THE EFFECTS OF PRISM BALLASTED SOFT TORIC CONTACT LENSES ON THE CORNEA

MARCH 17, 2000

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Abstract

Purpose: To evaluate the effects of prism ballasted soft toric contact lenses on the cornea.

Methods: Eight toric contact lens wearers who showed corneal topographic changes upon examination were asked to discontinue contact lens wear. The Humphrey corneal topographer was used to evaluate the greatest areas of change. Topographies were taken on the day of discontinuing contact lens wear and monthly thereafter until the corneas appeared to become stable. The topographies were then compared using the healing trend difference plot.

Results: Corneal changes were observed both superiorly and inferiorly. No specific steepening or flattening trend was observed superiorly, however twelve of the sixteen eyes showed a steepening trend inferiorly. Most of the eyes showed the greatest amount of change one month after discontinuing contact lens wear.

Conclusion: The types of changes that may occur after contact lens wear may vary from patient to patient, therefore the importance of evaluating contact lens wearers for contact lens induced corneal changes should not be overlooked. Corneal topographies should be taken before fitting a patient with contact lenses and periodically thereafter to monitor any corneal changes that may be caused by contact lens wear.

Introduction

The following discussion will highlight several patients who exhibit corneal changes as a result of prolonged exposure to prism ballasted toric lenses. The patients in this study wore toric lenses for several years prior to discontinuing contact lens wear temporarily. Only patients who appeared to have lens induced corneal topographic alterations on the day of contact lens removal were chosen for this study. Previously, change in the corneal shape had mostly been associated with rigid gas permeable and PMMA lenses (8). The focus of this paper is to prove that soft toric lenses can also cause corneal changes. It will also focus on the cornea's stabilization trend.

This paper will show that individual topography data points can not be focused on for comparison purposes, but that overall topography plots can be inspected for trends and differences. Instead of focusing on individual specific points, smaller areas of curvature provided significant data for curvature comparisons. The Humphrey Corneal Topography System enabled the type of comparisons necessary to determine subtle changes of the cornea due to contact lens wear.

Patients and Methods

Seven females between the ages of 32 and 46 and one male aged 21 who had worn soft toric contact lenses for at least two years prior were asked to temporarily discontinue contact lens wear. These eight patients were chosen from a larger population because they exhibited topographical changes during their examinations. Fifteen eyes had cylindrical correction of at least 1.25 Diopters. Only one eye did not have cylindrical correction. Cylindrical correction ranged from 1.25 D to 4.00 D with an average of 1.63 D. None of the subjects had any ocular history of corneal disease, trauma, or surgery.

The Humphrey System was used to evaluate all of the corneas. A tangential view was used to measure change in corneal curvature. The Healing Trend Difference plots compare each visit and calculate the overall difference in power and curvature. The custom view allowed three discrete exams to be compared simultaneously. The cursor was manipulated carefully to position the cross hair display on the area of greatest localized change. Topographies were recorded immediately after removing the contact lenses and monthly until the topographies appeared stable. Stability was determined by visually inspecting the Humphrey Corneal Topographic maps and interpreting the gradient color scales.

Results

Each patient's cornea stabilized as can be seen based on a visual inspection of each patient's corneal topography (Humphrey Plots 1-40). All of the patients eventually stabilized; however, a repeatable stabilization pattern was not present amongst all the patients. Specific points on the surface could not be analyzed and compared to create an empirical constitutive relationship, but rather served to create a color gradient plot that could be visually inspected and compared between patients.

While looking at the specific area of greatest change it was difficult to associate a specific trend superiorly amongst the patients. Half the eyes initially showed superior flattening while the other half showed superior steepening (plots 1-2). A repeatable pattern was not discovered. However, the topographies did show a steepening pattern inferiorly on most of the corneas. Twelve eyes showed inferior steepening and only four eyes showed inferior flattening (plots 3-4).

Although a specific healing trend was not observed, most of the patients appeared to have the greatest amount of change during the first month after discontinuing contact lens wear and eventually all the corneas stabilized. Superiorly, six eyes appeared to stabilize after one month. Three other eyes appeared to have the greatest change in diopters during the first month, while four eyes appeared to have the greatest change during the second month after discontinuing of contact lens wear. One eye required three months to stabilize and two eyes required four months (plots 1-2).

Inferiorly, seven eyes appeared to stabilize after one month. Another eight eyes appeared to have the greatest amount of change during the first month and one eye showed the greatest amount of change to have occurred during the second month after discontinuing contact lens wear. Only one eye required three months to stabilize and two eyes required four months to stabilize (plots 3-4).

All of the patients' meridian of maximum change in the superior direction ranged from 78 degrees to 128 degrees (for left and right eyes) with an average meridian of 94.5 degrees for the right eyes and 88.8 degrees for the left eyes (plots 5-6). The range for the inferior direction was 254 degrees to 294 degrees (for left and right eyes) with an average meridian of 275.3 degrees for the right eyes and 269 degrees for the left eyes (plots 7-8). It can be concluded that the averages for inferior and superior meridians for all the patients fall within five degrees of the major vertical meridians.

All of the patients' distance from the vertex in the superior direction ranged from 1.78mm to 3.33 mm (for left and right eyes) with an average distance of 2.42mm for the right eyes and 2.71mm for the left eyes (plots 9-10). The range for the inferior distance was 1.57mm to 3.84mm (for left and right eyes) with an average distance of 2.82mm for the right eyes and 2.61mm for the left eyes (plot 11-12). It can be concluded that the averages for inferior and superior distances from the vertex were within 3.84mm of the vertex.

Discussion

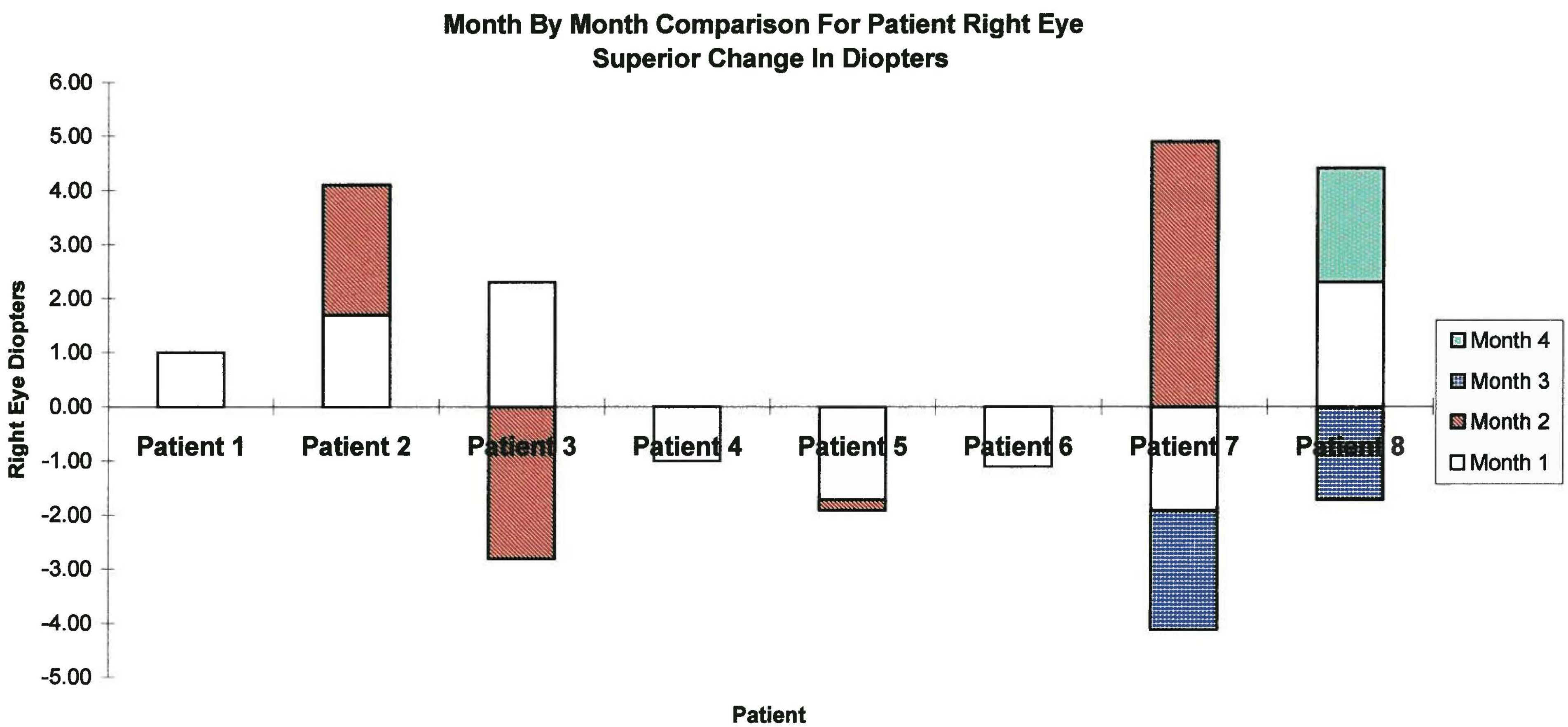
The results in this study indicate that prism ballasted soft toric contact lenses can cause changes in corneal curvature. A specific trend was not observed superiorly but inferiorly the contact lenses appear to cause steepening although this is not the rule. Lebow and Grohe (2) did find superior corneal flattening and inferior corneal steepening induced by contact lens wear which was similar to patients with keratoconus. The findings in many other studies have shown variation, with relative steepening in corneal contour being detected in some and flattening in others (3, 8, 9, 11).

Gas Permeable and PMMA lenses have been found to cause corneal warpage in a pattern that is related to the contact lens fit (3, 6, 8, 9, 11). Maeda and co-authors found a correlation between the topography and resting position of the contact lens in most corneas with warpage from a rigid contact lens (1). This may also hold true for soft contact lenses , however it is difficult to make such a correlation with soft contact lenses because they conform to the shape of the cornea. McCarey and co-authors address this issue in their study (4, 5). They state that a toric soft contact lens shapes itself or flexes to conform to the anterior corneal curvature. The factors affecting lens flexure are: material mechanical properties, cross-sectional thickness (i.e., lens power), diameter, and the ratio between contact lens base curvature and corneal anterior curvature (5). All of these factors may play a role in corneal changes due to soft toric contact lens wear. Furthermore, corneal warpage may result from the mechanical action of the lens on the cornea, contact lens interference with corneal metabolism, or both (1).

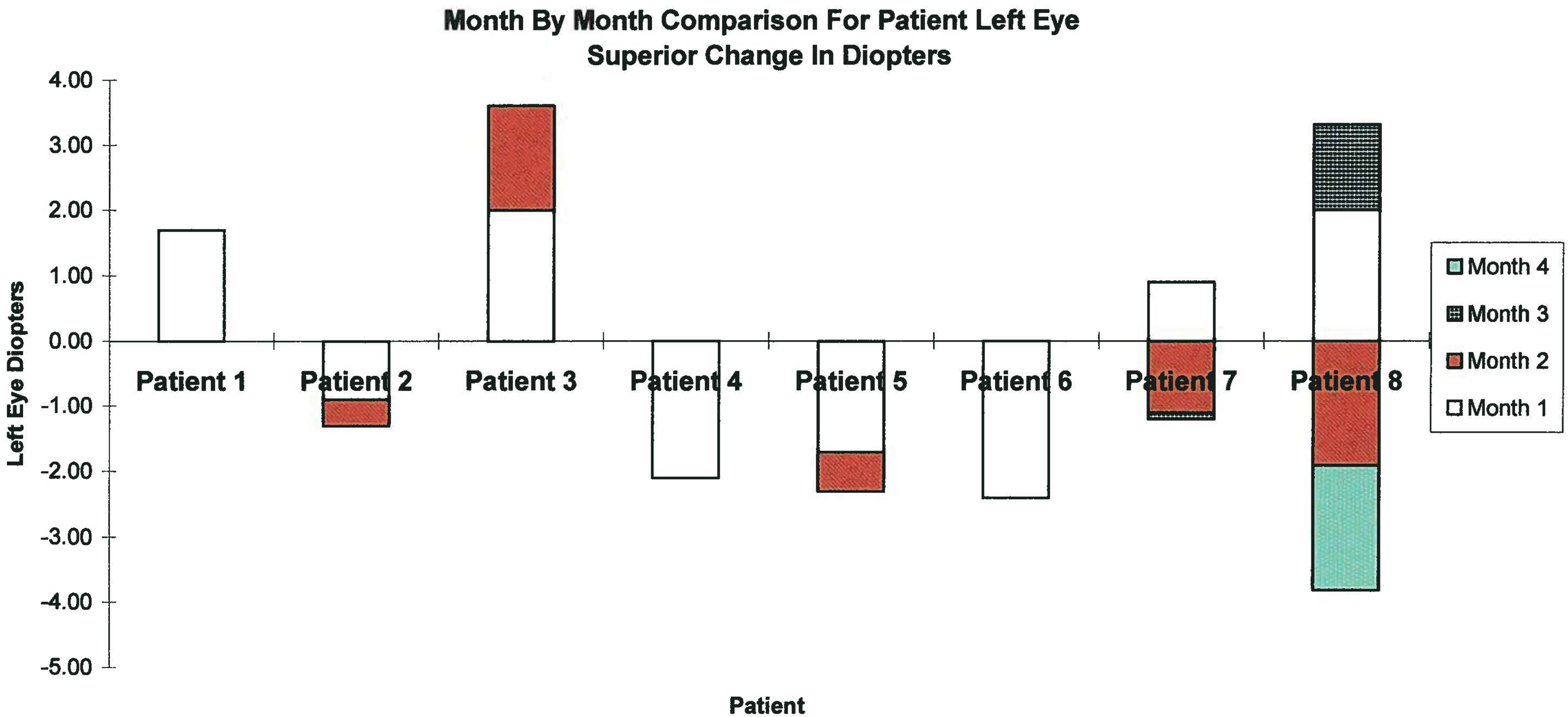
Budak and co-authors found that after lens removal the cornea typically regains a normal topographic pattern within three to four weeks. Usually, the refractive error changes rapidly; astigmatism increases, reaching a maximum about three days after lens removal and becoming stable after three weeks. In isolated cases of rigid contact lens wear, however, corneal stabilization may take up to eight months or even longer. In other cases, the alterations can be permanent (1, 11). Our results agree with Budak and co-authors that the most amount of dioptric change occurs during the first month of discontinuing contact lens wear for most corneas but not all.

Although our results indicate that corneal changes may be associated with soft toric contact lens wear, others argue that those corneas that show changes would have done so regardless of whether or not they were contact lens wearers (6). While this may be true in some cases, the fact that many corneas stabilize after discontinuing contact lens wear is a strong indicator that corneas can be affected by soft toric contact lens wear. The reasons that some corneas show changes and others don't may be related to the contact lens parameters and fit, or the physiologic differences between corneas, or a combination of the variables. This study and others show that most of the corneas which do show change return to their normal state after discontinuing lens wear (1, 3, 6, 8, 9, 10, 11). Maybe it can be argued that those that do not improve after discontinuing wear, may have undergone corneal changes even if contact lenses had never been worn.

The types of corneal changes that can occur with contact lens wear may vary from patient to patient. It is important to evaluate contact lens wearers for contact lens induced corneal changes. Corneal topographies should be taken before fitting a patient with contact lenses and periodically thereafter to monitor any corneal changes that may be caused by contact lens wear.

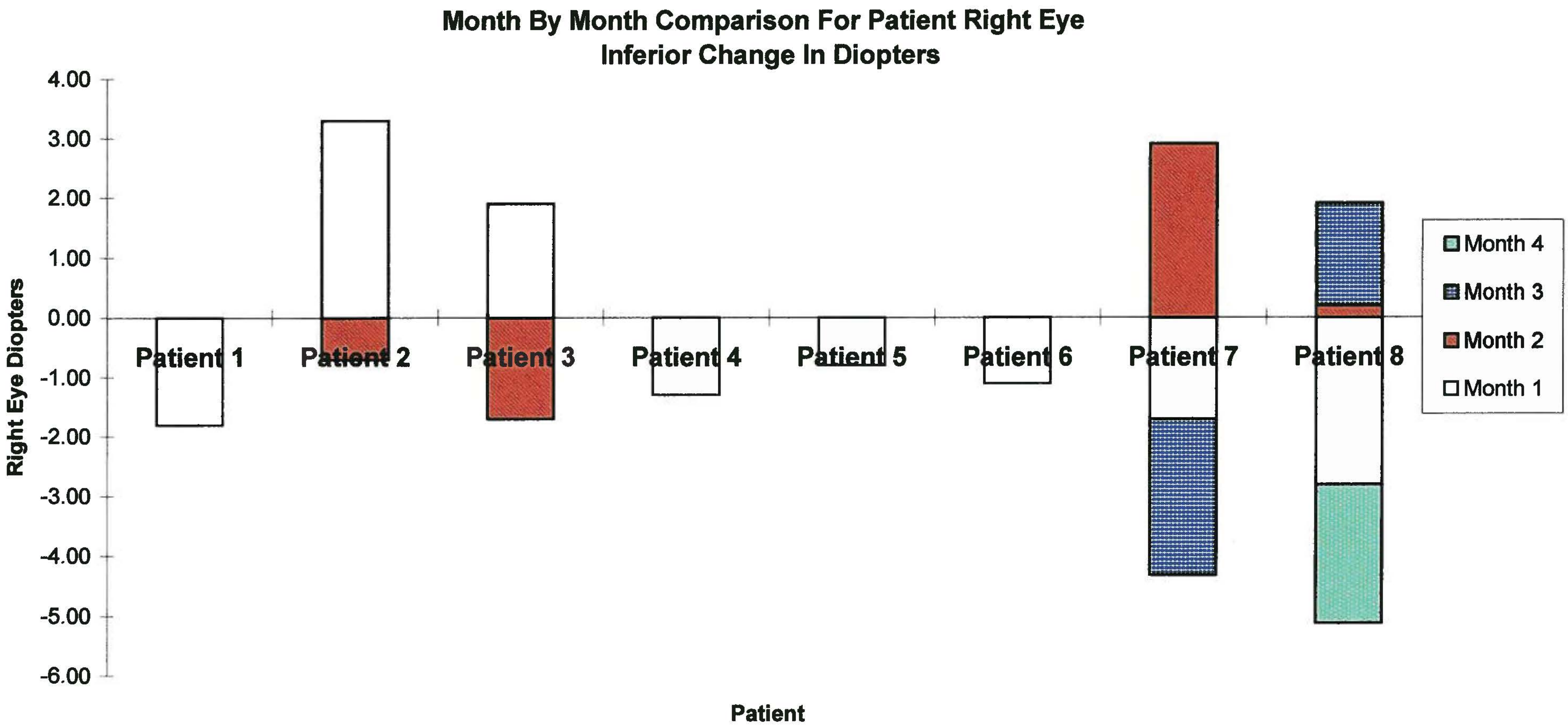

Month By Month Comparison For Patient Right Eye
Superior Change In Diopters
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
Right Eye Diopters
Patient 1
Patient 2
Patient 3
Patient 4
Patient 5
Patient 6
Patient 7
Patient 8
Month 4
Month 3
Month 2
Month 1
Patient

Plot 1

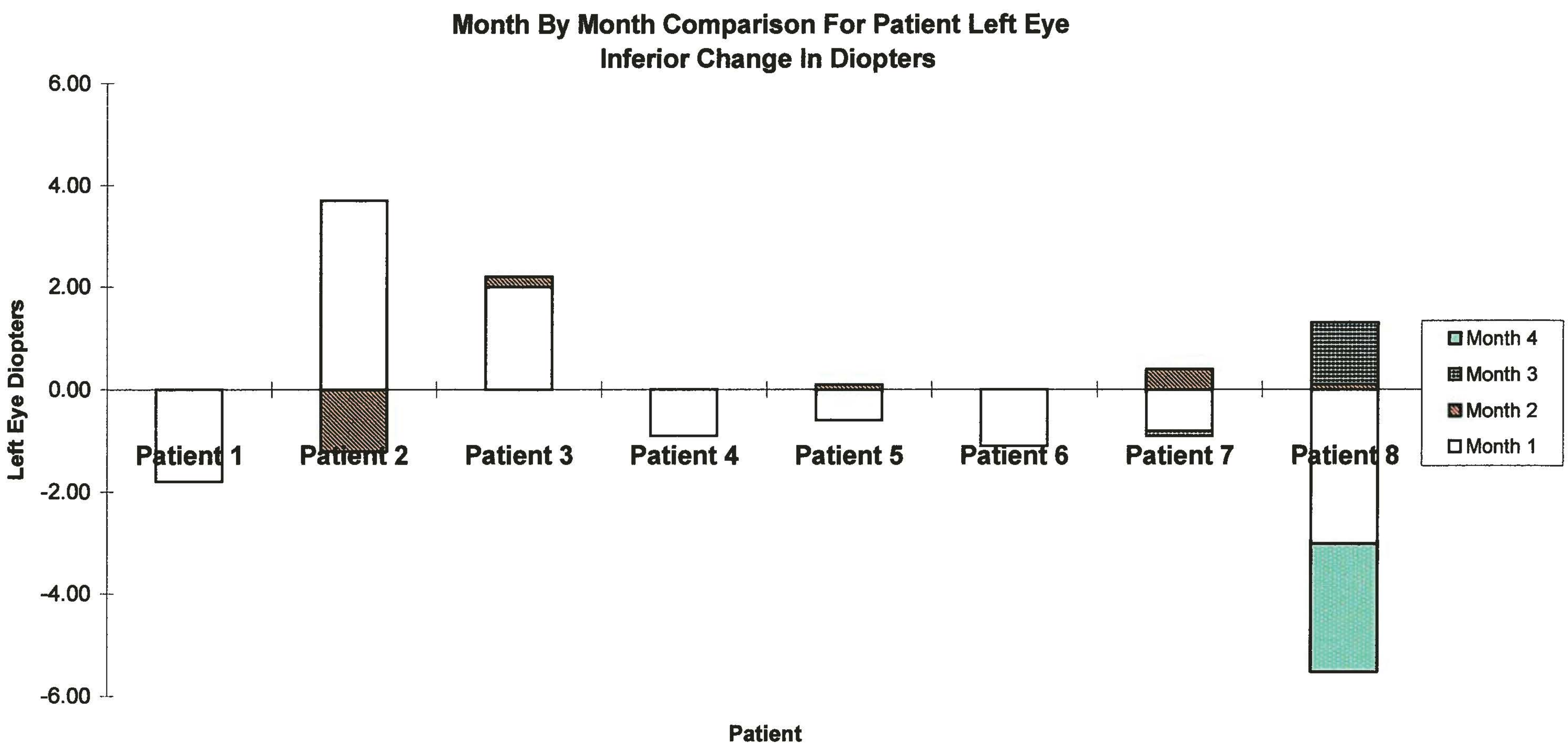


Month By Month Comparison For Patient Left Eye
Superior Change In Diopters
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
Left Eye Diopters
Patient 1
Patient 2
Patient 3
Patient 4
Patient 5
Patient 6
Patient 7
Patient 8
Month 4
Month 3
Month 2
Month 1
Patient

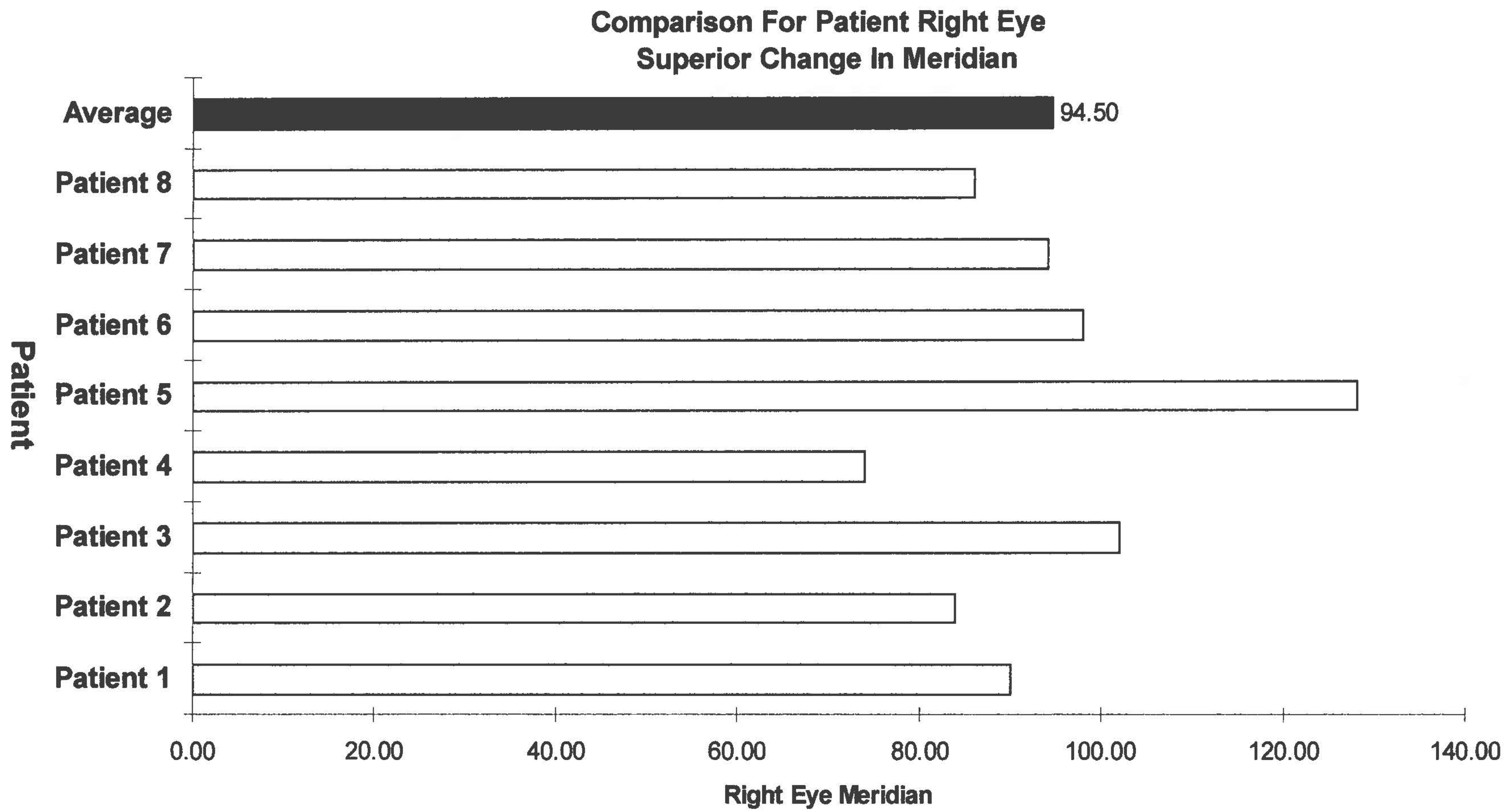
Plot 2


Month By Month Comparison For Patient Right Eye
Inferior Change In Diopters
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
Right Eye Diopters
Patient 1
Patient 2
Patient 3
Patient 4
Patient 5
Patient 6
Patient 7
Patient 8
Month 4
Month 3
Month 2
Month 1
Patient

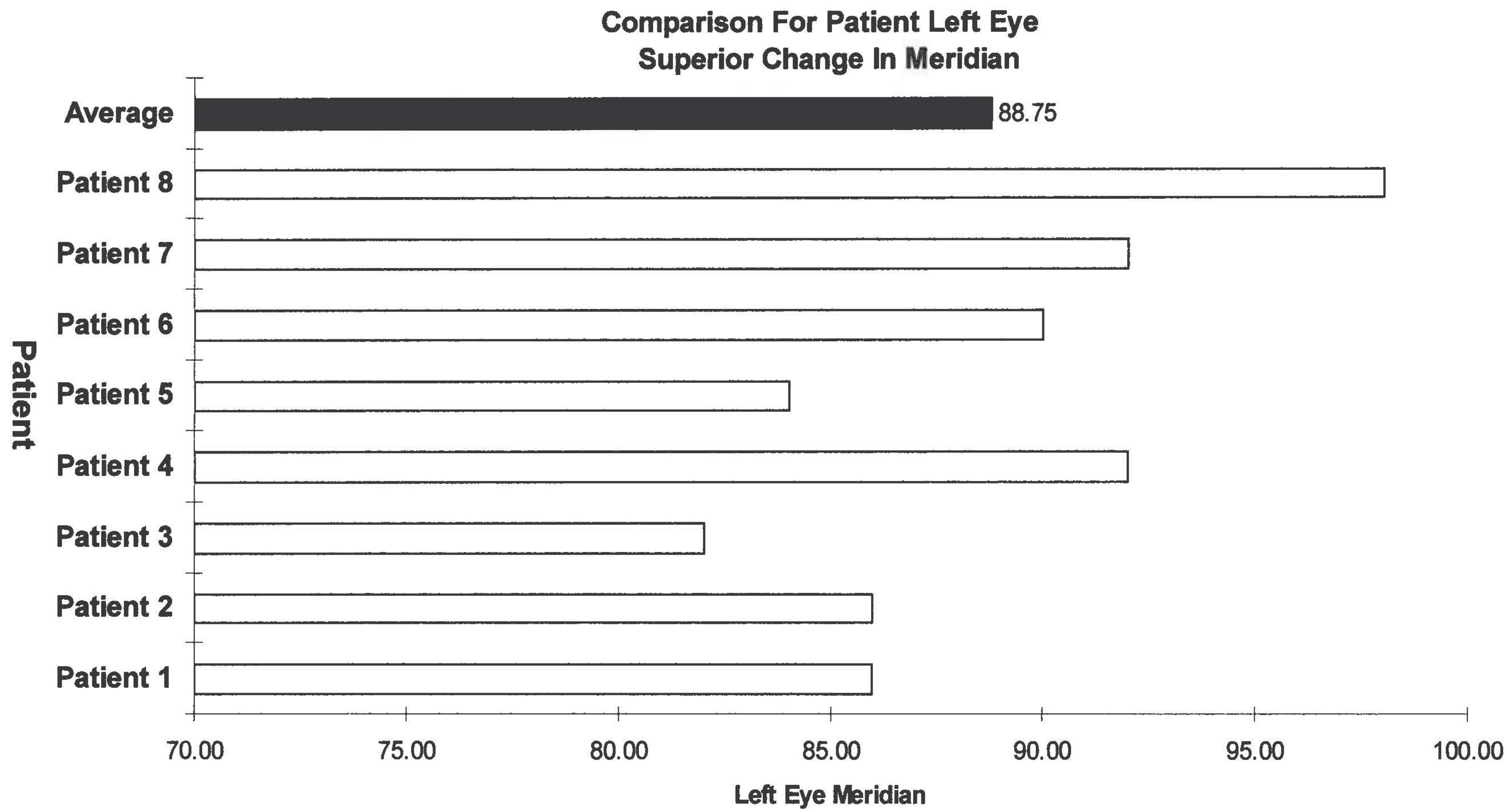
Plot 3


Month By Month Comparison For Patient Left Eye
Inferior Change In Diopters
Left Eye Diopters
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
Patient 1
Patient 2
Patient 3
Patient 4
Patient 5
Patient 6
Patient 7
Patient 8
Month 4
Month 3
Month 2
Month 1
Patient

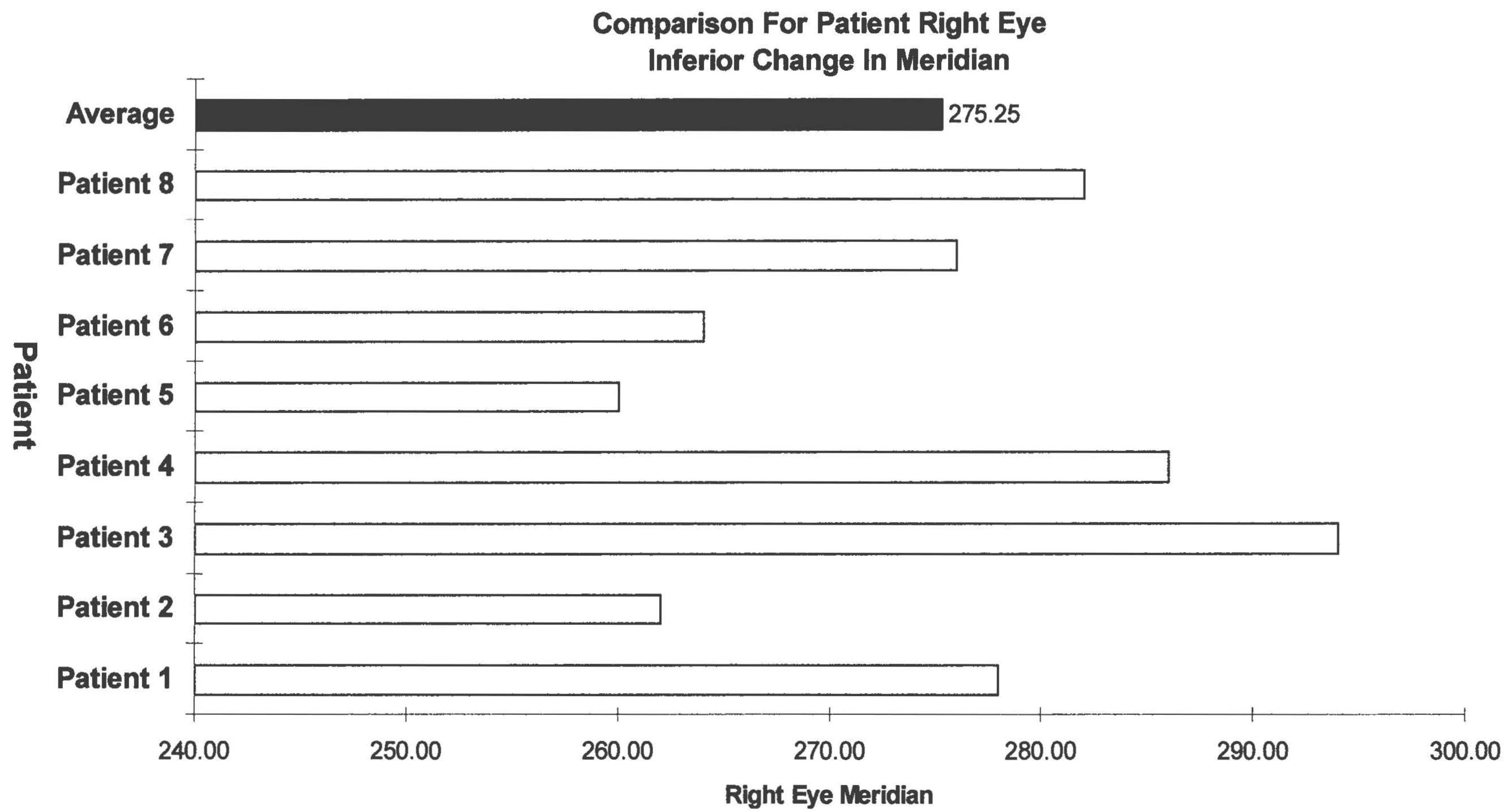
Plot 4


Comparison For Patient Right Eye
Superior Change In Meridian
Average
94.50
Patient 8
Patient 7
Patient 6
Patient 5
Patient 4
Patient 3
Patient 2
Patient 1
Patient
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
Right Eye Meridian

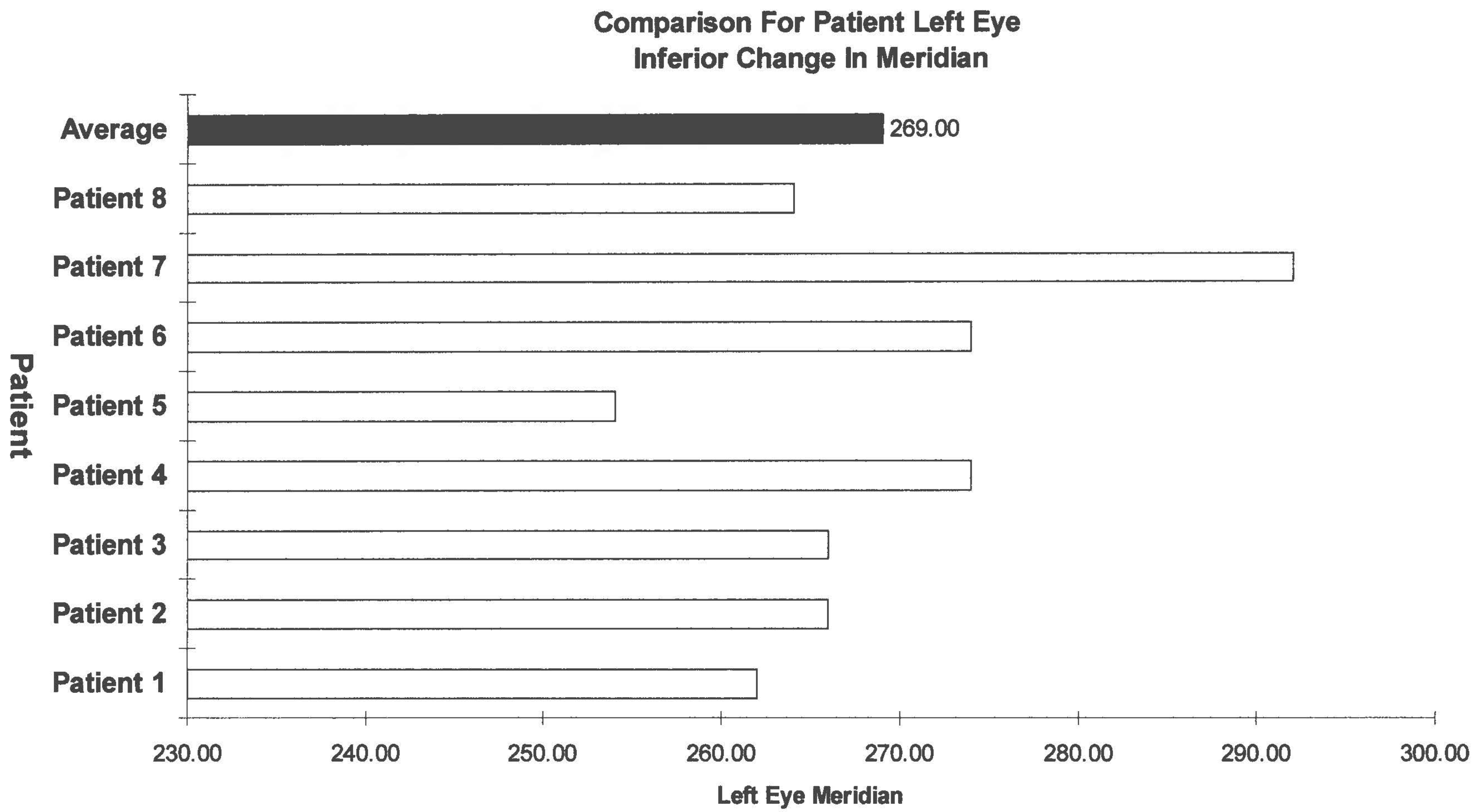
Plot 5


Comparison For Patient Left Eye
Superior Change In Meridian
Average
88.75
Patient 8
Patient 7
Patient 6
Patient 5
Patient 4
Patient 3
Patient 2
Patient 1
Patient
70.00
75.00
80.00
85.00
90.00
95.00
100.00
Left Eye Meridian

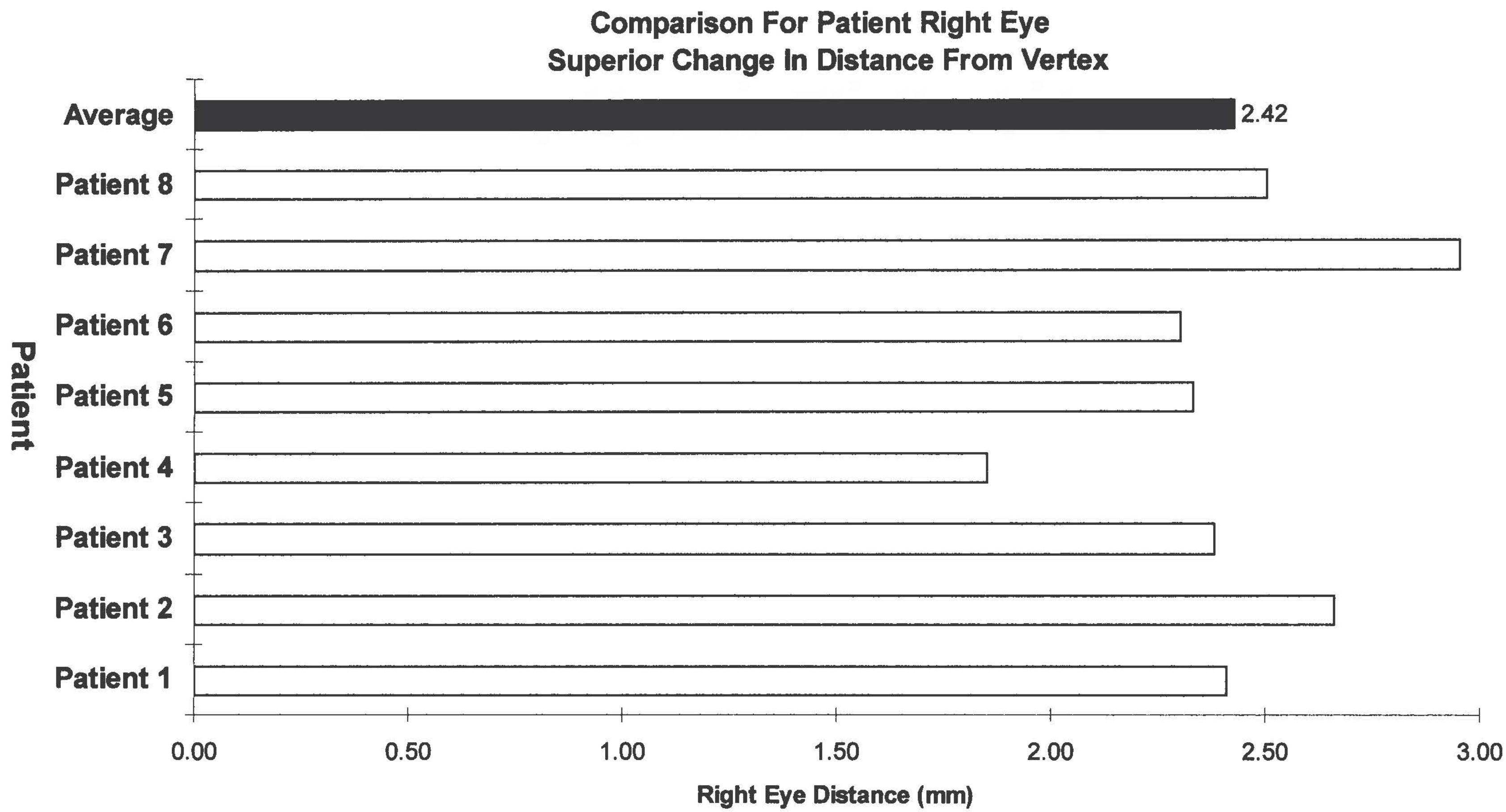
Plot 6


Comparison For Patient Right Eye
Inferior Change In Meridian
Average
275.25
Patient 8
Patient 7
Patient 6
Patient 5
Patient 4
Patient 3
Patient 2
Patient 1
Patient
240.00
250.00
260.00
270.00
280.00
290.00
300.00
Right Eye Meridian

Plot 7

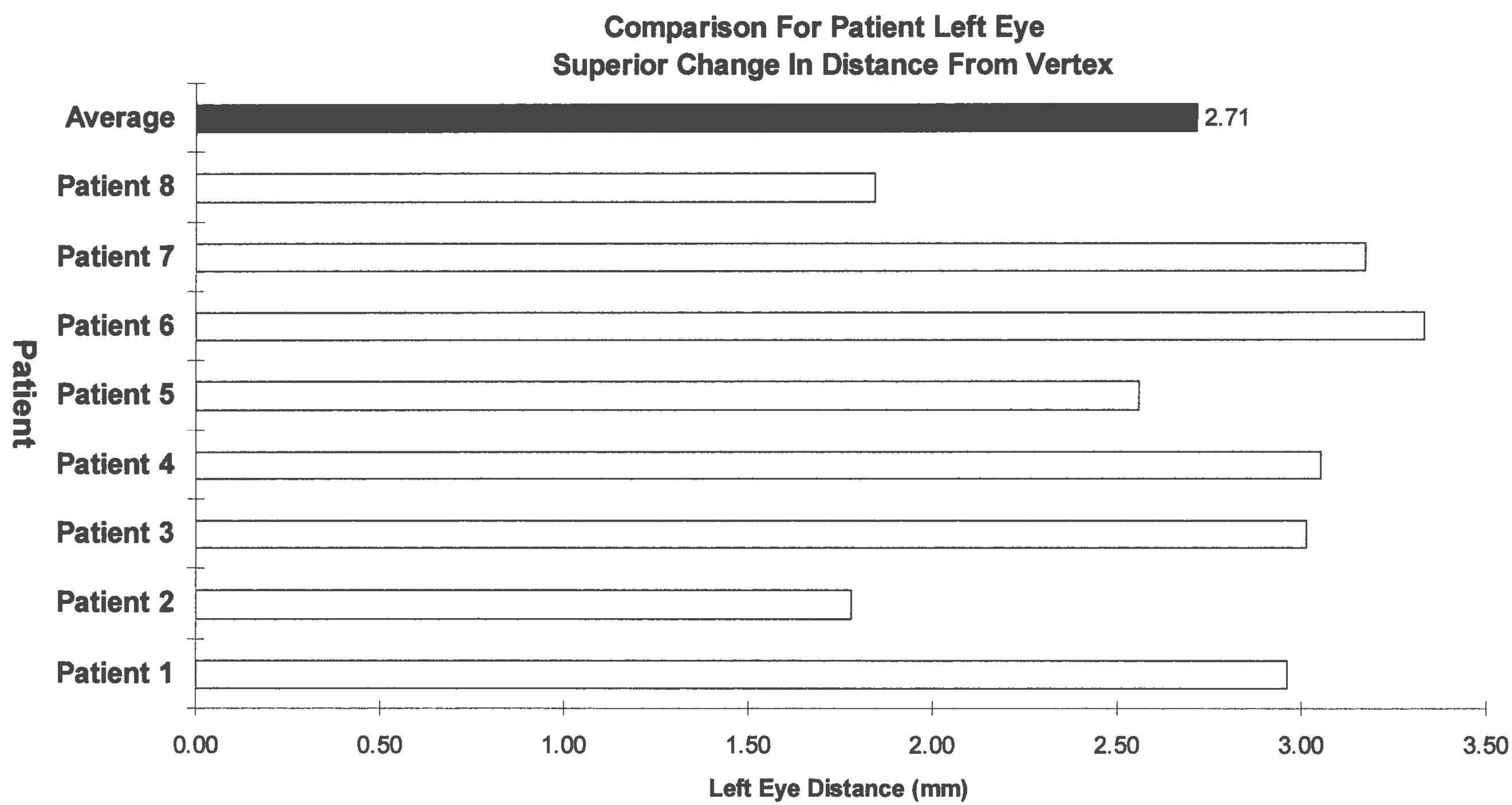

Comparison For Patient Left Eye
Inferior Change In Meridian
Patient
Average
Patient 8
Patient 7
Patient 6
Patient 5
Patient 4
Patient 3
Patient 2
Patient 1
269.00
230.00
240.00
250.00
260.00
270.00
280.00
290.00
300.00
Left Eye Meridian

Plot 8

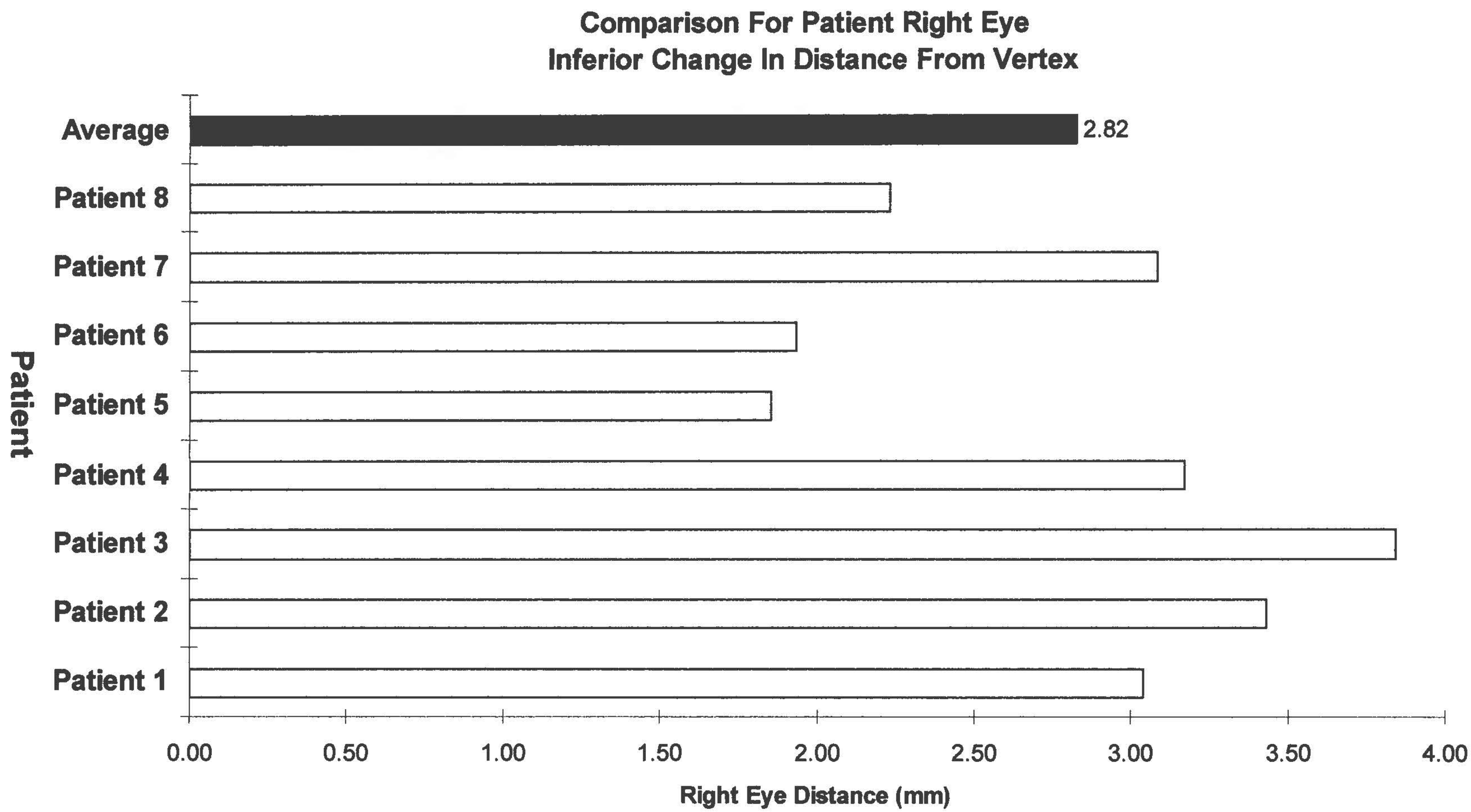


Comparison For Patient Right Eye
Superior Change In Distance From Vertex
Average
2.42
Patient 8
Patient 7
Patient 6
Patient 5
Patient 4
Patient 3
Patient 2
Patient 1
Patient
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Right Eye Distance (mm)

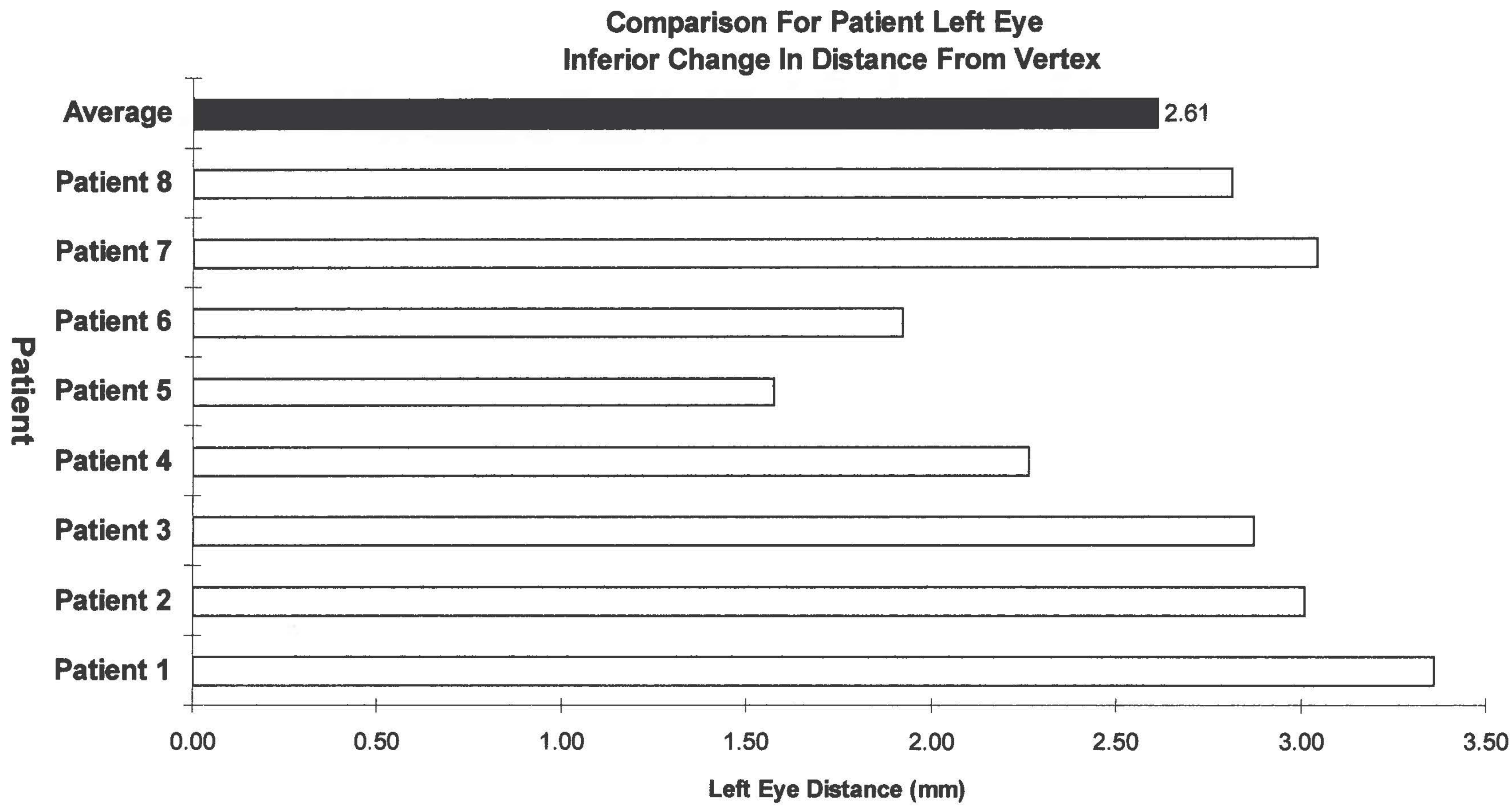
Plot 9


Comparison For Patient Left Eye
Superior Change In Distance From Vertex
Average
2.71
Patient 8
Patient 7
Patient 6
Patient 5
Patient 4
Patient 3
Patient 2
Patient 1
Patient
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
Left Eye Distance (mm)

Plot 10


Comparison For Patient Right Eye
Inferior Change In Distance From Vertex
Average
2.82
Patient 8
Patient 7
Patient 6
Patient 5
Patient 4
Patient 3
Patient 2
Patient 1
Patient
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Right Eye Distance (mm)

Plot 11


Comparison For Patient Left Eye
Inferior Change In Distance From Vertex
Average
2.61
Patient 8
Patient 7
Patient 6
Patient 5
Patient 4
Patient 3
Patient 2
Patient 1
Patient
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
Left Eye Distance (mm)

Plot 12

References

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