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Re: Magnetic Resonance Imaging of the Globe–Tendon Interface for Extraocular Muscles: Is There an “Arc of Contact”?



EDITOR:

EACH EXTRAOCULAR MUSCLE NORMALLY LEAVES ITS INSERTION, wraps around the globe along a contact arc, and departs, tangent to the globe (perpendicular to its radius, departure angle = 0), at a departure point en route to its connective tissue pulley or trochlea. Recessed muscles, muscles with posterior sutures, and muscles in extreme ipsiversive gaze can unwrap from the globe, lose tangency (departure angle >0), and suffer their oculorotary force reduced by the cosine of the departure angle.

Clark and Demer¹ mean to cast doubt on the contact arc notion. Accordingly, they looked for departure angles >0, but only with eyes in extreme ipsiversive gaze where muscles were unwrapped from the globe and in abnormal and operated eyes—all cases for which contact arc models would also predict loss of tangency.² Their study therefore does not bear on the existence of contact arcs.

Instead of simply measuring departure angles relative to globe tangents, Clark and Demer¹ wrongly assert that contact arcs require muscles to take straight paths to their anatomic origins, as though pulleys did not exist, and compare their measurements to “predicted” departure angles, determined by globe center (their white pixel “1”), insertion (“2”), and anatomic origin (“4”). Their magnetic resonance imaging analysis is consequently spurious.

Looking away from these conceptual errors, one can ask how large the claimed effects were. The largest deviation from tangency reported for normal eyes is 6.2°. The cosine

of 6.2° is 0.995, which means that the reduction in oculorotary torque related to a loss of tangency is 0.5%. Far from “fundamentally alter[ing] the globe–tendon interface,” effects of this size would best be described as “negligible.”

Nothing in their article in any way discredits existing modeling.

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REPLY



WE THANK DRS. MILLER AND SCOTT FOR REVIEWING OUR work and enabling us to elaborate. As they succinctly state, the “arc of contact” model predicts an extraocular muscle departure angle of 0°—a perfect tangent to the globe whereby all extraocular muscle force parallels globe circumference at the insertion. Given this defining prediction, any data that convincingly demonstrate a significantly nonzero departure angle under appropriate conditions is inconsistent with the “arc of contact” model. Any such inconsistency, if observed, should be interpreted within the context of 2 additional considerations. First, nonzero departure angles are predicted by the arc of contact model when globe rotations exceed an angle where tendon tangency is lost and the only tendon contact with the globe is at the scleral insertion. In other words, the arc of contact predicts a 0° departure angle only when at least some of the extraocular tendon remains wrapped around the globe. Second, a nonzero departure angle would only be problematic for the arc of contact theory were it sufficiently different from 0° to materially affect the mechanics of ocular rotation. We agree that a slightly nonzero departure angle, even if statistically significantly so, may have too small a mechanical effect for its existence to compromise the arc of contact model for practical purposes. We interpret the letter by Miller and Scott as arguing for the second consideration. We maintain that we have provided evidence that nonzero tendon departure angles are often too large to be neglected.