THE EFFECT OF 2D FORCES ON KINESIN MOTILITY

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Studying how forces affect individual motor proteins can provide important clues to the underlying motility mechanism. Using a recently-developed automated 2D force clamp, we investigated the influence of controlled forces on kinesin motility applied in several directions (forwards, backwards, and sideways) and for various ATP concentrations. Upon application of forward loads out to 8 pN, kinesin speed decreased slightly at saturating [ATP] and increased slightly at limiting [ATP], although these variations were not significantly different from zero. We also found that ATP hydrolysis and mechanical stepping remained tightly coupled under forward loads. In contrast, the application of backwards loads decreased kinesin speed monotonically, exhibiting a stall force of 6-8 pN, in agreement with previous studies from this and other labs. Forces applied in a direction perpendicular to motion (either to the left or right) had a less dramatic effect on kinesin velocity. For example, at saturating [ATP], perpendicular loads out to 8 pN slowed motors by just ~15-30%. Furthermore, the perpendicular force dependence is left/right asymmetric, resulting in different decreases in velocity and processivity for the two directions. Our data also suggest that the perpendicular force dependence varies with ATP concentration.