

Postoperative Management of Dry Eye Conditions following LASIK: A subjective pilot study comparing viscous eye drops (Systane®) and viscoadaptive eye drops (I-Drop®)

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Abstract

Purpose: A pilot study evaluating two commercially available eye drops, Systane (Alcon) and I-Drop (Biocia) was conducted on 20 post-LASIK surgery patients in order to measure subjective outcome parameters. The rheological properties of four commercially available dry eye solutions were studied to determine dynamic elastic and viscous modulae of these solutions.

Methods: Twenty consecutive patients presenting for LASIK surgery were enrolled in the comparative pilot study. Rheological evaluations were performed on four commercially available dry eye solutions. A Bohlin VOR rheometer was used to study dynamic elastic and viscous modulae of all four solutions with special focus on the mean blinking frequency (8 Hz).

Results: Both eye drops appear to have a similar mechanism of action, i.e. a mucoadhesive artificial tear substance which is adherent to the ocular surface for long lasting protection, coating and moisturizing as a either a viscous shield, in the case of Systane, or a viscoadaptive shield with I-Drop. Comfort and residence time appear to be clinically similar. However, immediate clarity of vision was superior with the viscoadaptive I-Drop. Results from this evaluation indicate that 80% of patients preferred I-Drop over Systane because they experienced less immediate blurring of vision following administration. Forty percent of patients indicated that I-Drop felt more comfortable and 60% felt that there was no difference while none preferred Systane as a tear substitute. Ninety percent of patients indicated that there was no difference between the number of applications required for both products and 70% of patients indicated that they preferred I-Drop over Systane. The rheological evaluations of four commercially available dry eye solutions show that I-Drop exhibits clearly different physical chemical characteristics when the dynamic viscous and elastic modulae were measured. It is postulated that these rheological differences translate to desirable clinical characteristics.

Conclusions: This subjective pilot study was designed to compare the physical characteristics of four commercially available dry eye solutions and therapeutic differences of two commercially available eye drops. Results suggest that further clinical evaluations are required to objectively substantiate the clinical advantages of I-Drop as a unique viscoadaptive eye drop. This study is presently ongoing at the Diamond Vision Laser Center with preliminary results compatible with the findings reported in this monograph.

Methods & Materials

A commercially available viscous eye drop was selected that is promoted for its high lubricity containing a polymer system and HP-Guar formulation (Systane). This ocular lubricant has recently met with wide acceptance as an ocular lubricant. A new eye drop that has viscoadaptive properties (I-Drop) was selected for comparison. I-Drop is composed of hyaluronan as a delivery vehicle for the glycerin lubricant and provides a high degree of long-lasting moisturizing with clarity of vision. Twenty post-operative LASIK patients were given unit-dose, preservative-free samples of both eye drops. They were instructed to use I-Drop in the left eye and Systane in the right on the first day and then to switch to Systane in the left eye and I-Drop on the right for the second day. Then alternate each product in each eye for the next four days (for a total of six days after surgery) so that the eye receiving I-Drop on the previous day would receive Systane on the subsequent day and visa-versa. A questionnaire was presented to each of the twenty patients which included the following four questions:

1. Which product causes more blurring of vision after application?
2. Which product feels more comfortable on your eye?
3. Which product requires more frequent applications to provide relief from discomfort throughout the day?
4. Which product do you prefer?

Materials for the rheological study were purchased from regular commercial sources and the solutions were measured in a Bohlin VOR rheometer. This is a computerized rheometric system that measures stress resulting from controlled deformation. Dynamic rheological properties were measured in the oscillation mode. The storage modulus G' characterizes the elastic behaviour and the loss modulus G'' characterizes the viscous behaviour of the material.

2. Which product feels more comfortable on the eye? 8 of the 20 respondents preferred I-Drop and the remaining 12 of the 20 respondents felt there was no difference.

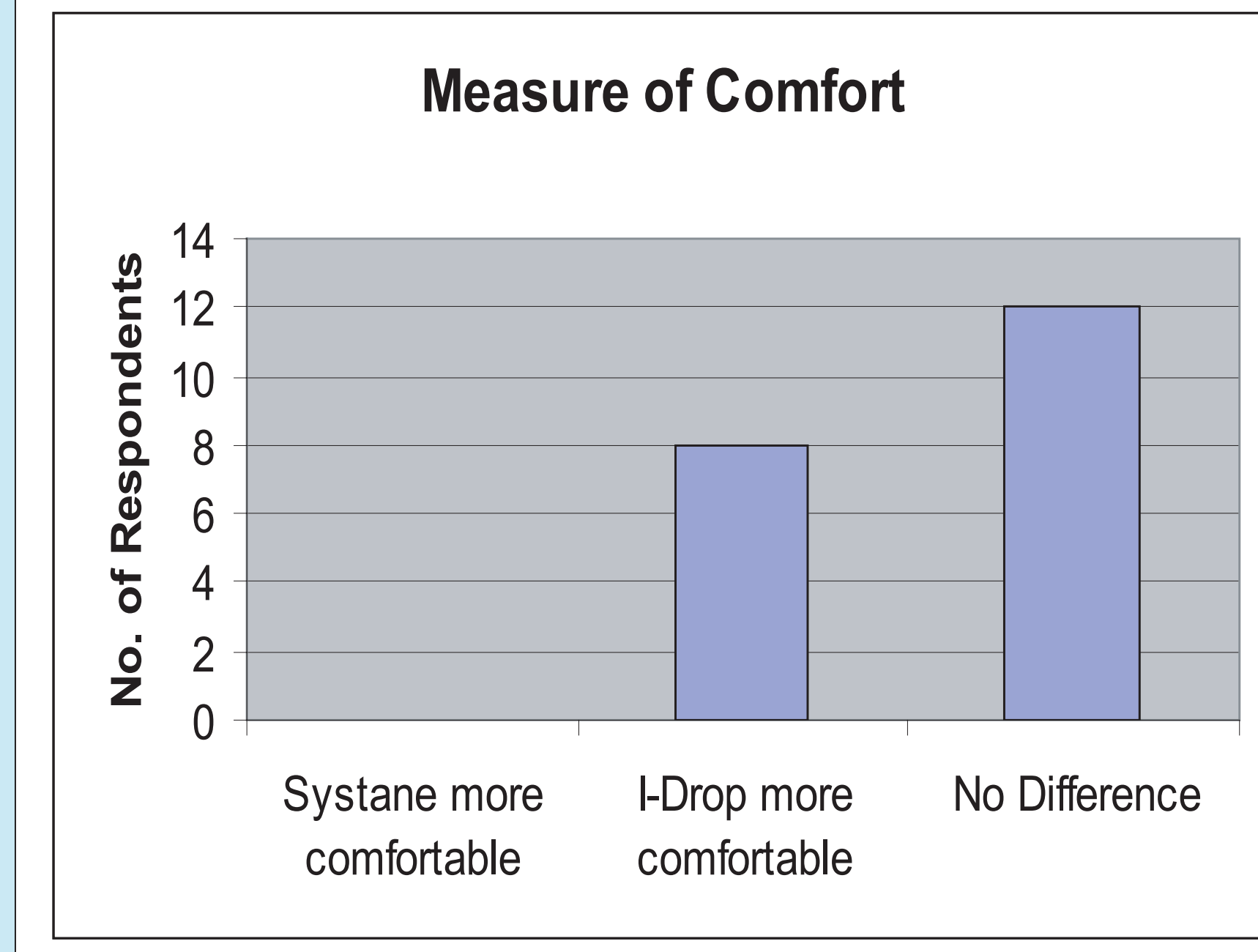


Fig 2: Comparison of comfort as a result of products used

4. Which product do you prefer? 14 of the 20 respondents preferred I-Drop. The Systane cohort cited the facility of the administration of this unit-dose package which was easier to compress and contained twice the amount of fluid.

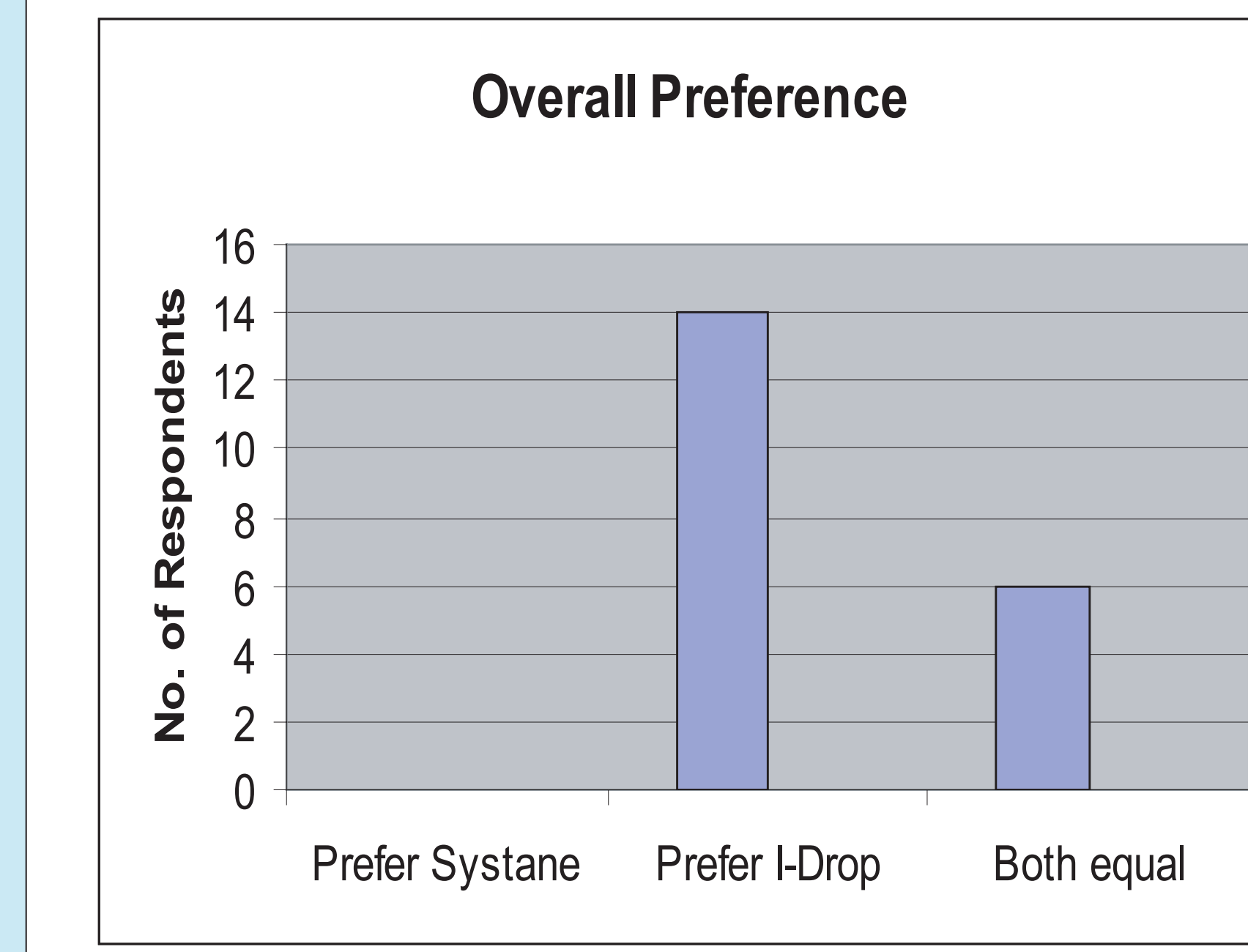


Fig 4: Comparison of overall preference of products used

In addition, a comparison of rheological properties of several commercially available dry eye drops was performed. In particular the dynamic elastic modulus (G') and the dynamic viscous modulus (G'') of these products were plotted in relation to the blinking frequency. These results are presented in Figures 5 and 6 below.

3. Which product requires more frequent application? 18 of the 20 respondents felt there was no difference between the two products. 2 of the 20 respondents indicated that I-Drop required more applications.

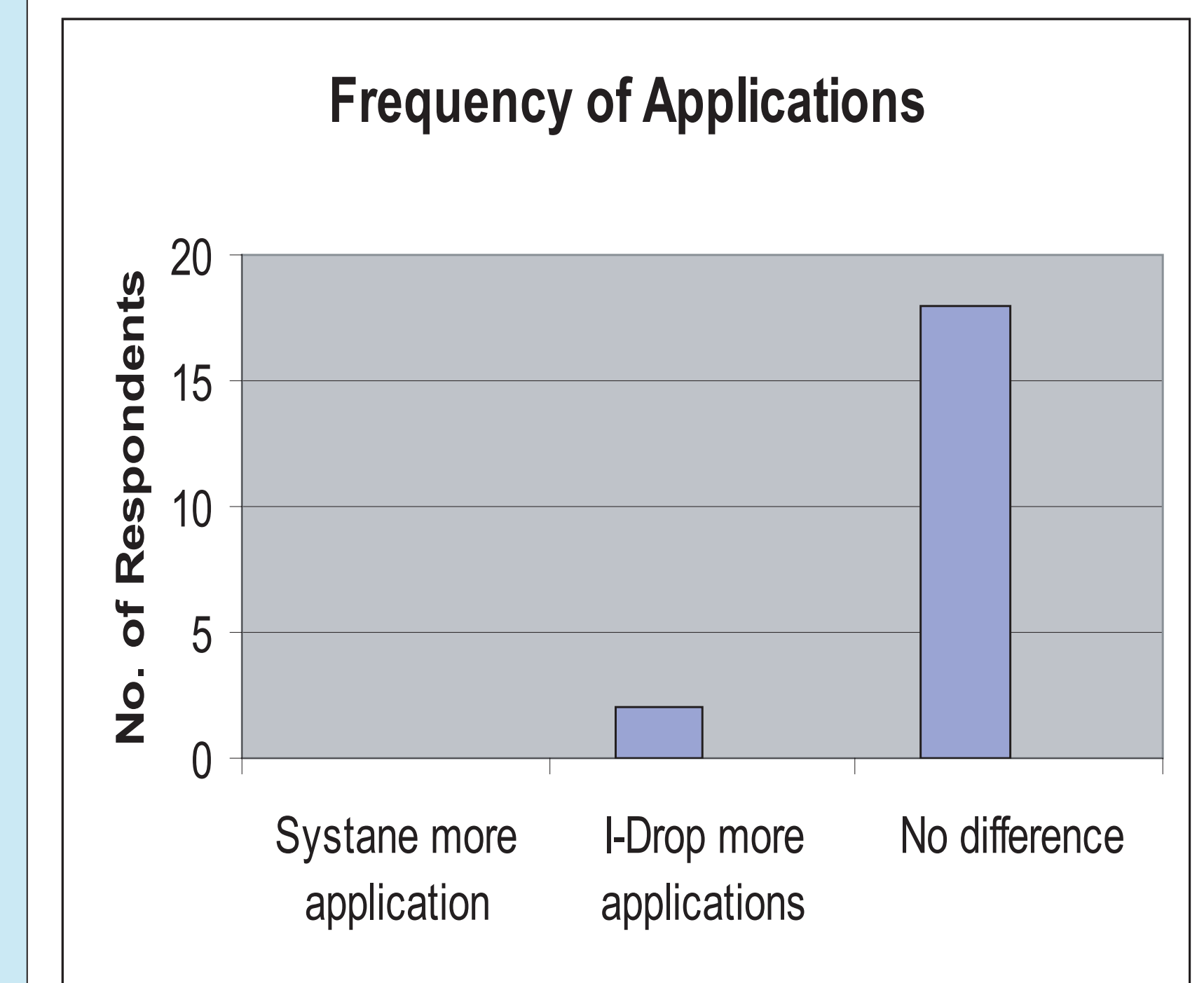


Fig 3: Comparison of frequency of applications of

Results

1. Which product causes more blurring? 16 of the 20 respondents stated that Systane caused more blurring. This group lauded the clarity of I-Drop and felt it reassuring to have rapid visual recovery following LASIK. 4 of the 20 respondents did not feel there was a significant difference.

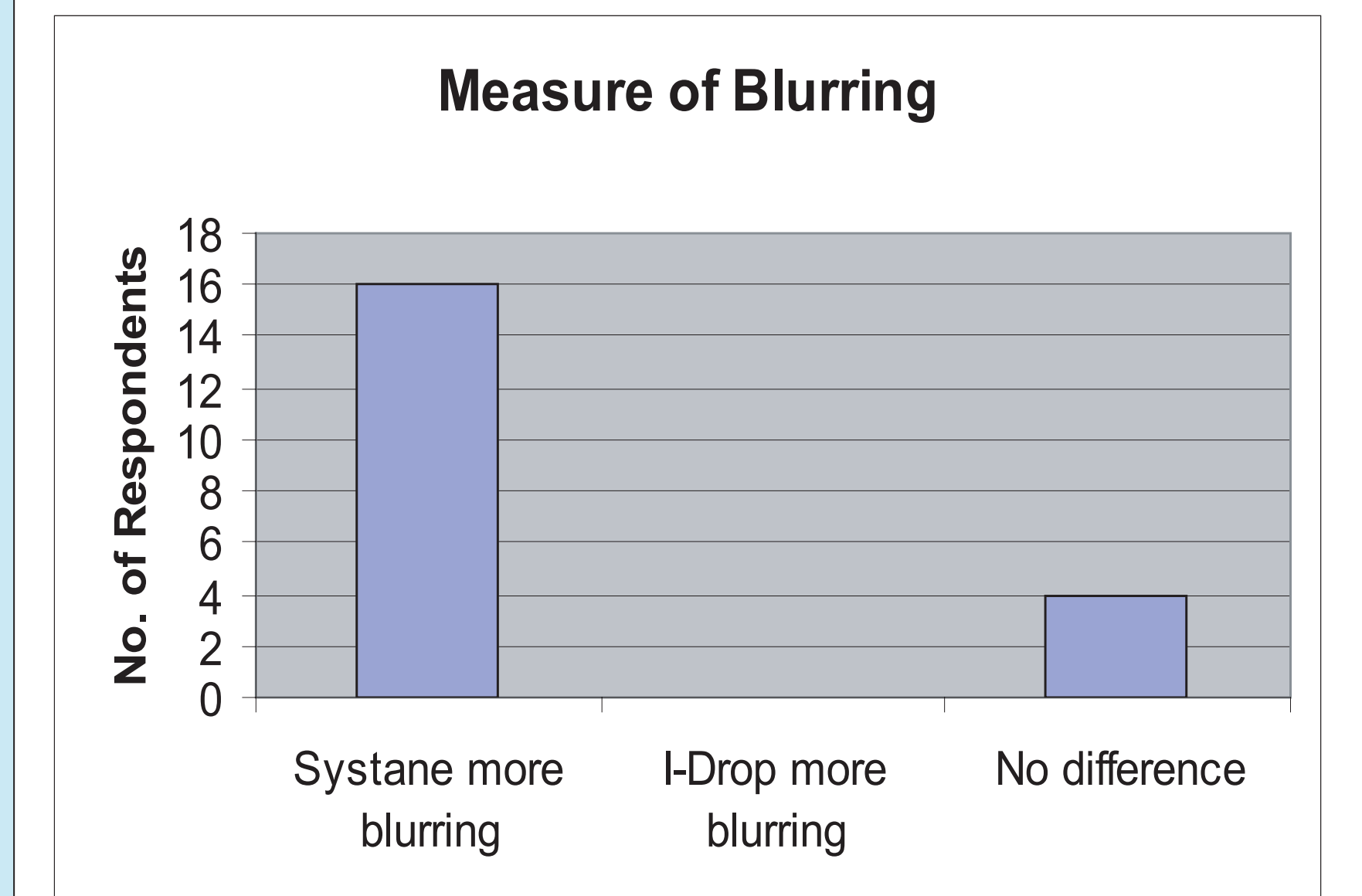


Fig 1: Comparison of blurring by products used

Introduction

Over the past decade refractive surgery has continued to grow so that it is now a dominant surgical procedure in ophthalmology. The leading refractive operation is laser in situ keratomileusis (LASIK). In this instance, a surgical flap of the outer third of the cornea is generated and a controlled Excimer laser ablation is applied to the underlying stroma changing the shape of the cornea to correct optical aberrations. The creation of the flap allows a painless ablation of the stroma while the highly sensitive corneal epithelium is left intact and a comfortable postoperative course is achieved. However, the cutting of the stromal corneal nerves results in a denervated cornea which suppresses the normal stimulus for tear generation. The production of sufficient tears both in quantity and quality is essential to corneal health and comfort. The tear film is a complicated entity consisting of an aqueous layer sandwiched between oily and fatty layers abounding with various proteins. The reduction in neuronal feedback to the brainstem reduces the normal stimulus to the lacrimal glands and diminishes tear production.² However, the nerves regenerate and corneal sensation usually returns in 3 to 6 months.³ During this recovery phase, continuous ocular lubrication and moisturizing is essential for comfort and optimal vision.⁴ Prior to this decade the most common tear substitutes were viscous. These compounds usually consisted of hydroxycarboxy methylcellulose or polyvinyl alcohol were relatively effective as far as protecting the corneal surface but blurring of vision for prolonged periods was a common complaint, especially if higher concentrations were used in certain popular commercially available eye drops. In the nineties, viscoelastic polymers were introduced which attempted to address the limitations of the viscous eye drops. However, while blurring was reduced, the frequency of applications was still relatively high as in the case with viscous eye drops. Now, in the 21st century the first viscoadaptive eye drop has been developed which provides superior comfort, prolonged moisturizing, surface contact longevity and visual clarity. In order to substantiate these claims a comparative clinical study was performed to test these precepts. The study compares the subjective clinical response post-LASIK to two eye drops exhibiting viscous (Systane) and viscoadaptive (I-Drop) properties.

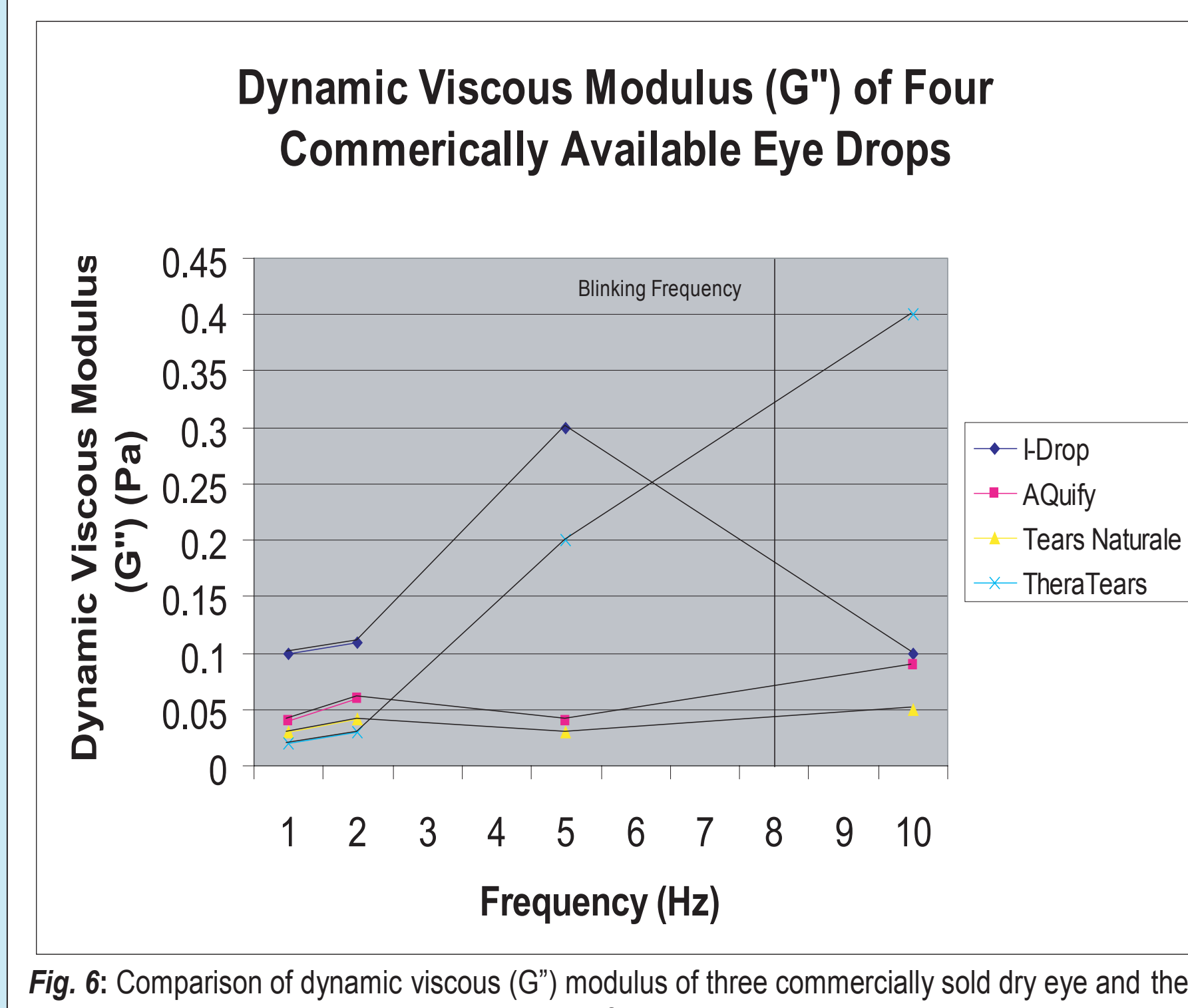


Fig 6: Comparison of dynamic viscous (G'') modulus of three commercially sold dry eye and the new viscoadaptive I-Drop, in relation to blinking frequency

Discussions

The challenge of making the ideal lubricant eye drop is to create a formulation which provides lasting lubrication and moistening to the surfaces of the corneal epithelium and inner eye lids without causing a foreign body sensation or blurring of vision. It must be a biocompatible formulation without adverse effects. It must have long residence time and be cost effective. Finally it should be preservative-free.

For decades the most common tear substitutes were viscous. Viscous solutions become more effective as the concentration increases; however, as concentration is increased, the solutions become more uncomfortable to the patient. Also, as the concentration of viscous eye drops is increased, residence time can become diminished because the higher concentrated viscous solutions tend to cause blurring of vision and foreign body sensation. This produces excessive blinking which results in rapid elimination from the corneal surface. Therefore this group of tear substitutes have limited efficacy.

With viscoelastic eye drops, the concentration and molecular weight of the biopolymers in the solution can affect the duration of residence time, patient comfort and the degree of moisturizing the vital surfaces of the eye. Increases in the concentration or molecular weight of viscoelastic eye drops may result in greater patient comfort and longer residence time but concomitant blurring of vision can occur which can be debilitating and potentially dangerous to the patient, especially during the three to six month post-LASIK phase when the patient is involved in daily activities.

Systane eye drops contain a unique gelling and lubricating polymer system. The polymerizing protection of Systane is achieved through the interaction of demulcents (polyethylene glycol 400 and propylene glycol), HP-Guar and the natural tears. When HP-Guar combines with natural tears, a chemical reaction occurs. HP-Guar binds to the hydrophobic surface, forming a network with gel-like consistency. HP-Guar helps keep the demulcent system on the surface longer. This creates an ocular shield, allowing epithelial repair in a healthy environment. In addition Systane's lubricity has been compared with other popular tear substitutes and found to be superior.⁵

I-Drop exhibits both viscous and viscoelastic properties and therefore claims the role of a "viscoadaptive" tear replacement. The viscous glycerol has dispersive physical properties due to the low molecular weight of this biopolymeric molecule. The viscoelastic hyaluronan component exhibits cohesive physical properties. In combination, these biopolymers within the I-Drop viscoadaptive eye drop provide excellent blink-activated coating and recoating of the surfaces of the eye, for superior moisturizing and lubrication, for enhanced patient comfort and longer residence time without blurring of vision or foreign body sensation. The unique elastic and pseudoplastic properties of the hyaluronan component assists in keeping the mucoadhesive glycerin lubricant on the ocular surface longer resulting in enhanced residence time.⁶

The rheological data presented in Figures 5 and 6 indicate that when I-Drop is compared to a viscoelastic solution such as AQuify® (0.1% sodium hyaluronate) it has superior elastic properties. This is usually a function of molecular weight, thus suggesting that the sodium hyaluronate in I-Drop has a higher molecular weight than that for AQuify. When viscous properties are compared in Figure 6, it may be noted that I-Drop has viscous properties no only higher than that measured for the viscous eye drops (Tears Naturale® and TheraTears®) but also higher when compared to the viscoelastic AQuify at rest but this changes dramatically during blinking (approximately 8 Hz). This may explain the observations made by the 20 post-LASIK surgery respondents in this study, noting that I-Drop causes less blurring than the viscous Systane solution. From the rheological graphs (Fig. 5 and 6) it can be seen that I-Drop exhibits superior elastic and viscous modulae especially in the blinking frequency range (8 Hz). These rheological properties suggest that this solution will cause less blurring than viscous solutions and will more easily resurface the cornea with each blink (blink activation) thus providing a longer residence time.

This subjective pilot study, which was designed to compare the physical and therapeutic differences of two commercially available eye drops, suggests that further clinical evaluations are required to objectively substantiate the clinical advantages of I-Drop as a unique viscoadaptive eye drop. This study is presently ongoing at the Diamond Vision Laser Center with preliminary results compatible with the findings reported in this monograph.

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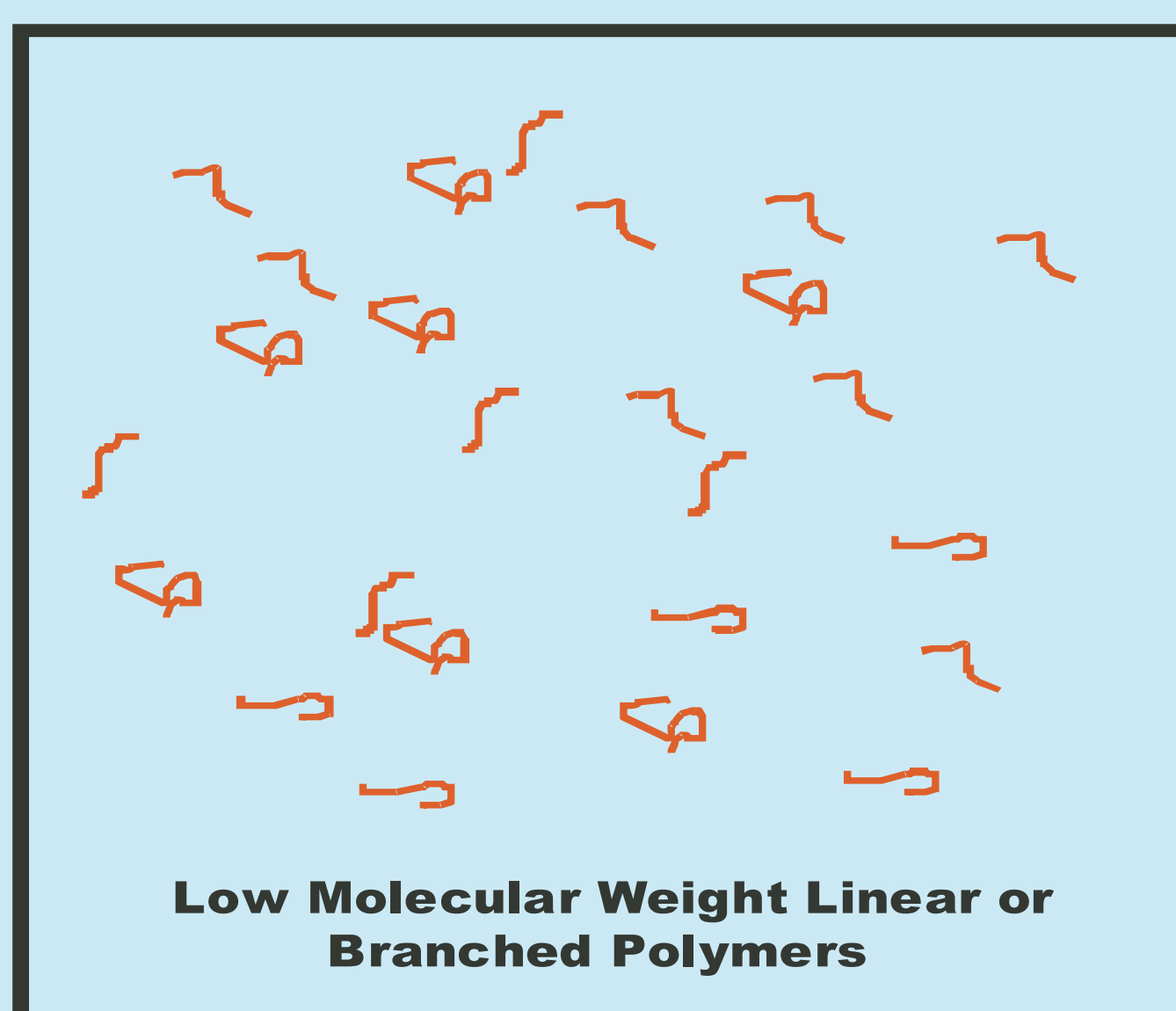
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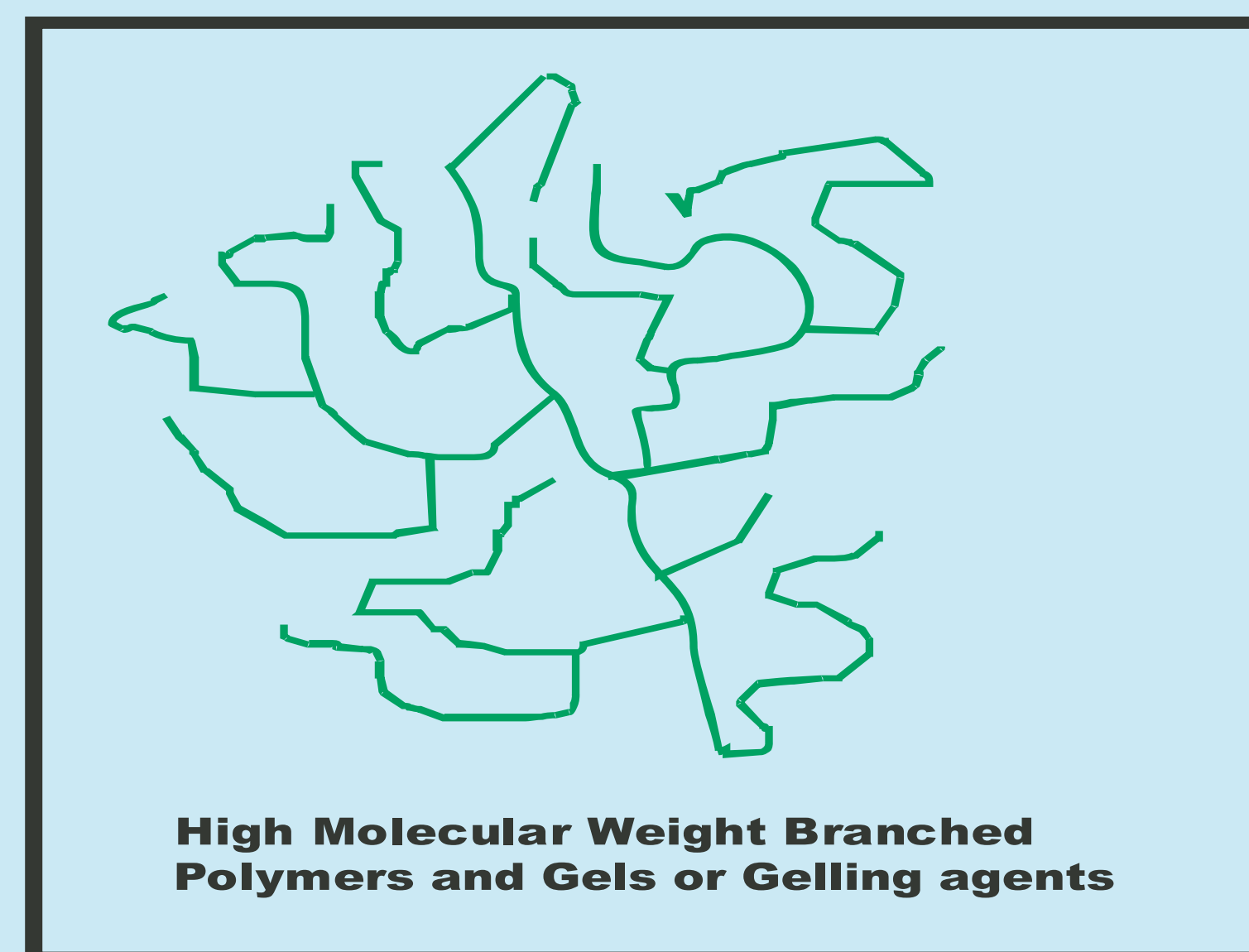
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Composition of Common Viscous Eye Drops

DISPERSIVE & ADHESIVE

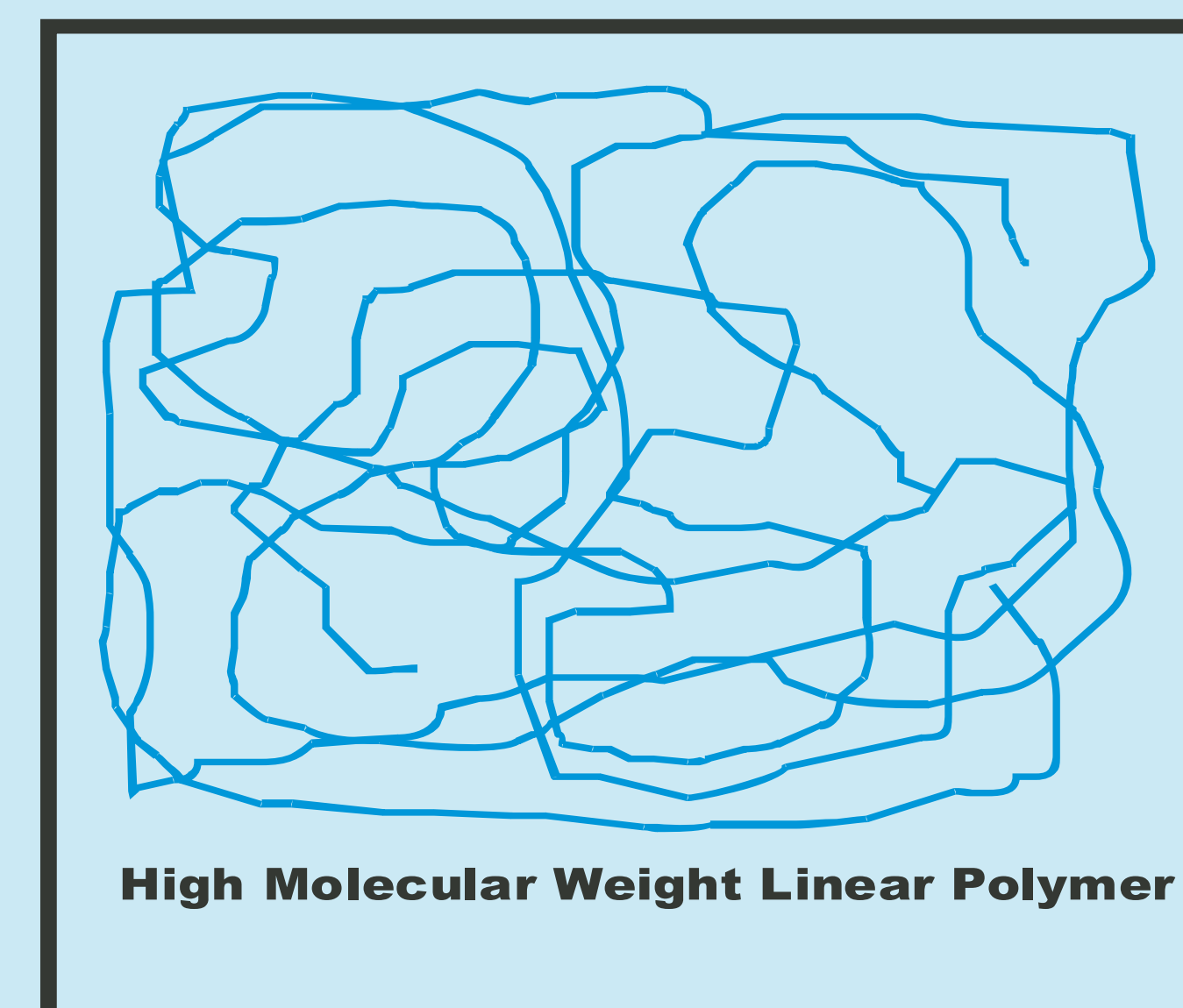


DISPERSIVE



Composition of Viscoelastic Eye Drops

COHESIVE



Composition of Viscoadaptive Eye Drops

COHESIVE & DISPERSIVE

