

# FURTHER ANALYSIS OF THE MECHANISM OF ORIGIN OF THE FIRST EXTRAUTERINE BREATHS

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The character of origin of the first extrauterine breaths was studied in experiments on dog, cat, and rabbit fetuses at the end of intrauterine development and born by caesarian section (after ligation of the cord) and also in the natural way. Corresponding observations were made on human fetuses born naturally. The first extrauterine breath is characterized by typical features of apnea, expressed as intensive contractile activity of the respiratory muscles causing stretching of the lung parenchyma. Activity of the respiratory muscles is combined with contractile activity of the skeletal muscles of the trunk and limbs. On the whole the first extrauterine breath has the character of a sustained and generalized respiratory response of the extensor type.

KEY WORDS: extrauterine breathing; skeletal muscles; respiratory muscles.

Investigations in the writers' laboratory have shown that intrauterine respiratory movements (IRM) constitute respiration of the natural gasping type combined with an orthotonic position characteristic of the fetus. During IRM of gasping-type, activity of the respiratory muscles only, is recorded on the electromyogram (EMG). During episodic generalized motor responses (GMR), which are opisthotonic in character, activity not only of the limb and neck muscles, but also of the respiratory muscles, is recorded on the EMG. The episodic performance of GMR of opisthotonic type is connected with a periodic deficiency of nutrients of oxygen in the fetal blood stream [1, 2]. The first extrauterine breath (FEB) arising after tying of the cord, when the level of fetal hypoxemia rises, has the character of apnea [2]. The contractile activity of the respiratory muscles during the first breath is much greater than during IRM, as a result of which the lung parenchyma is stretched for the first time [2, 4, 5]. It has been noted that the appearance of the FEB is combined with a change in skeletal muscle tone.

The object of this investigation was to study the role of skeletal muscular activity in the origin of the FEB.

## EXPERIMENTAL METHOD

Experiments were carried out during caesarian section (morphine-ether anesthesia) on dog fetuses joined to the mother by the umbilical cord (during the last week of pregnancy), and also on rabbit and cat fetuses removed from the uterus during the last days of pregnancy. The FEB was recorded by x-ray cinematography so that the degree of filling of the lungs with air could be estimated. The appearance of the FEB in canine and human fetuses born naturally also was observed visually and recorded by motion pictures. The investigations were carried out on 60 dog, cat, and rabbit fetuses and on 64 human fetuses born naturally.

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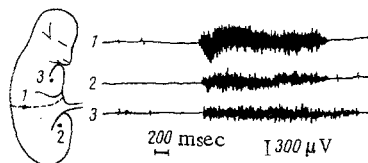


Fig. 1

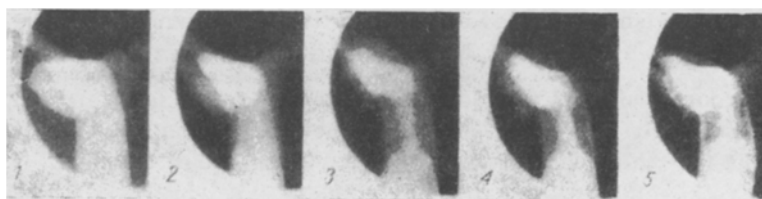


Fig. 2

Fig. 1. Contractile activity of respiratory and skeletal muscles during the FEB (after typing of the cord) in a dog fetus: 1) diaphragm; 2) quadriceps muscle (hind limb); 3) biceps muscle (forelimb).

Fig. 2. X-ray cinematographic recording of the FEB: 1) before FEB (lungs airless), head hanging passively; 2, 3, 4) separate phases of the first inspiration. The contracting diaphragm is depressed, the lungs are filled with air, and the head is raised simultaneously with the sustained GMR; 5) expiration (the relaxed diaphragm rises and the fetal head hangs passively).

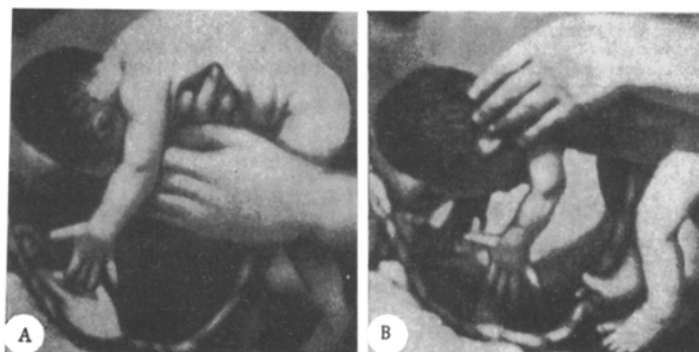


Fig. 3. Motion picture record of sustained GMR associated with the FEB; extension and fanwise spreading of the fingers (A) and toes (B) as components of the GMR.

### EXPERIMENTAL RESULTS

To record the EMG (Disa Electronic myograph) of dog fetuses joined to the mother by the cord, electrodes were fixed to the diaphragm and the muscles of the fore- and hind limbs and neck. If the cord was tied during IRM, they ceased and the FEB occurred after 30-50 sec. In all cases, during the FEB activity not only of the diaphragmatic muscles, but also of the skeletal muscles of the fore- and hind limbs was recorded on the EMG (Fig. 1). Consequently, the FEB is apparently a GMR of extensor character, much more intensive than that in the fetus before the cord is tied. The well-marked contractile activity of the respiratory muscles under these circumstances is a component of the GMR.

The rabbit (unanesthetized) and cat (anesthetized) fetuses removed from the uterus were put in a vertical position (suspended by their forelimbs) to allow x-ray cinematographic recording to be carried out. The appearance of the FEB was accompanied by a GMR; in connection with the contraction of the neck muscles the head assumed the opisthotonic position and the lungs filled with air (Fig. 2). During natural birth in dogs as soon as the fetus emerges from the birth passages the mother herself ruptures the membranes. The FEB of the newborn puppy thus produced is characterized by typical features of a GMR. In some cases the appearance of the GMR is preceded by a motor response of the jerky type.

It was found previously [3] that the GMR of the newborn infant has a well-marked extensor character. The fanwise extension of the fingers (analogous with Moro's reflex) and toes (analogous with Babin-ski's reflex) is simply a component of the sustained GMR. The present investigation showed that the FEB in physiologically mature fetuses on emerging from the birth passages takes place before the cord is tied. The FEB also has the character of a GMR in which the activity of the respiratory muscles is combined with extensor activity of the trunk and limb muscles and, in particular, by fanwise extension and spreading of the fingers and toes (Fig. 3). The GMR and, consequently, the FEB thus arise as a rule when the child is turned during delivery around the dorso-ventral axis. The sustained GMR associated with the onset of

the FEB can also be induced by various stimuli – by tapping on the table on which the child lies, by eliciting Arshavskii's heel reflex [2], by sprinkling with cold water, and so on.

In dogs and cats, immediately after birth of the fetus and before the appearance of the FEB, as soon as the mother has ruptured the membranes she begins to lick her offspring vigorously; this acts as the stimulus for the sustained GMR and the appearance of the FEB.

The sustained GMR associated with the FEB thus helps to product the greatest expansion of the chest and the most efficient stretching of the lung parenchyma. Together with other familiar indices [6], the sustained GMR can be used as a simple criterion for the rapid assessment of the state of the newborn infant.

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