

Selective cooling of the brain in reindeer

H. K. Johnsen, A. S. Blix, & J. B. Mercer

Department of Arctic Biology, Institute of Medical Biology, University of Tromsø, P. O. Box 635, 9001 Tromsø, Norway

Selective cooling of the brain during hyperthermia has been demonstrated in several species of mammals (Baker 1979, 1982). Such cooling is achieved by heat exchange between the cooled venous blood returning from the nasal mucosa and the warmer arterial blood entering the brain via the carotid rete.

Spot measurements of brain temperature (T_{br}) and carotid blood temperature (T_{car}) were made within 1 min. of death in 40 wild reindeer (*Rangifer tarandus tarandus*). At T_{car} lower than 40.5°C T_{br} was higher than T_{car} . With increasing T_{car} above 40.5°C T_{br} remained at approximately 40.5°C, indicating that selective cooling of the brain had occurred.

Angiographic examination of the distribution of the venous return from the nasal mucosa during induced hypothalamic or rumen heating and cooling in trained reindeer demonstrated that the angular oculi veins were constricted during cold stress and dilated during heat stress. A segment of the facial vein appeared to be completely occluded during heat stress as a result of which the cooled venous return from the nose was directed to the cavernous sinus via the angular oculi veins. Histological examination of the vaso-active segment of the facial vein showed unusually rich longitudinal and circular layers of smooth muscle cells.

Clamping the angular oculi veins in the heat stressed animal resulted in an immediate rise in T_{br} , which returned to the control level after the clamp was released.

Qualitative measurements of nasal air flow were made in two heat stressed reindeer. When the animals' respiratory pattern changed from closed to open mouth panting, inspiration through the nose continued while expiration occurred predominantly through the mouth.

Conclusions

Selective cooling of the brain in reindeer seems to be achieved by constriction of a part of the facial vein which obstructs the flow of cold venous blood in the facial vein and directs the venous return from the nose to the cavernous sinus via the angular oculi veins. Cooling of the brain is maintained even when the respiratory pattern changes from closed to open mouth panting because the reindeer continue to breathe in through the nose, thus, ensuring that cooling of the nasal passages is sustained.

References

- Baker, M. A. 1979. *Sci. Am.* 240, 114 - 122.
- Baker, M. A. 1982. *Ann. Rev. Physiol.* 44, 85 - 96.