Potassium-Selective Microelectrodes Reveal Excessive Changes of Brain K+.

Franklisk Vyskocil
Institute of Physiology
Czechoslovak Academy of Sciences
142 20 Prague 6-803
Czechoslovakia

February 15, 1969

This short article described the application of a new technique to a well-recognized but unanswerable problem. Potassium-selective microelectrodes with a fixed ion-exchanger membrane were developed in 1970 by LL Walker, and the technology was brought from Salt Lake City to Prague by our colleague and friend Dr. Pavel Holc. Two or 3 (P1 and P2) easily modulated the production of the microelectrodes, yet together the new equipment (with the assistance of engineer J. Urban) and developed various experimental techniques for recording intracellular potassium concentration in nerve cells and glial cells at L. Vyskocil. At the same time a number of other investigators explored the field and tested the hypotheses. Some authors (20) used the electrodes for testing the hypothesis that the propagating wave of the spikes spreading depression of the cell activity is due to a slow solution of potassium ions from depolarized zones in an extracellular concentration causing depolarization of adjacent nerve cells. Such K+ increase had been postulated since 1954 and demonstrated by indirect methods, but its absolute magnitude remained unknown (see references 3 for a review).

The actual experiments were performed in a small, crowded laboratory of our institute during two weeks of intensive work in the latter quarter of 1972. As the results, the first results confirmed our expectations in the technical way. It was true that at a certain level of 200 to 300 units during spreading depression and up to 300 units during normal activity, the results were most convincing. By making use of the ability of the K+ selective electrodes to record potassium concentration and the power of the method, which enabled us to specify parameters about both microenvironment, we were sure that our groups were not on the same track. The feeling that we were participating in a race contributed to the realization that our results as well as to the decision to expedite publication by admitting the results to the general readership. Indeed, the results of our research in Munich, 600 kilometers from Prague, were published only a year later, and publications in an other laboratories followed in 1974. Our paper that began the first of a series marking a wave of renewed interest in the mechanism of spreading depression, which was recognized as "a dramatic example of the failure of potassium hemostasis in the CNS of normal nervous system." (C. Michelson). It was used as a source of later studies employing intracellular microelectrodes to demonstrate transmembrane studies not only of K+, but also of Cl-, Na+, and Ca2+ during spreading depression. The results were combined in the early 1980s, when many scientists started to be used for testing the role of extracellular osmotic acids and their antagonists in cerebral brain damage.

Our paper was the result of a short-term correspondence of three authors with different backgrounds (biochemistry, electrochemistry, medicine), coming from different laboratories and engaged in different types of research, whose solution was not significantly influenced by this paper. The high impact of the paper was already shown as it went the center for the next-coined paper from our institute. Besides this, the study did not receive any particular recognitions but had a considerable publication from the national and international academic establishment.