

Advantages of Mitomycin-augmented Nonpenetrating Deep Sclerectomy (NPDS) in Post-uveitic Glaucoma leading to the discovery of the “Jigsaw effect”

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Abstract:

Purpose:

High intraocular pressure (IOP) has been documented as a source of damage to the optic nerve, resulting in severe vision problems, potentially leading to blindness. Glaucoma and cataracts are two common comorbid eye conditions that can progress to blindness, being the top two leading causes of blindness worldwide. Glaucoma has been shown to be associated with cataract development. The goal of glaucoma treatment is to preserve visual fields and optic disc function, which is managed by IOP reduction to preserve optic function.

Minimally invasive glaucoma surgery (MIGS) with cataract surgery has incidentally risen in popularity in recent years over trabeculectomy, which has been the initial surgical treatment of choice for years.^{1,2} However, surgical invasion of the anterior chamber (via trabeculectomy, tube shunt, or MIGS) can induce iatrogenic primary uveitis and reactivation or exacerbation of pre-existing uveitis, worsening actual clinical outcomes while falsely exaggerating the IOP-reducing efficacy of the treatments in question. Active uveitis can inhibit aqueous secretion, producing hypotony maculopathy, the visual impact of which may persist long after IOP is normalized. Pigment-laden macrophages and PAS can obstruct trabecular outflow and produce massive IOP increase once ocular inflammation has been successfully controlled.

Mitomycin-augmented non-penetrating deep sclerectomy (NPDS) is a surgical filtering procedure designed to significantly lower intraocular pressure (IOP) without damaging the trabecular endothelial layer, thus reducing risks of postoperative hypotony, hyphema and inducing other inflammatory processing (figure 1).^{3,4} Mitomycin C has been shown to improve surgical NPDS outcomes by reducing fibrosis and hyperemia and thereby enhancing the decrease of IOP.³

Methods:

This is a follow-up retrospective review and analysis study utilizing data that has been collected in a previous Institutional Review Board (IRB)-approved retrospective study that included all eyes of patients undergoing planned NPDS surgery and its correlation to the discovery of the “Jigsaw effect”.^{4,5} Heat maps were generated allowing quantitative visualization of left and right eye thresholds and their actual HCD binocular projections versus those based on the 47 means of the 470,000 co-isopteric pairings. Distributions of actual (a) versus mirror-image (c) HCD values were also generated to assess the relative contribution of simple anatomic symmetry as a binocular compensatory factor.

Results:

Following NPDS, a sustained mean IOP decrease of 10mmHg (45%) was sustained (figure 2), with stable acuity, substantially increased perimetric function and a 90% reduction in medical therapy requirement (figure 3). HVFA 30-2 Visual Field Results: Mean Deviation reflected a strong intra-eye correlation ($R=0.89$) between baseline and postoperative mean deviation (MD) values with a propensity for postop improvement in MD (+1.3 dB; $P=0.0002$) (figure 4). After NPDS surgery, visual field analyses remained remarkably consistent, with evident disappearance of intermediate “grey” and consolidation of “black and white” areas corresponding closely to extinct and extant axonal areas, respectively, on corresponding OCT nerve fiber layer analysis (figure 5).

Conclusion:

Mitomycin-augmented NPDS has shown to be very effective and minimally invasive without disrupting the trabecular meshwork. Doing so, avoids the post-op inflammatory cascading events that can commonly occur in surgeries involving the anterior chamber. Additionally, post-NPDS residual visual field pairs like these provided the first evidence toward confirming CNS-directed bilateral conservation of function in any age-related neurodegeneration and lead to the discovery of the “Jigsaw Effect”. As glaucoma progresses, the two eyes and brain are essentially working as a single entity, maintaining the best possible binocular visual field. With present day technology, this discovery of bilateral conservation of function in an age-related neurodegenerative condition could not be readily demonstrated using any system other than the visual pathways, where 2-dimensional functional concordance is so readily mapped, and testing can be carried out competently in a cognizant patient even when a very high proportion of relevant axons are dead. This finding suggested that neuroplasticity via SC border cells that can function as either right- or left-eye input receptors may further enhance the brain’s capacity to help compensate for what might otherwise be overlapping zones of functional loss. NPDS has made it possible to significantly advance our understanding of CNS compensation in age-related neurodegeneration.

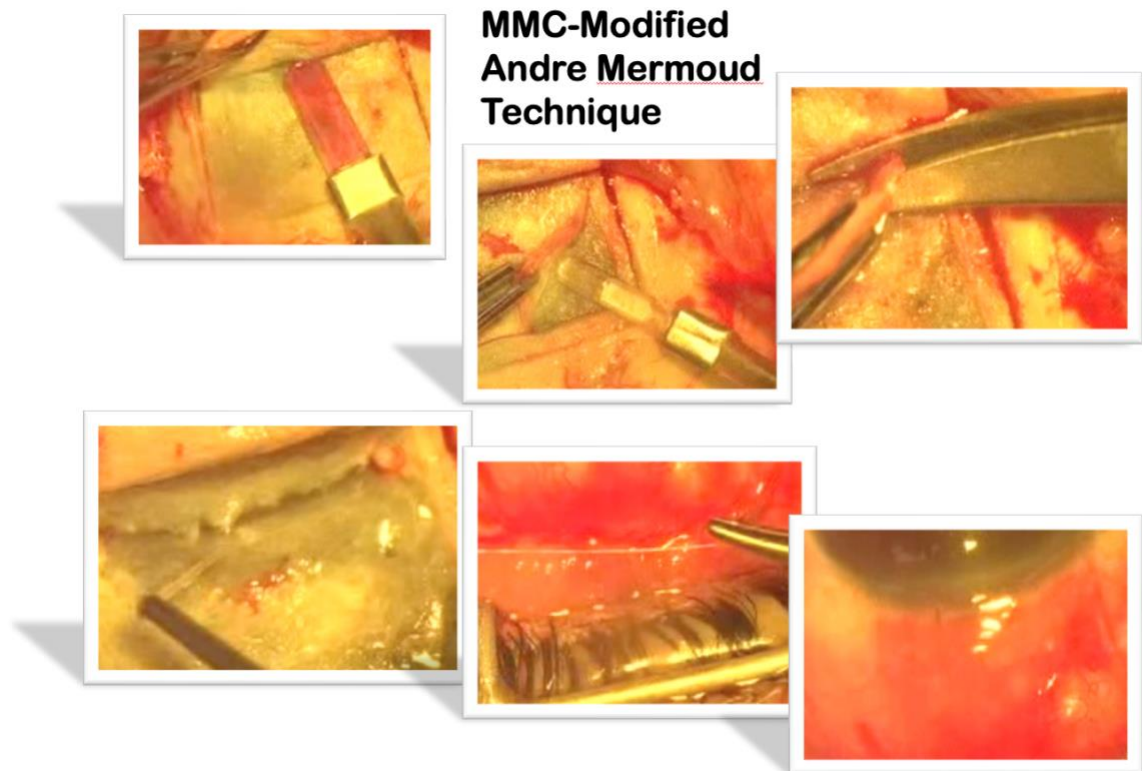
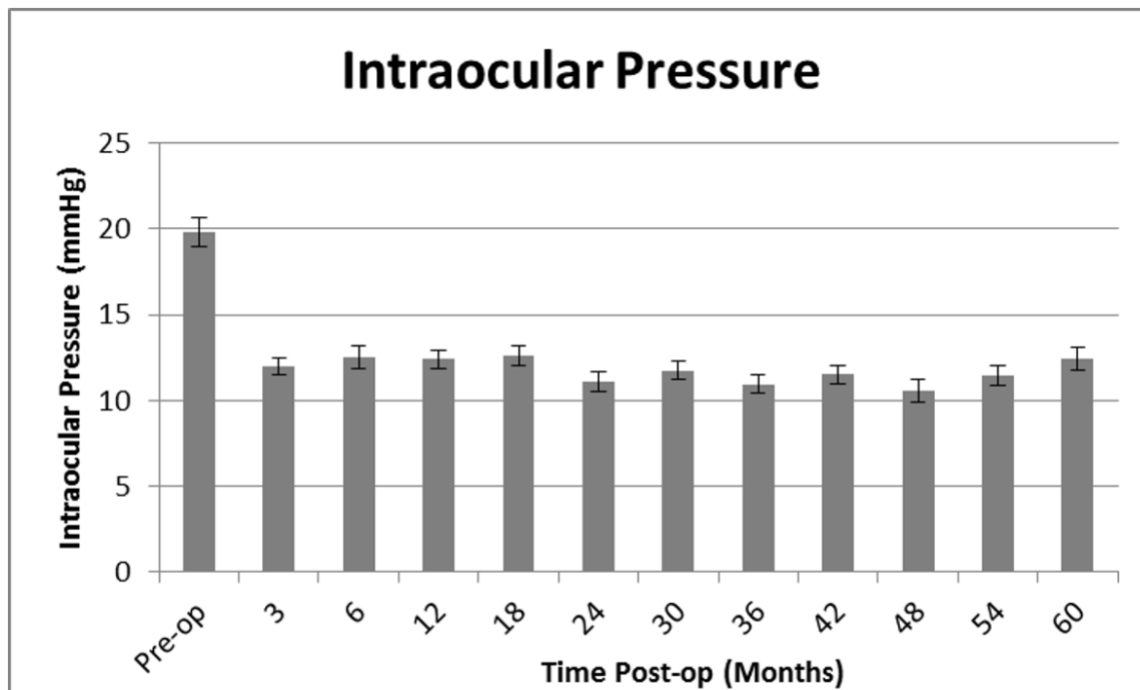
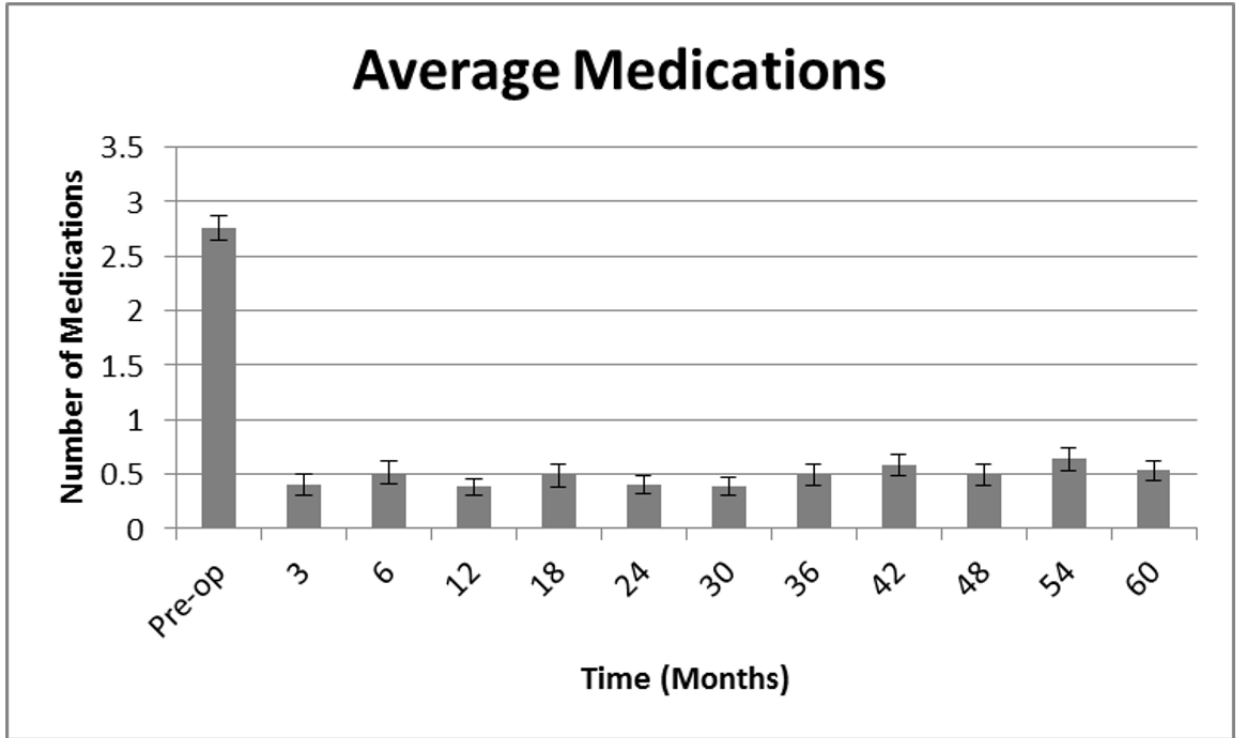


Figure 1: Mitomycin-augmented Nonpenetrating Deep Sclerectomy (NPDS)



At 5 years, $p < 10^{-6}$

Figure 2: Post-op IOP over 5-years



At 5 years, $p < 10^{-20}$

Figure 3: Average number of medications used post-op over 5 years.

NOTE:

- 1) the strong intra-eye correlation ($R=0.89$) between baseline and postoperative mean deviation (MD) values
- 2) the propensity for postop improvement in MD (+1.3 dB; $P=0.0002$)
- 3) *not* a learning effect (mean of 6 preop HVF)

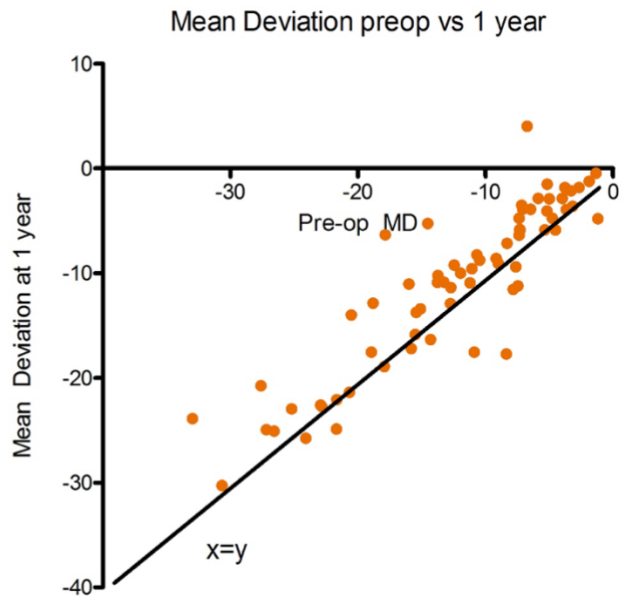
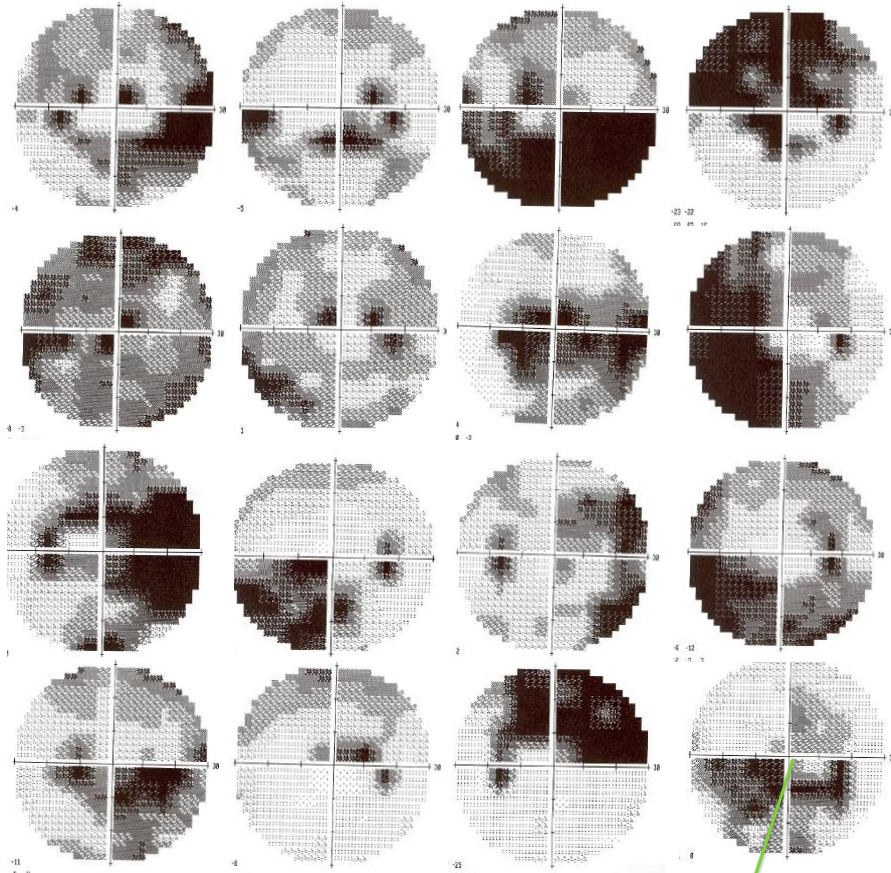


Figure 4: HVFA 30-2 Visual Field Results: Mean Deviation



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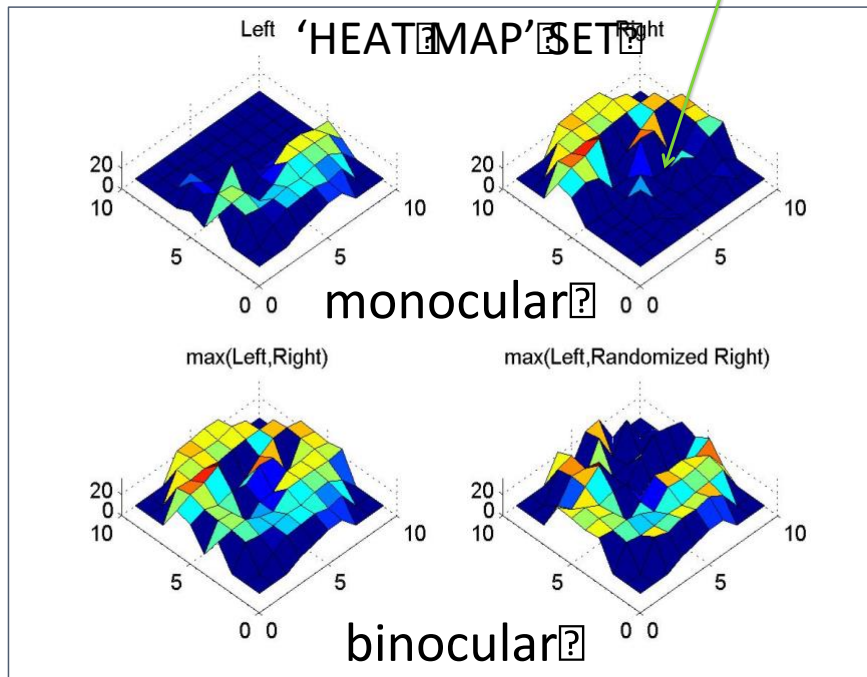


Figure 5: Post-op visual field with heat map pairing.

Citations:

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