Observations on the foetal development of the reindeer

Jouni Timisjärvi[1], Mauri Nieminen[2] and Eija Eloranta[2]

[1] Department of Physiology, University of Oulu, Oulu, Finland
[2] Finnish Game and Fisheries Research Institute, Reindeer Research, Rovaniemi, Finland

The offsprings of different species show a wide range of stages of maturity at birth. The young may be almost completely unable to move and require perfect protection and rather thorough nursing, or may have an excellent insulatory hair coat and be able to walk almost immediately after birth. Regardless of the degree of maturity at birth a prerequisite of extrauterine life exists common among all mammalian species. All young must have developed circulation and lungs capable of maintaining independent life.

The foetal systemic and pulmonary circulations are coupled parallely and the pulmonary circuit comprises a high-pressure system. The foetal shunts and high poulmonary vascular resistance guarantee a larger flow in the systemic circulation than in the pulmonary circulation. After birth placental oxygenation of the blood is completely abolished and replaced by the lungs. The circulatory rearrangements occurring after birth consist not only of the closure of the shunts, but also recoupling of the two circuits in series as seen during extra-uterine life. The pulmonary circulation now becomes a lowpressure system while systemic arterial pressures gradually rise towards the adult levels.

During the first breath the airways open. The requirements the peri- or neonatal cardiorespiratory system is facing to is comprised, not only of the maintainance of life under basal conditions, but also the demands raised by thermoregulation, the alimentary canal after feeding or by locomotion or excretory organs.

Ruminant calves are able to walk and run soon after birth. This is because of a well-developed locomotor system at birth. This system comprises not only the muscles and lever systems, but also the coordinative functions served by the central nervous system. The newborn reindeer calf shows highly advanced adaptation to hostile environment by having a good insulating coat and being capable of moving almost immediately after birth.

In the present series we have made x-ray studies on foetal reindeer calves with reference to the vasculature and ossification process, especially that of the extremities.

Altogether 40 foetuses were collected either from slaughtered reindeer hinds or as stillbirths during the last winter (1985 - 86) within the Finnish reindeer rearing area. The weighing was performed on ordinary laboratory scales with a precision of 1 g, or as in the case of larger foetuses, with a precision of 10 g. After weighing the samples were frozen.

X-ray filming was done with the foetuses against the cassette. Special care was taken to avoid geometric errors by placing the long bones parallelly with the surface of the cassette. The length of the metacarpal bones was measured to the nearest 1 mm.

The studies on vasculature were carried out on two foetuses of estimated age of 150 to 170 days by injecting x-ray contrast medium either into the aorta or into the umbilical vein. The injection of the contrast medium was monitored fluoroscopically and by taking cineangiocardiograms.

The cineangiogardiograms showed a high degree of vascularization. The systemic arterial system was, in gross orientation, the same as seen after birth. The pulmonary arterial system could be demonstrated to exist as a dormant entity. The contrast medium could be forced from the aorta through the *ductus arteriosus* into the pulmonary artery, as it was shown to flow from the right atrium to the left one. The *ductus venosus* was clearly visible when the contrast medium was injected into the umbilical vein. Figure 1 depicts the gross anatomy of the blood vessels.

The ossification of the largest bones had begun in all foetuses involved in this series. Hence, the whole number of vertebrae and ribs, the scapulae

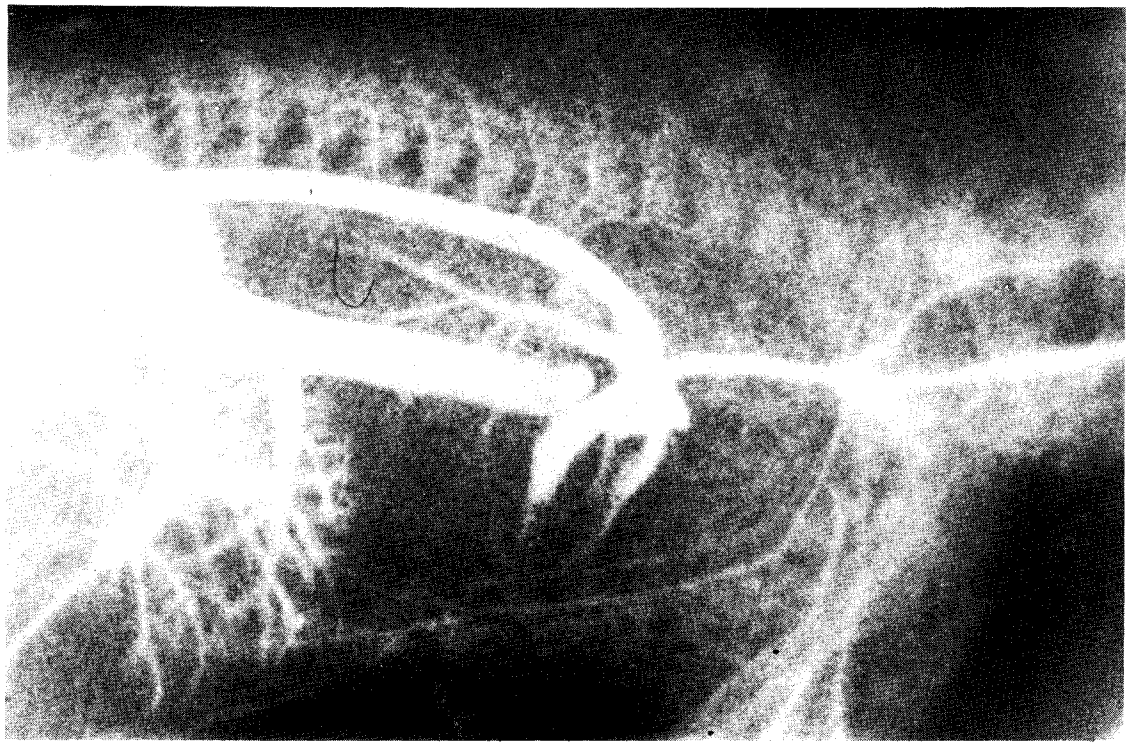

Fig. 1. Gross anatomy of the blood vessels in the reindeer foetus. Contrast medium injected into the aorta and inferior caval vein. Pulmonary arteries are visualized by the contrast medium flowing through the *ductus arteriosus.*

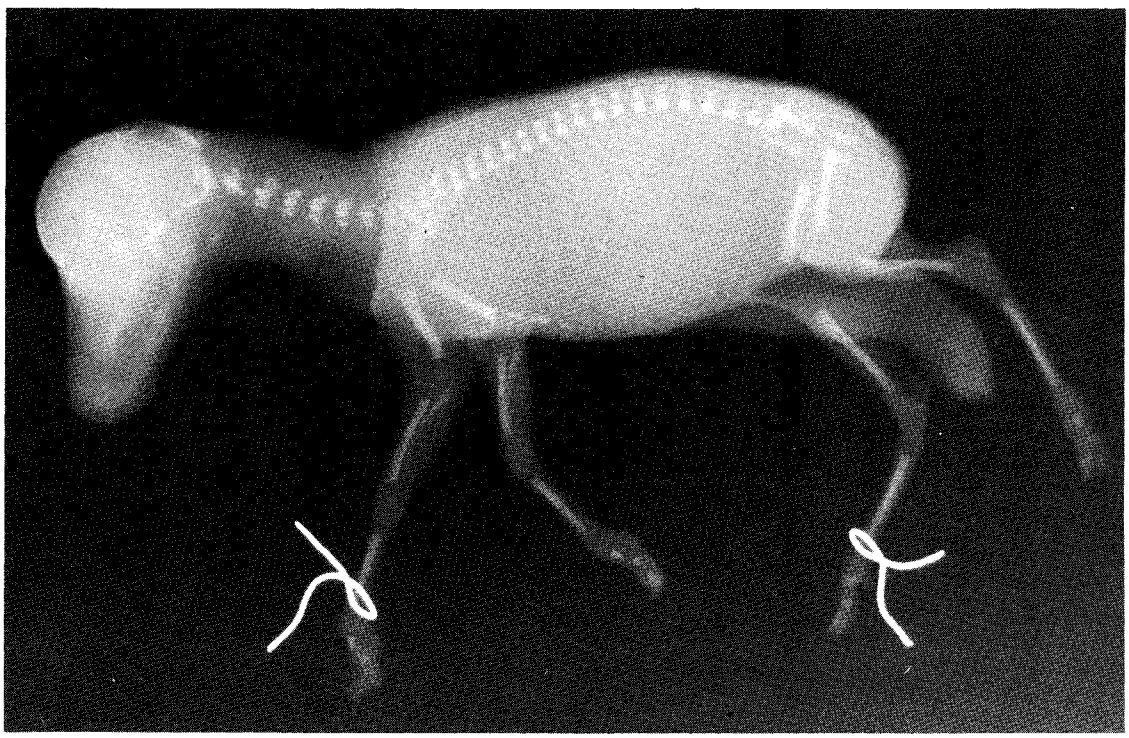

Fig. 2. Development of the bones. The ossification of the long bones of the extremities advanced. The small bones visible only as minor foci.

and pelvic bones, the bones of the skull and extremities were clearly discernible. The ossification foci of the smaller bones such as digiti or calcanei or teeth appeared later. Figures 2 and 3 depict the development of the long bones of the extremities. Measurements were taken in respect to the metacarpal bone both in the foreleg and the metatarsal bone in the hindleg. The results were plotted against the foetal weight. The growth is faster in the hindleg. Epihyseal lines and the ossification foci of the joint surfaces appeared in the foreleg when the metacarpal length was at least 6 cm and in the hindleg when the metatarsal length was 7 cm, respectively. This corresponds to a foetal weight of about 1 kg.

The material included malformations in 4 cases and one multifoetus case.

In conclusion, the developing reindeer foetus shows a well-advanced circulatory system at least at an age of 5 months, corresponding to a weight of about 1.7 kg. The development of bones is slower with the small bones of extremities having the latest starting point. However, the locomotion system shows a faster rate of growth than the weight gain and is satisfactorily matured during intrauterine life. The weight gain is then fastest during the last weeks of gestation.

References

Dawes, G.S. 1969. Foetal and neonatal physiology. — *Year Book Medical Publishers, Inc. Chicago.* 247 pp.

Development of the vascular system. Ciba Foundation Symposium 100. 1983. — *Pitman, London.* 254 pp.

Hirvonen, L., Lind, J., Peltonen, R. & Peltonen, T. 1982. Kreislauf und Atmung im Fetal- und Neonatalstadium. — *Oulu.* 100 pp.

Hirvonen, L., Timisjärvi, J. & Peltonen, T. 1979. Observations on circulatory adjustment in newborn reindeer and elk. — *Med. Biol.* 57: 352 - 356.

Roine, K. 1974. Studies on reproduction in female reindeer with special reference to morphological and physiological conditions and foetal development. — *Helsinki.* 58 pp.

Roine, K., Nieminen, N. & Timisjärvi, J. 1982. Foetal growth in the reindeer. — *Acta Vet. Scand.* 23: 107 - 117.

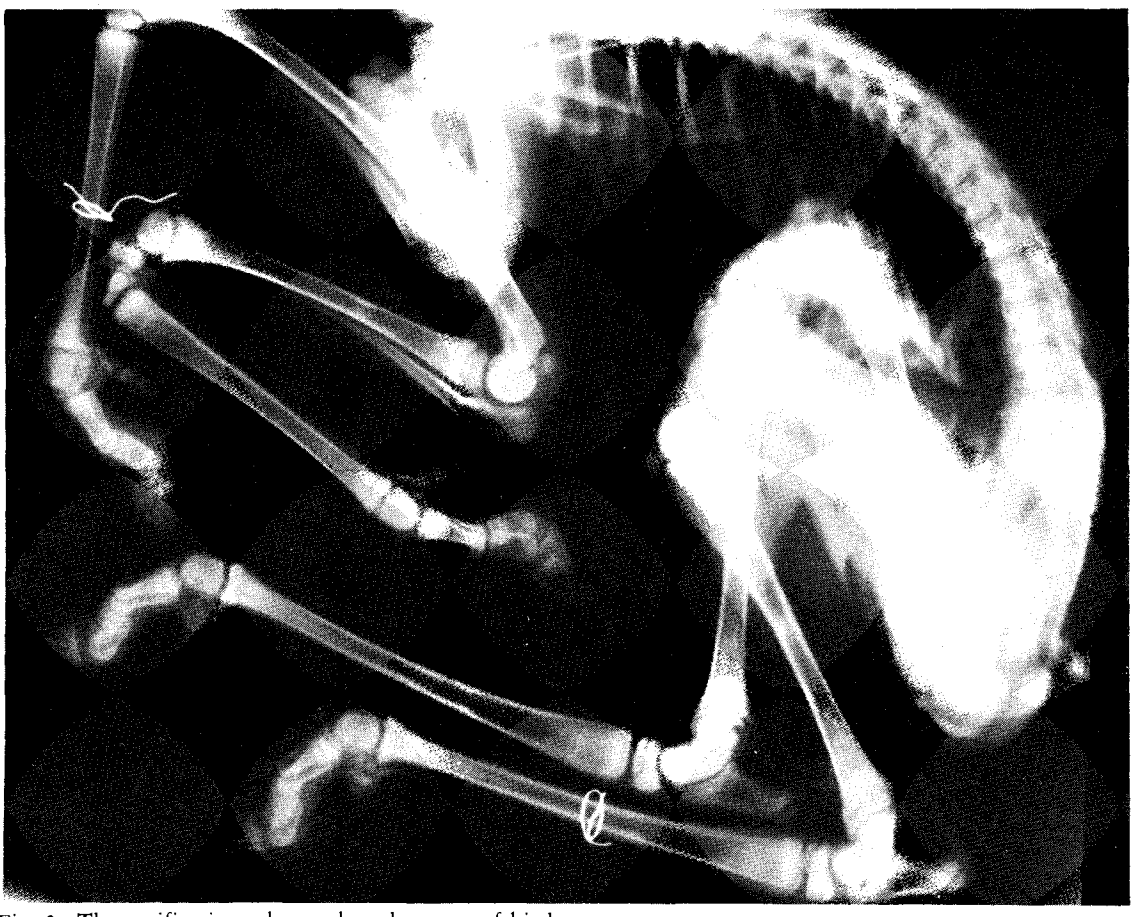

Fig. 3. The ossification advanced to the stage of birth.