

Development of Milking Machine for Human with Reference to Human Babies' Behavior

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Abstract: This paper deals with human nursing and milking. We have made clear the principle of milking of human babies that consists of biting force, sucking pressure and movement of tongue. Base on this observation, the tongue mechanism was proposed. Then new type milking machine was developed and helpful milking was realized by controlling it with reference to human babies behavior. The experimental result of milking from nursing bottles and breast of mothers are shown in this paper. According to the result, the machine has almost same ability as babies.

1. Introduction

The importance of breast-feeding was recognized in recent years. And the number of mothers who select breast-feeding is increasing. They sometimes need milk themselves when their child is a premature or they control their mammary and feeding time. In this case, some mothers use milking machine for their help.

But current milking machines are pointed out some harmful influence, such as mastitis, enlargement of nipple and so on.

This study aims to develop new milking equipment that helps mothers who need milking.

2. Measurement of babies milking

Human babies milking behavior consists of bite, suck and milk by tongue. Then we built up measurement equipment (Fig.1) and observe babies' milking behavior. The biting force is measured by strain gauge. Pressure transducer measures the sucking pressure. Echography (Supersonic imaging machine) applied to recognize movement of tongue. Two-week and twelve-week old babies are observed.

3. Measurement result

Figure 2 shows an example result of biting force and sucking pressure of twelve-week old

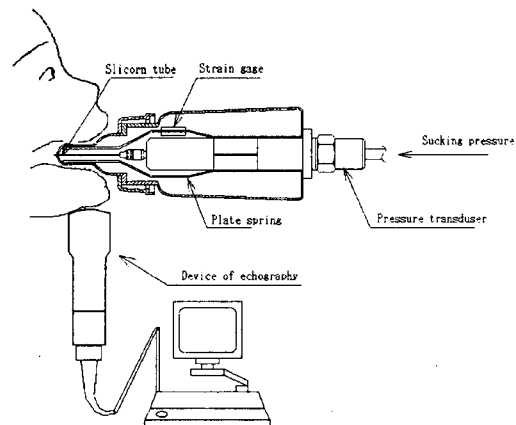


Fig.1 Measurement device

baby. Phase difference is almost $2/5 T$. It is as same as two-week-old babies. Sucking pressure is higher than two-week-old babies (Fig.3). Biting force and sucking pressure change periodically. According to FFT result, they have a peak at 1.1Hz.

The movement of tongue is analyzed from echographic image. Figure 4 shows the movement of tip of tongue. Displacement peak of tongue moves from tip to center. It indicates peristaltic motion of tongue. Figure 5 shows the movement of root of tongue. Each position has a peak simultaneously. It indicates the tongue

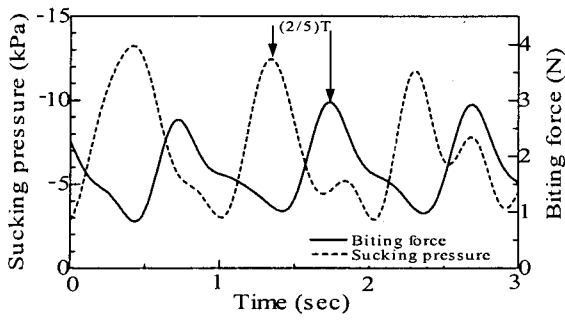


Fig.2 Sucking pressure and biting force

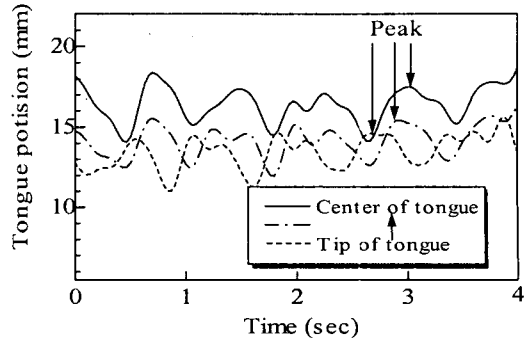


Fig.4 Movement of near tip of tongue

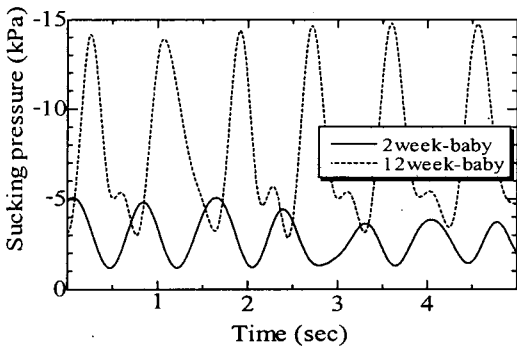


Fig.3 Comparison of sucking pressure between twelve-week-old baby and two-week-old baby

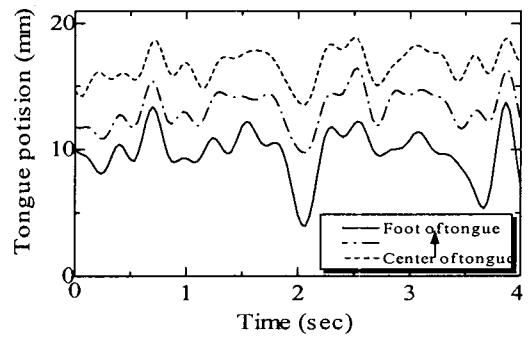


Fig.5 Movement of near foot of tongue

4. Milking machine

Based on observations of human babies' milking behavior, new milking system was developed as Fig.6. Queued thin plates that

connected to air cylinder emulate the peristaltic motion of tongue. It also make stimulus to nipple then milking this machine is very close to natural milking.

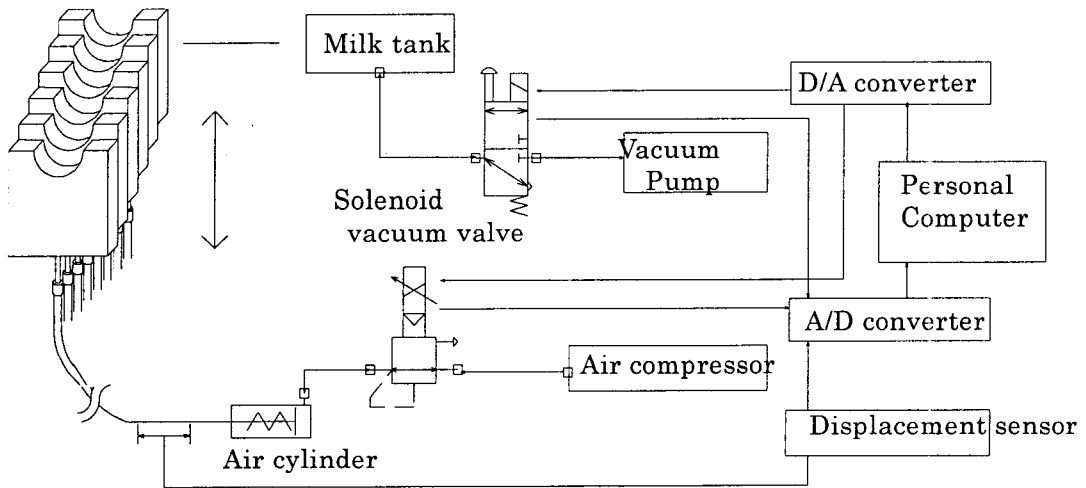


Fig.6 Configuration of milking machine

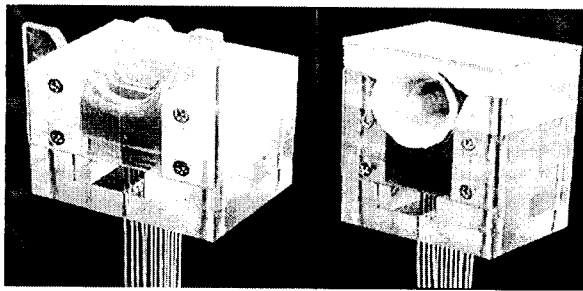


Fig.7 Tongue mechanism

Tongue mechanism is shown Fig.7. Its configuration is shown Fig.8

5. Experiment

Several experiments are executed by developed milking machine. To compare the result, current milking machines are also investigated.

Current milking machines operate only sucking pressure. Then sucking pressure was measured and compared with human baby's sucking pressure (Fig. 9, 10).

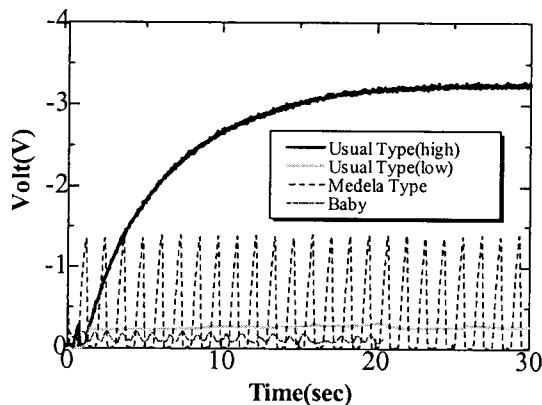
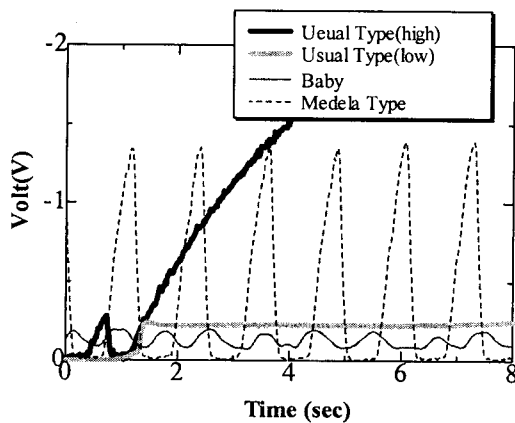


Fig.8 Configuration of tongue mechanism



Change of Sucking pressure (enlarged)

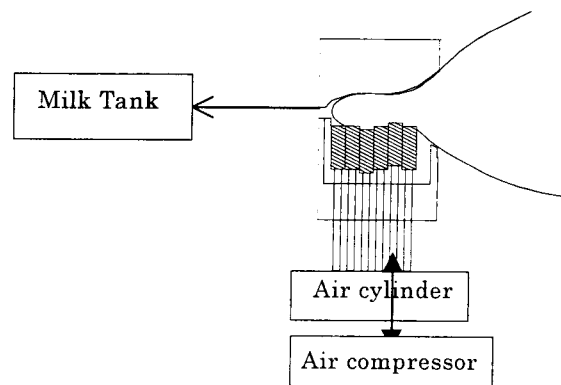


Fig.8 Configuration of tongue system

According to Fig.8, current milking machine generates 10 times high pressure than a newborn infant. Medela type milking machine also operate only pressure, but it has rhythm as same as human babies.

5.2 Milking from nursing bottle

Milking test from nursing bottle was executed before milking test from breast. Table 1 shows the result. The current milking machine was used under low-pressure condition. In this experiment, the current machine cannot milk well. The developed machine milks very well. Even training nipple, this machine shows good record. It indicate that tongue motion works well.

Table 1 Result of milking from nursing bottle

	Normal Nipple	Training nipple
Baby	60	20
Current	5	0
Medela	35	10
Developed	90	30

[cm³/min]

5.3 Milking from mother

Milking test from mother was executed by using developed machine. The machine could milk from good condition mother. Their impressions of this machine are too weak than actual baby.

6. Conclusion

The milking machine that emulates human babies behavior was developed. According to experimental result, this machine has almost same ability as human babies' milking.