Dynamics of Calcium in the neuronal dendrite

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Ca plays an important role such as synaptic plasticity. To investigate dynamics of Ca in Purkinje cell (PC) dendrites in mouse cerebellar slices, we performed whole-cell patch clamp and imaging with fluorescent Ca indicators. High frequency parallel fiber stimulation (50Hz 30-50 times) depolarized PC and caused a large increase in [Ca] at anatomically expected sites in dendrites for seconds that turned out to reach ~100 μM of Ca measured by furaptra fluorescence. The magnitude of Ca transients was much higher than was reported previously. The [Ca] increase was confined to a small area and sustained for a longer period of time as more stimuli were applied. Pharmacological interventions revealed that Na and Ca influxes through AMPA receptor and P/Q-type Ca channel, respectively, were essential players. AMPA receptor did not operate as a Ca influx pathway, and Ca release from the stores did not seem to be a major source for these large Ca transients. With smaller number of stimuli, Ca released from intracellular Ca store site can be observed as a second peak of a biphasic Ca transient, first peak of which is composed of Ca influx through the P/Q channel. We have found that this Ca release is necessary for the induction of long-term depression in the parallel fiber-Purkinje cell synapse. We compared this parallel fiber-evoked Ca release activity between PCs from 2 and 4 week old mice. PC dendrite is still developing in the rodent cerebellum at two week after birth. We found that similar Ca release activities between the majorities of PCs from these ages, however, there was a small population of PCs showing strong Ca release activities in the 2 w PCs, and there was a small group showing little Ca release activities in the 4 w PCs. We would like to discuss a possible relation between the Ca release activity and the synaptic development.

Reference: Inoue et. al. J. Neurosci. 18 5366-5378 1998, Kuruma et. al. in press J. Neurosci. Res.