Background

- There are several methods of repairing RRD including pneumatic retinopexy (PnR), silicone oil (SO), and gas pars plana vitrectomy (PPV).
- Retinal displacement, detected by the presence of retinal vessel printings on fundus autofluorescence imaging, is common following PPV (Fig 1).
- Retinal displacement remains a poorly understood phenomenon with unclear pathophysiology.
- A recent study demonstrated that retinal displacement rates are significantly lower with PnR compared to PPV.
- Although a variety of modifications to vitreoretinal surgical techniques have been suggested, there has been no definitive strategy that substantially minimizes the risk of retinal displacement.
- The purpose of this study was to use a theoretical computer simulation model to assess the forces at play in retinal displacement.
- Hypothesis: retinal displacement will result if the retina adheres to the retinal pigment epithelium (RPE) in a state of stretch or compression (Fig 2).

Methods

- To understand the mechanism of retinal displacement, we consider the interaction between the tamponade and the retina.
- The Bond number (Bo) is a measure of the tamponade forces against the retina to deform it, and the interfacial tension forces attempting to maintain the spherical shape of the tamponade. It is defined as:
  \[ Bo = \frac{\Delta P g a^2}{\gamma} \]
- Small Bo: tamponade nearly spherical, and will have a relatively small contact area (e.g., PnR and SO).
- Big Bo: the tamponade will be highly deformed with a nearly flat bottom, and will have a relatively large contact area (e.g., PPV).

Results

- The retinal displacement profile, which is the component of the displacement field (µm) on the inner retina in the θ direction for PnR, PPV and SO at (a) 1 s, (b) 1 min, (c) 10 min, (d) 1 hr. The initial thickness of the subretinal film is 200 µm. Bottom of the images represent the anterior portion of the eye.

Conclusion

- The results of this study demonstrate that iatrogenic flow of subretinal fluid induced by the buoyant force of the endotamponade leads to retinal stretching and displacement.
- Retinal stretch occurs less significantly with PnR and SO compared to PPV.
- This model provides a framework with which variations in surgical technique can be simulated to determine how retinal displacement can be minimized.
- Future studies will consider patient positioning following RRD repair surgery, a 3-dimensional model of fluid relocation, and the thickness of the subretinal fluid before endotamponade injection.