Switching of myosin V force generation mode between lever-arm swing and Brownian search-and-catch under load

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Motor proteins are force generating nano-machines that are highly adaptable to their ever-changing biological environments and have a high energy conversion efficiency. Here we constructed an imaging system that uses optical tweezers and a DNA handle to visualize elementary mechanical processes done by a nanomachine while under load. We apply our system to myosin-V, a well-known motor protein that takes 72 nm 'hand-over-hand' steps composed of a 'lever-arm swing' and a 'Brownian search-and-catch'. We find that the lever-arm swing generates a large proportion of the force at low load (< 0.5 pN), resulting in 3 k_BT of work. At high load (1.9 pN), however, the contribution of the Brownian search-and-catch increases to dominate, reaching 13 k_BT of work. We believe the ability to switch between these two force generation modes facilitates myosin-V function at high efficiency while operating in a dynamic intracellular environment.