"Optical patch-clamping": single-channel recording by imaging Ca^{2+} flux through individual muscle acetylcholine receptor channels. Demuro A and Parker I. *J Gen Physiol* 126: 179–192, 2005.

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Question: What advantages can be gained by monitoring ion channels via "optical patch-clamping"?

Background: Ion channels are fundamental for regulating the activity of cells. The patch-clamp technique revolutionized our ability to monitor the activity of these channels, allowing currents to be recorded through single channels with subpicoampere and submillisecond resolution. Nevertheless, patch-clamping is limited by an inability to spatially map the channels, to independently record from more than one channel at a time, and by the disruption of the cytoskeleton caused by the micropipettes. Although optical imaging techniques have held some promise in circumventing these issues, the temporal resolution (~30 ms) and signal-to-noise ratio has hindered their use.

Observations: Technical enhancements allowed Demuro and Parker to use total internal reflection fluorescence microscopy (TIRFM) to examine the behavior of Ca^{2+}-permeable ion channels in *Xenopus* oocytes. They imaged the activity of nicotinic acetylcholine receptors/channels, which notably have only partial permeability to Ca^{2+}, by employing an ultrafast, high-sensitivity camera that improved the temporal resolution to ~2 ms. Thus, although this approach is restricted to imaging Ca^{2+} flux, it will be applicable to diverse channels that show appreciable Ca^{2+} permeability.

Significance: This technique marks an important step in the use of noninvasive optical techniques to examine ion channel kinetics of numerous individual ion channels. The major advantages of this technique include the ability to monitor channel motility over time, spatial resolution of channel locations, and simultaneous comparisons between channel-gating kinetics. As noted by the authors, single-channel imaging may also hold promise as a more approachable high-throughput screening process to determine drug effects on ion channel activities.