic pain and short-term pain was 66.7%.

Discussion

1 Guidance concerning holds, and actual practice



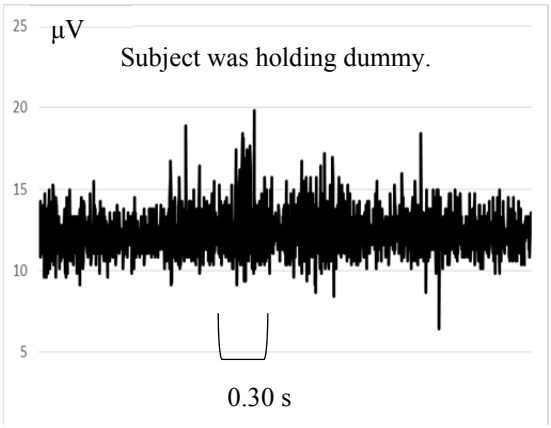


Figure 7: EMG before and after Subject held Dummy on side-lying position

There was an overall similarity between the guidance on breastfeeding holds received from medical institutions and the holds that were actually used by mothers. However, almost all the subjects had used the side-lying hold, despite not having received guidance on it; whereas they had all received guidance on the cross-cradle hold but most did not actually use it. It is typical to sit where the baby is latching on to the nipple, and therefore to use a cradle hold, cross-cradle hold, or football hold. It can be inferred that in most cases they were either using holds regarded as traditional (Colson, 2005; UNICEF UK, 2008), or had received guidance on the cross-cradle hold. In a study by Chidozie, seated positions accounted for 80% of positioning in breast-feeding (Chidozie, 2013). This percentage differs from the present

Table 4: Pains during lactation period & One sided breastfeeding

	Right			Left			Ratio in sitting position (%)		Ratio in side-lying (%)	
Subjects	Forearm	Upper arm	Shoulder	Forearm	Upper arm	Shoulder	Right	Left	Right	Left
1	○		○	○		○	50	50	50	50
2		○	○		○	○	70	30	50	50
3		○			○		30	70	50	50
4			○			○	40	60	50	50
6	○	○			○		60	40	70	30
7							40	60	50	50
9	○		○			○	60	40	70	30
10			○			○	50	50	50	50
11			○	○	○	○	60	40	100	0
12	○	○	○	○	○	○	40	60		
13				○		○	50	50	40	60

Pains during lactation period:Up to 6 months after birth（Chronic pains)
Sitting position:Cradle hold,Cross-cladle hold,Australian hold,Football hold,Lying-back
One sided breastfeeding in sitting position
Left/Right Imbalance pains and Left/Right breast Imbalance in side-lying
Subject 8 was excluded from the study because of equipment problems
Subject5 was excluded from the study because of Breastfeeding time is 10minute.

Table 5: Pains in side-lying position

Subject	Breastfeeding side			Other side		
	Forearm	Upper arm	Shoulder	Forearm	Upper arm	Shoulder
1		○	○			
2		○	○			
3		○	○			
4			○			
6						○
7						
9		○	○			
10			○			
11		○	○			
12						
13		○	○			

○: Where subjects felt pain
Subject 12 did not use the side-lying position
Subject 8 was excluded from the study because of equipment problems.
Subject 5 was excluded because breastfeeding time was 10 min.

Table 6: Chronic pains and Short term pains in side-lying position

Subject	Breastfeeding side			Other side		
	Forearm	Upper arm	Shoulder	Forearm	Upper arm	Shoulder
1			○		○	
2	○	○	○	○		
3	○	○		○		○
4	○	○	○	○	○	
6			○	○		
7	○	○	○	○	○	○
9			○	○	○	
10	○	○	○	○	○	○
11		○	○	○	○	
12						
13			○	○	○	○

○: Chronic pains and Short term pains were same.

Subject 12 did not use the side-lying position
Subject 8 was excluded from the study because of equipment problems.
Subject 5 was excluded because of Breastfeeding time was 10 min.

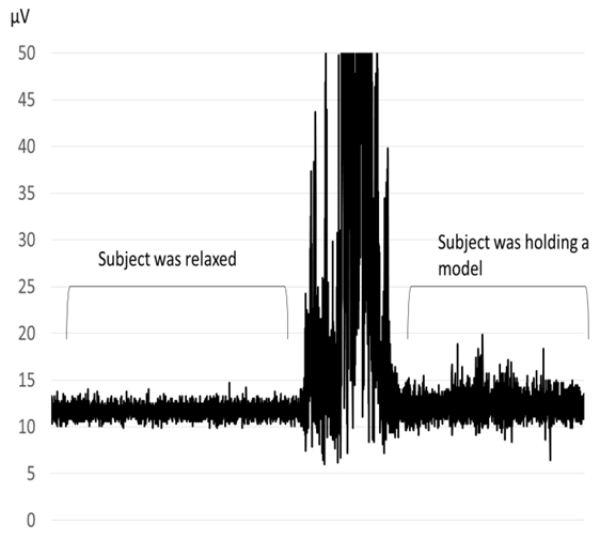


Figure 7: EMG before and after subject held model in side-lying position

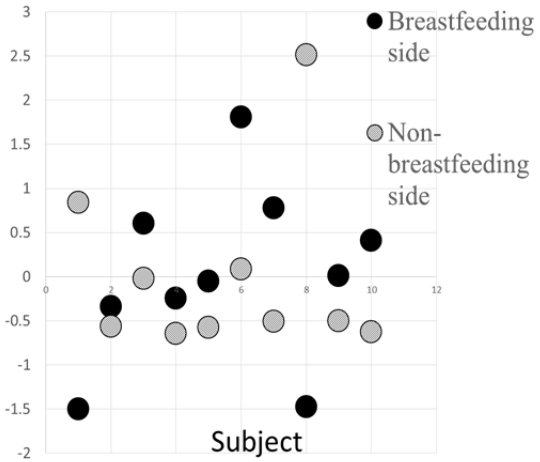


Figure 8. EMG data (Z score) on the breastfeeding and non-breastfeeding side

study. The study by Chidozie was carried out in the USA, and Chidozie noted the risk of ear infection or suffocation for a child in the side-lying hold (Chidozie, 2013); also, there is reportedly a relationship between an infant's sleeping environment and the risk of sudden infant death syndrome (SIDS) (AAP, 1992). In the USA, safety measures have been promoted regarding co-sleeping and use of the side-lying hold, which may explain the decreased use of

the side-lying hold. In Japan, however, co-sleeping is a traditional practice, and many mothers in Japan practice it, as reported by Ohkubo in a study of family sleep practices, in which a high proportion of children under age 3 slept in the same room as their parents (Ohkubo, 2005). In the present study, most subjects had used the side-lying hold, which suggests that the side-lying hold may function as an extension of co-sleeping. Chidozie stated that breastfeeding in the side-lying hold offers comfort and relaxation to both mother and child (Chidozie, 2013), and mothers who are fatigued presumably chose the side-lying hold as a method of breast-feeding that is easy and allows them to rest. In a study of child-rearing support by public health nurses, easy breastfeeding methods such as the side-lying hold were often suggested for situations where the mother is very fatigued (Nunohara, 2009); the side-lying hold is thought of as a breastfeeding method that allows the mother to relax. "Breastfeeding counselling: a training course A" (UNICEF, 1993) also states that the side-lying hold is effective for establishing the mother's breastfeeding position in mothers who are fatigued. However, it is also possible that for our subjects this was self-taught, due to insufficient guidance provided by medical institutions and other advisors.

The cross-cradle hold allows for easy adjustment of the angle of the baby's head and the angle of feeding with the nipple, and is thus considered suitable for preterm births, infants with weak muscle tone, and infants with a weak rooting reflex or suction (WHO, 1993. Birute Efe, 2013. Ayushveda US, 2009). It makes latching easiest, and is effective in the neonatal period, when breastfeeding is new and unfamiliar. A transition may be made to the cradle hold after a certain time. Ogawa et al. also stated that "even with objects of the same weight, each person's load changes significantly depending on how the object is positioned" (Ogawa, 2015), and it may also be that supporting the infant's head by crossing the non-breastfeeding side forearm and upper arm is not practiced because it creates a greater load than the cradle hold. It should be included in guidance that a transition can be made to the cradle hold once it allows adequate latching, but because one of the advantages of the cross-cradle hold is ease of latching, guidance on its use should be given if there are signs of poor latching, such as nipple redness or cracking.

2 Diversity of arm positioning for each hold

The side-lying hold involved seven different observed patterns of arm positioning, representing the greatest variability among the holds. With the side-lying hold, the positions of the torso and arms are typically designated in less detail than is the case for the other holds, and an absence of guidance at other medical institutions may also contribute to the diversity in positions.

The side-lying hold is the breastfeeding position chosen by many mothers, most likely because it is comfortable. Therefore, the body positions that are involved should to be studied in greater detail, to establish methods of guidance.

3 Chronic pain and the left/right breastfeeding ratio

Breastfeeding was often unevenly distributed between the left and right sides. Investigation of the relationship between the left/right distribution of chronic pain and the left/right breastfeeding ratio (either in one of the seated positions, or in a side-lying hold) showed that for the side-lying hold, the left/right breastfeeding ratio and chronic pain are related. On an individual scale, pain occurred disproportionately in arms and shoulders on the breastfeeding side (usually the

bottom side in the lateral decubitus position). So et al. reported a mechanism by which pain is derived from "numbness" arising from poor blood circulation or peripheral neuropathy (So, 2016). Thus, pain may occur because of poor circulation or other factors related to being on the lower side. Some mothers use the side-lying hold only at night, and may even end up going to sleep in that position, resulting in the same body position being maintained for an extended time, which may be one of the reasons why uneven left/right breastfeeding in the side-lying hold leads to chronic pain during lactation.

4 Factors related to short-term pain in the side-lying hold

When EMG in the side-lying hold was compared between the breastfeeding side and the non-breastfeeding side, the breastfeeding side showed higher values. Short-term pain was most commonly felt on the breastfeeding side (the bottom side in the lateral decubitus position), suggesting that sites with an increased muscle load may be linked to short-term pain.

In addition, there was a 66.7% match between chronic pain and short-term pain during sessions using the side-lying hold, raising the possibility that accumulation of short-term pain in the side-lying hold leads to pain throughout the entire lactation stage; however, the mechanisms that could underlying any such effect are unclear, and require further study.

5 Guidance for reducing physical problems resulting from co-sleeping

Because uneven breastfeeding on the left and right sides is a factor leading to lactation-stage pain, guidance should be provided on evenly dividing side-lying holds between the left and right sides, and on not going to sleep while in the side-lying hold.

The WHO/UNICEF recommended that mothers of healthy breastfeeding infants not limit the number of breastfeeding sessions or breastfeeding time, and that they change from one breast to the other between sessions (WHO/UNICEF, 2009). In the evidence cited for the "Ten steps to successful breastfeeding", the WHO/CHD stated that the number of suckling sessions and suckling time per 24 hours varies from one mother/child pair to another, and depends on timing (WHO/CHD, 1998). Based on this, one possible method for breastfeeding evenly on the left and right sides could be to complete breastfeeding on one side for one session, and then begin breastfeeding on the opposite side in the next session; another would be to stop in the middle of one session to switch from one side to the other.

Next, detailed guidance should be provided on the proper use of side-lying hold, considering that the positioning of the torso and arms are not usually specified in detail, and consequently individuals end up assuming their own idiosyncratic positions due to insufficient guidance. Support that may be helpful to postpartum inpatient mothers includes "Direct guidance on breastfeeding methods" and "Coming to visit often" (Hattori, 2009).

It has become clear that mothers need specific support during lactation. Tools for assessing breastfeeding include the LATCH Tool (Iqbal, 2015), and healthcare professionals need to acquire the skills for accurately assessing and providing specific guidance on lactation. As stated previously, it is commonplace during breastfeeding to use holds in a seated position, and many mothers are expected to practice seated holds for breastfeeding in the early postpartum period, while latching and positioning are unfamiliar (Japanese Association of Lactation Consultants, 2016). Medical staff often instinctively provide guidance for seated breastfeeding when they

observe the circumstances of breastfeeding. On the other hand, though no prior research has been found, mothers may begin using the side-lying hold at a time when they have become accustomed to latching and positioning, with many mothers doing so after discharge from the hospital with accumulated fatigue. Therefore, mothers who have become accustomed to breastfeeding in a seated position as inpatients must receive guidance on breastfeeding in the side-lying hold, and assessment of the breastfeeding circumstances. There is also a need for continued guidance, with cooperation between medical institutions and municipalities providing in-home visitation services.

Specific guidance at the behavioural level for the side-lying hold also needs to include recommendation of a body position that disperses the muscle load. This includes using a pillow to reduce the load for supporting the mother's head, placing a cushion under the forearm and upper arm on the breastfeeding side to support the child's head (to match the height of the child's mouth to the height of the nipple), using a suitable pillow or cushion to adopt Sim's position with the lower half of the body in order to stabilize the torso, and not sleeping in the side-lying hold.

The side-lying hold also reportedly causes otitis media (Kato, 2011), and—as stated previously—is a sleep environment risk factor for SIDS (The American Academy of Pediatrics, 2016). There is also a need for guidance concerning the possible effects on the child of falling asleep while in the side-lying hold, such as inadequate ventilation or gastroesophageal reflux.

This study on pain occurring in the arms during breast feeding positions, breastfeeding guidance, and breast-feeding positioning has yielded the following implications:

① The side-lying hold is chosen by many mothers, but it has become clear that inadequate knowledge leads to considerable variation in terms of individual customization of the position.

② The frequency of left/right breastfeeding in the side-lying hold is associated with chronic pain.

③ Short-term pain tends to affect the breastfeeding side more often in the side-lying hold.

The side-lying hold is readily adopted because it seems easy, but it may result in an unexpected degree of physical load being applied. However, this can be mitigated through improving mothers' knowledge about positions, and it may suffice for this knowledge to be superficial. More strategies for improving mother's knowledge are needed. There also needs to be additional examination, with participation of mothers who are currently breastfeeding their infants, using the methods of the study.

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