

SWAP Study for Early Detection of Glaucoma

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patients with early glaucomatous visual field loss are most likely to show progressive loss in the future. B-Y perimetry showed a faster rate of progressive loss than W-W perimetry.

Another study was conducted to determine if B-Y perimetry could predict the onset and location of impending glaucomatous visual field loss in patients with ocular hypertension sooner than W-W perimetry. (4) The participants were tested annually with both standard W-W and B-Y visual fields for 5 years. This study concluded that B-Y perimetry deficits are early indicators of glaucomatous damage and can predict future glaucomatous visual field loss for standard W-W perimetry.

A more recent investigation was conducted involving SWAP in low, medium, and high risk ocular hypertensive eyes.(6) Low risk ocular hypertensive eyes had a cup-to-disc (c/d) ratio below 0.6 and IOP between 21-26mm Hg. Moderate risk ocular hypertensive eyes had either IOP's greater than 26mm Hg or c/d ratio greater than 0.6. High risk ocular hypertensive eyes had both a c/d greater than 0.6 and an IOP greater than 26mm Hg. This study based itself upon the following four criteria: IOP, family history of glaucoma, age, and the vertical c/d ratio. Visual field testing with both B-Y and W-W was performed on each participant.

The main conclusion from this study was that increased vertical c/d ratio showed the greatest increase in SWAP deficits. This supports the fact that SWAP can detect early changes that occur at the optic nerve head in glaucoma. Within this study there was no relationship between family history of glaucoma or IOP and the prevalence of SWAP deficits.(6)

These early investigations and many others lead to the current development of the Humphrey short wavelength automated perimetry. This feature has become available within the past 3 years on the HFA I and HFA II. Many diagnosticians can use B-Y perimetry in the same way they use W-W automated perimetry.

Short wavelength automated perimetry has its advantages as well as its disadvantages. One advantage is being able to detect visual field abnormalities sooner in glaucoma suspects than with W-W visual fields.(1,4-6) SWAP can detect abnormalities 3 or more years prior than standard W-W visual fields. (1,2,4-6) SWAP can also be used to detect nonglaucomatous neurological ocular problems.(2)

There are also some disadvantages associated with SWAP. The results of SWAP have a greater variability within and between patients when compared to standard W-W visual fields.(2) SWAP is affected by an aging lens and macular pigment, due to the decreased transmission of the short wavelength light. (2) A generalized depression associated with an aging lens would not appear in a pattern deviation plot, and thus could be identified from a true glaucoma defect. Macular pigment would only affect the macular area and would remain unchanged over time. (2)

The disadvantages do not affect a definitive diagnosis of glaucomatous visual field defects in SWAP. However, it is important for diagnosticians to understand the advantages and

disadvantages associated with SWAP in order to make an accurate diagnosis.

MATERIALS and METHODS

The W-W and B-Y visual field testing was performed on a Humphrey Field Analyzer II (model 750). The program used for both W-W and B-Y was the full threshold 24-2 test. The short term fluctuation (SF) was turned off for W-W perimetry in an attempt to decrease test time and to maintain consistency, since SF is not available for SWAP. The glaucoma hemifield test was evaluated for each visual field. The standard W-W automated perimetry was conducted with a size III (0.5 degree diameter) white target that was superimposed on a 31.5 asb (10 cd/m²) white background. The B-Y automated perimetry was performed with a size V (1.75 degree diameter) blue target (440nm peak) that was displayed on a 100cd/m² yellow background.

Each participant was selected based on one or more of the following criteria:

- A. Patients with IOP over 22 mm Hg, normal optic nerves, and normal or suspect baseline W-W visual fields.
- B. Patients with normal IOP, suspicious optic nerves, and normal or suspect baseline W-W fields.
- C. Patients that have IOP asymmetry of 5mm Hg or more.

After being selected the patient would complete a W-W 24-2 full threshold. The patient would then return within 2 weeks for a B-Y 24-2 full threshold. This procedure was repeated at 3-6 months and 1 year from initial visual field.

PATIENTS

This study included nineteen patients (38 eyes) ranging from the ages of 17-77. Sixteen percent (3 out of 19) of the patients were between the ages of 17-40, fifty eight percent (11 out of 19) were between the ages of 40-60, and twenty six percent (5 out of 19) were between the ages of 60-77. Fifty two percent (10 out of 19) were females and forty eight percent were males.

The patients were chosen based upon the criteria outlined in the previous section. Thirty two percent of the eyes (12 out of 38) were chosen based upon the appearance of the optic nerve head alone. While forty six percent (17 out of 38) were chosen because of elevated intraocular pressure. Eleven percent (4 out of 38) were selected based upon the combination of elevated intraocular pressure and optic nerve head appearance. Another eleven percent were chosen based on intraocular pressure asymmetry and the appearance of the optic nerve head.

Thirty two percent (6 out of 19) of the total patients were able to complete the one year study, which included three W-W visual fields and three B-Y visual fields. Forty seven percent (9 out of 19) completed the 3-6 month study, which included two W-W visual fields and two B-Y visual fields. Twenty one percent (4 out of 19) never returned after their initial W-W

visual field and initial B-Y visual field.

RESULTS

The eyes that were chosen based upon the appearance of the optic nerve head cupping were thirty two percent (12 out of 38) of the total number of eyes within the study. Seventeen percent (2 out of 12) showed a W-W visual field defect initially, which progressed over time. Sixty seven percent (8 out of 12) showed a B-Y visual field defect initially, which progressed over the time of the study.

The eyes that were chosen based only upon elevated intraocular pressure were forty six percent (17 out of 38) of the total number of eyes within the study. Twelve percent (2 out of 17) of this group showed a W-W visual field defect initially, which did not progress over the time of the study. Seventy six percent (13 out of 17) showed a B-Y visual field defect initially and five out of the thirteen (38%) showed progressive B-Y visual field defects over the time of the study.

The next group of eyes were selected because of the combination of elevated intraocular pressure and optic nerve head cupping. This group was eleven percent (4 out of 38) of the total number of eyes within the study. This group did not show a W-W visual field defect initially, however one out of the four (25%) showed a progressive W-W visual field loss over the time of the study. Seventy five percent (3 out of 4) showed a B-Y visual field defect initially and one out of the three (33%) showed a progressive B-Y visual field defect over the time of the study.

The eyes that were chosen based upon the combination of intraocular pressure asymmetry and optic nerve head cupping were eleven percent (4 out of 38) of the total number of eyes. Fifty percent (2 out of 4) of this group showed a W-W visual field defect initially, which did not progress over the time of the study. The other fifty percent of this group showed a B-Y visual field defect, which did progress over the time of the study.

Figures 1A and 1B summarize the data for each of the groups selected as candidates for the study. The figures show that in each group there was a significantly larger amount of B-Y defects versus W-W visual field defects. A few example cases will be discussed in order to distinguish whether or not some of the B-Y visual field defects may be early signs associated with glaucoma.

Example case number one is a 58 year old female. Her medical history consists of hypertension and rheumatoid arthritis. Her medications include oral steroids and anti-hypertensives. Her ocular history consists of pseudophakia OD and a posterior subcapsular cataract OS. Her best corrected visual acuities are 20/20 OU and intraocular pressures are 23 OD and 26 OS. Her cup to disc ratios are .45/.45 OD and .5/.5 OS. Figures 2A and 2B show her W-W and B-Y visual fields.

In case number one the patients right eye does not show either W-W or B-Y visual field defects. However, the left eye does show B-Y visual field defects. The left eye does have an intraocular pressure of 26 mm Hg and an optic nerve head cupping of .5/.5. The left eye does have a posterior subcapsular cataract. The optic nerve head cupping did not change over the one year study, however her intraocular pressure did change. It decreased from 23 OD and 26 OS to 18 OD and 20 OS. At this point it is unclear whether the B-Y visual field defects are due to glaucoma or the presence of the cataract. In this particular case the patient will need to be followed for a longer period of time in order to determine if the B-Y defects are consistent with glaucomatous changes.

Case number two is a 32 year old male. He has no medical health problems and is not currently taking any medications. The ocular exam revealed pigmentary dispersion syndrome. His intraocular pressures were 26 OD and 25 OS. The best corrected visual acuities were 20/20 OU. The patients cup to disc ratios were .2/.2 on both eyes. Figures 3A and 3B show his W-W visual fields and B-Y visual fields.

In case number two the initial W-W visual fields appeared to be within normal limits. The initial B-Y visual fields suggested a nasal step for the right eye and some early B-Y visual field defects for the left eye. The patient returned six months later for a follow up. The intraocular pressures changed to 28 OD and 21 OS. There was no change in the optic nerve cupping at this time. However, the W-W visual field for the right eye began to show a nasal step. The left eye W-W visual field remained within normal limits. The B-Y visual field showed a possible nasal step for each eye. In this particular case the B-Y visual fields demonstrated an early glaucomatous visual field defect. This patient was withdrawn from the study and treated with Ocupress ophthalmic drops in each eye to lower intraocular pressures.

Case number three is a 59 year old female. Her medical history consists of osteoporosis and non-Hodgkins lymphoma and she has completed chemo-therapy. Her medications include Daypro (NSAID) and Fosamax (for osteoporosis). Her ocular history consists of pseudophakia OU. Her intraocular pressures were 19 OD and 15 OS. The best corrected visual acuities were 20/25 OU. The patients cup to disc ratios were .5/.4 OD and .5/.5 OS. This patient was considered to participate in the study as a normal tension glaucoma suspect. Figures 4A and 4B show her W-W and B-Y visual fields.

In case number three the initial W-W visual fields show a nasal step. (Please note that the initial W-W visual fields were accidentally performed using a 30-2 program) The initial B-Y visual fields show an inferior arcuate defect. The patient returned six months later to repeat the visual fields. Her W-W visual fields appeared within normal limits. However, the B-Y visual fields still revealed inferior arcuate defects. The patient returned again at one year and the visual fields were repeated. The W-W visual fields showed possible nasal steps, but not as significantly as the year prior. The B-Y visual fields still showed inferior arcuate defects, but again it was not as significant as the year prior. The patients pressures and optic nerve heads appeared to remain the same. She will return again in another six months for repeat visual fields and a follow up.

This case was interesting because her W-W defects appeared to improve over the one year time period. The B-Y visual field defects improved somewhat, but not as much as the W-W defects. Some of the improvement may have been due to a learning curve. The initial W-W was performed using a 30-2, which would extend further out in the periphery. This may also attribute to the more significant W-W visual field defect noted in the initial test.

The above example cases show that B-Y visual fields are more sensitive than W-W visual fields. However, in two of the cases a longer follow up was required in order to make an accurate diagnosis. In the second case an accurate diagnosis was made within the year study.

CONCLUSION

The results of this study demonstrated that short wavelength automated perimetry does show an increased sensitivity when compared to standard W-W perimetry for early detection of glaucoma. When comparing defects of B-Y perimetry to W-W perimetry, B-Y defects were three times more likely in three of the four groups studied. The patients selected for the study based solely on optic nerve head appearance showed 17% W-W visual field defects and 67% B-Y defects. The patients that were chosen due to elevated intraocular pressures exhibited 12% W-W visual field defects and 76% B-Y defects. The third group was selected based on elevated intraocular pressures and optic nerve head appearance. This group had no W-W visual field defects, but had 75% B-Y visual field defects. The final group, which included patients with suspicious optic nerve head appearance and intraocular pressure asymmetry showed 50% W-W visual field defects and 50% B-Y visual field defects.

The short wavelength automated perimetry began to show defects prior to the standard white automated perimetry in some of the patients within the study. In example case number two, the patient displayed a B-Y nasal step six months prior to displaying a W-W nasal step. The patient began an early treatment for glaucoma based upon the early detection of this visual field defect.

The majority of the patients that participated within the study remain as glaucoma suspects. They will continue to have routine six month follow ups to monitor visual field changes, along with intraocular pressure and optic nerve head evaluations. Glaucoma is a slow disease process. In order to have an accurate conclusion on the early detection of glaucoma with short wavelength perimetry, a longer study should be conducted. Within the one year study, two patients began treatment and management for glaucoma. The majority of studies that preceded this study were over a five year time period.

There are other factors that should be considered when doing an evaluation of short wavelength automated perimetry. Patients that have cataracts may exhibit larger generalized visual field defects that may disguise early glaucomatous defects. Most generalized defects caused by cataracts can be compensated for in a pattern deviation plot. Short wavelength automated perimetry may have a greater variability within and between patients when compared to standard

W-W visual fields.⁽²⁾ Therefore, long term visual field follow ups may be needed to make an accurate diagnosis.

This study, along with other previous studies, provide evidence that short wavelength automated perimetry is valuable in detecting and monitoring early glaucomatous defects. It has been shown to detect changes three to five years sooner than standard W-W perimetry. ^(1,2,4-6) More practitioners are beginning to use SWAP in their practices. As more patient data is gathered, SWAP will become a major factor for early diagnosis and management of glaucoma.

Figure 1.A

W-W VF defects

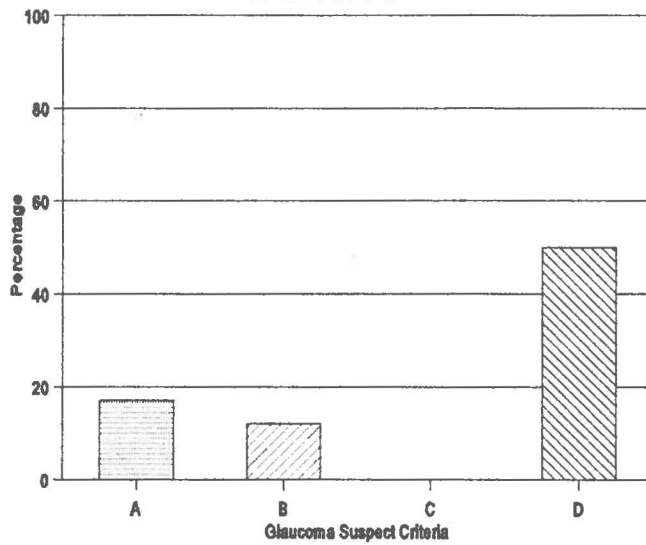
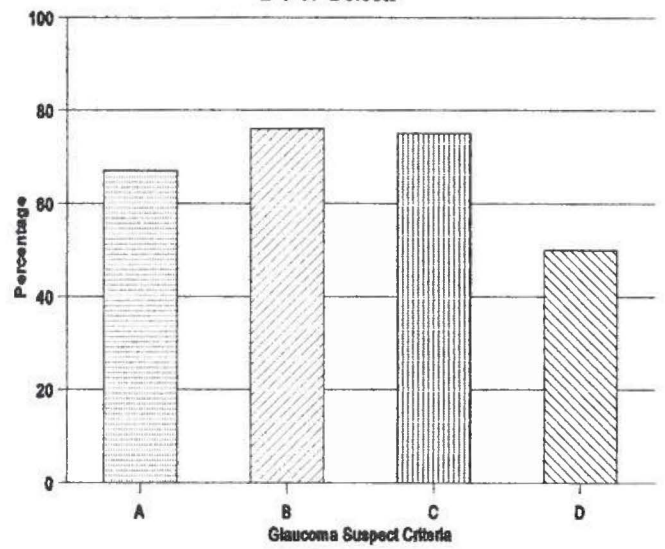


Figure 1. B

B-Y VF Defects

**Glaucoma Suspect Criteria**

A= Suspicious ONH cupping

B= Elevated IOP

C= Elevated IOP & ONH cupping

D= IOP asymmetry & ONH cupping

W-W VF's

B-Y VF's

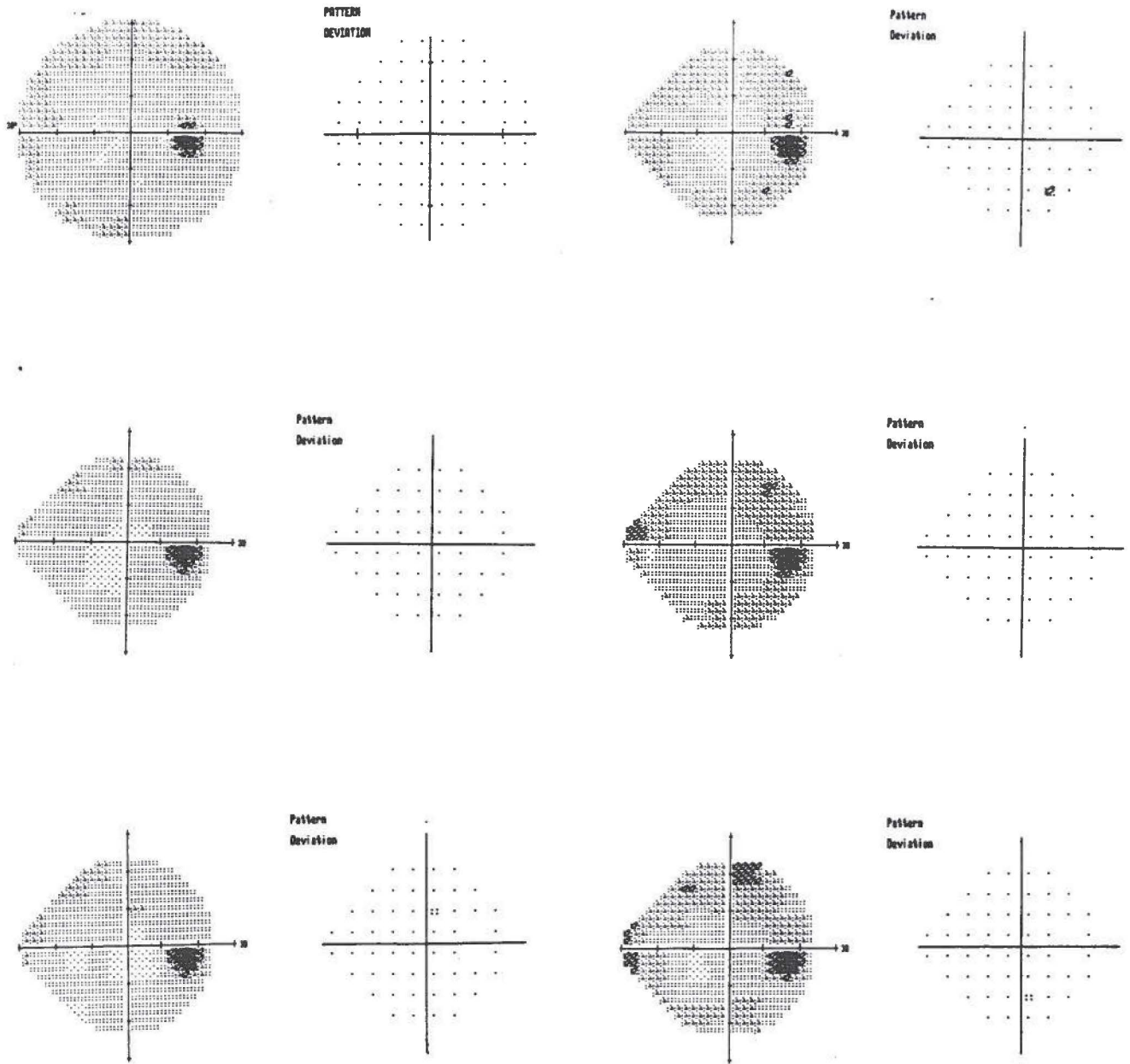
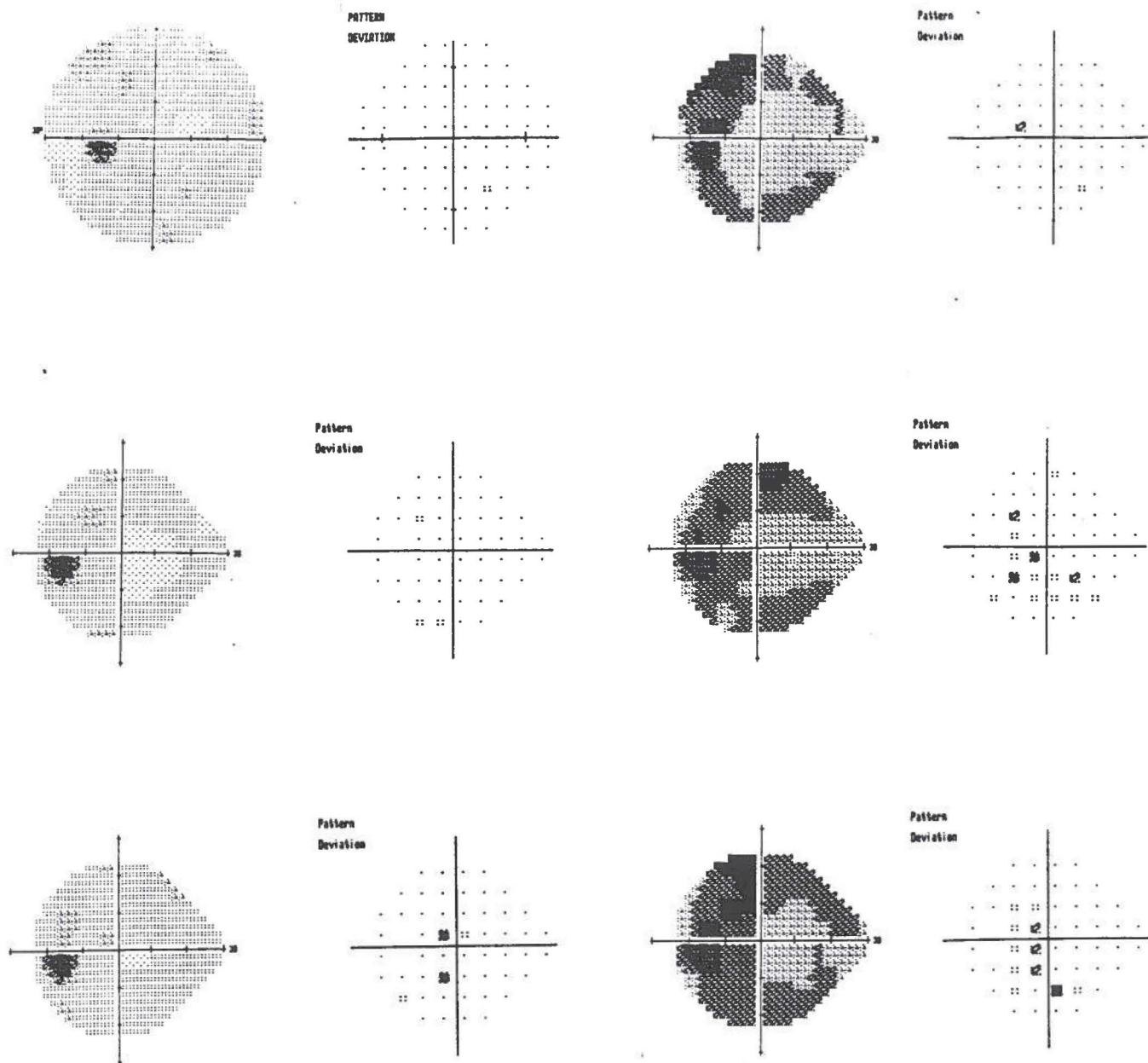


Figure 2A

The top VF's were done at the initial exam. (Please note that a 30-2 was accidentally performed as the initial W-W VF) The middle row of VF's were performed at the 6 month follow-up. The bottom row was performed after one year.

W-W VF's

B-Y VF's

**Figure 2B**

The top VF's were done at the initial exam. (Please note that a 30-2 was accidentally performed as the initial W-W VF) The middle row of VF's were performed at the 6 month follow-up. The bottom row was performed after one year.

W-W VF's

B-Y VF's

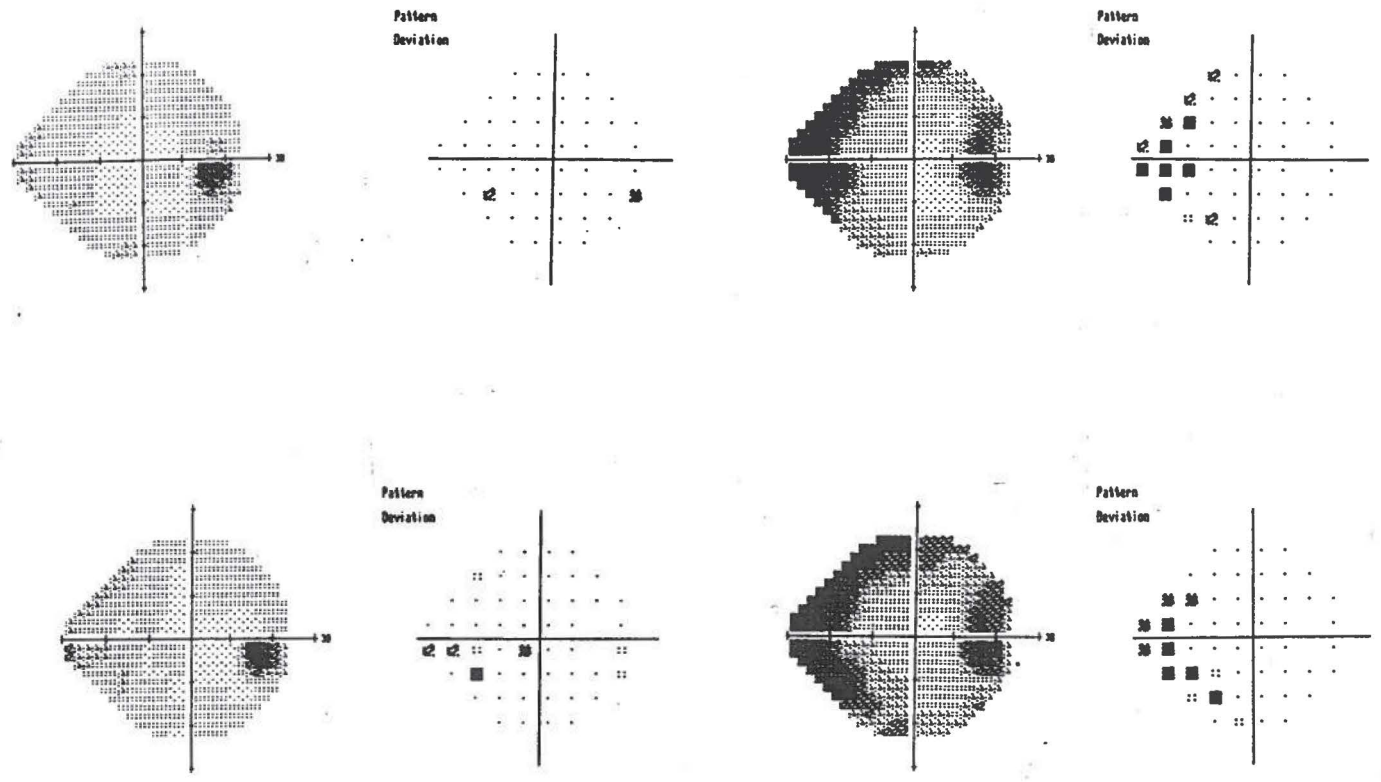
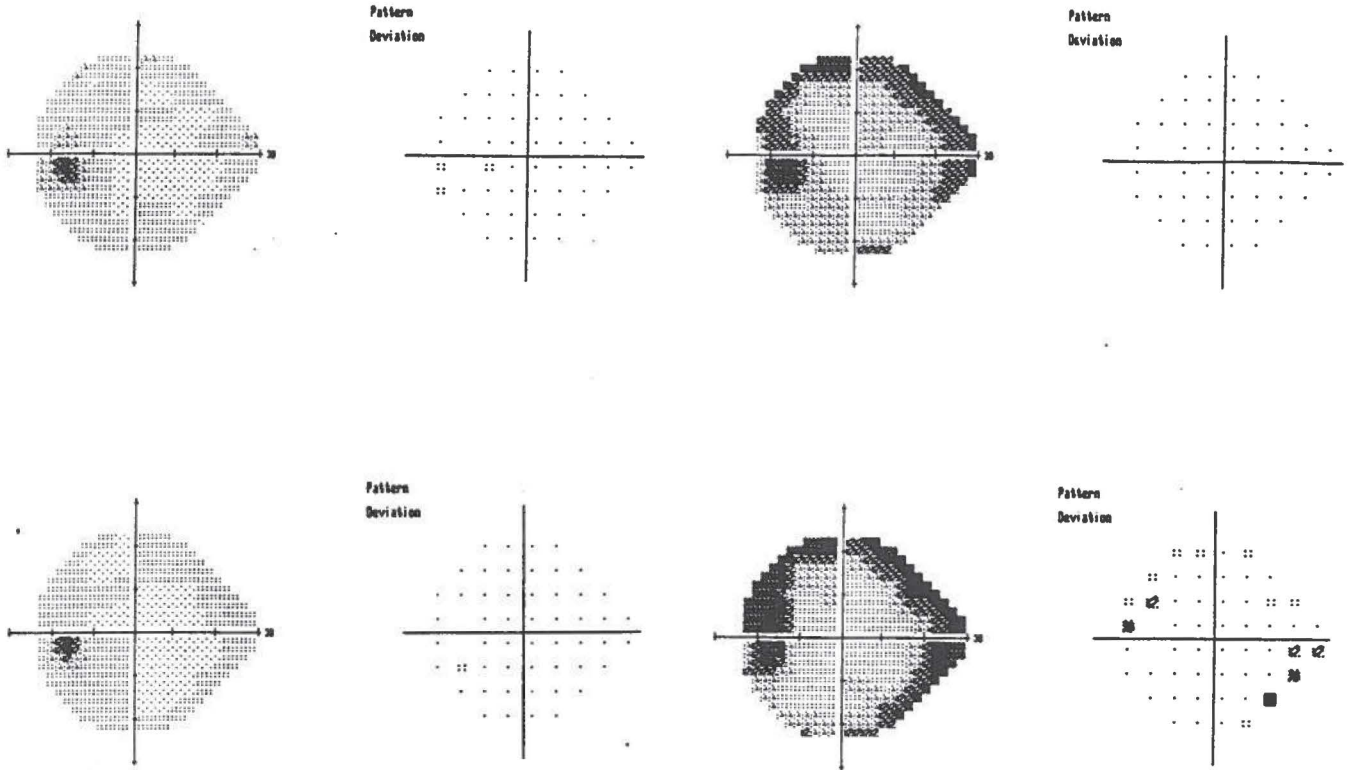


Figure 3A

The top VF's were done at the initial exam. The bottom row of VF's were performed at the 6 month follow-up.

W-W VF's

B-Y VF's

**Figure 3B**

The top VF's were done at the initial exam. The bottom row of VF's were performed at the 6 month follow-up.

W-W VF's

B-Y VF's

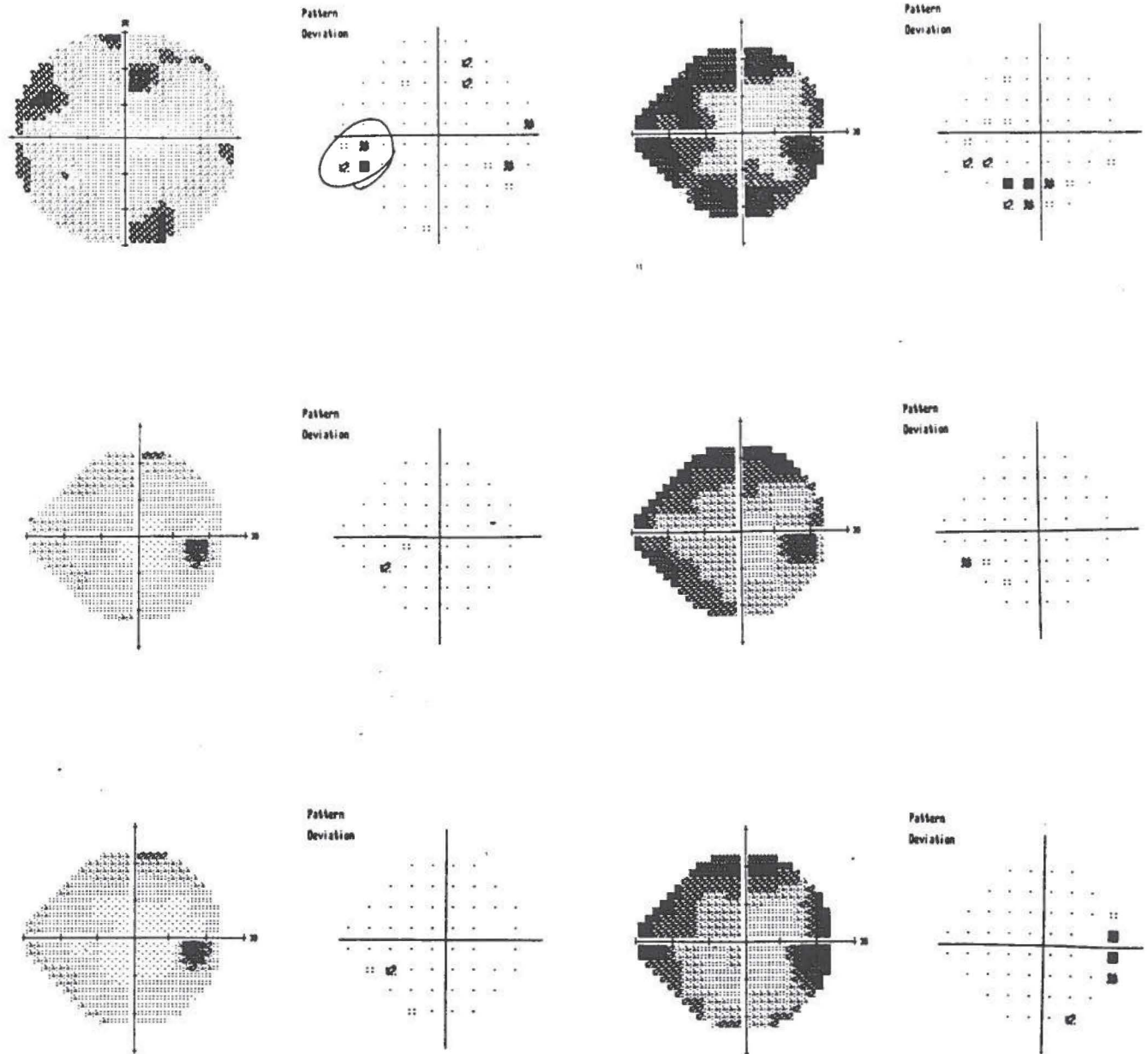


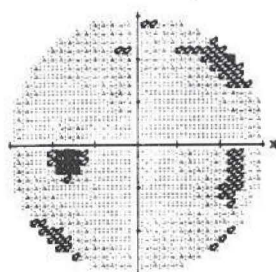
Figure 4A

The top VF's were done at the initial exam. (Please note that a 30-2 was accidentally performed as the initial W-W VF) The middle row of VF's were performed at the 6 month follow-up.

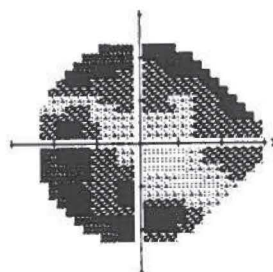
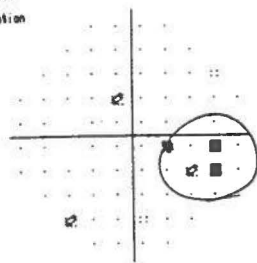
The bottom row was performed after one year.

W-W VF's

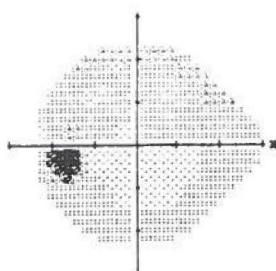
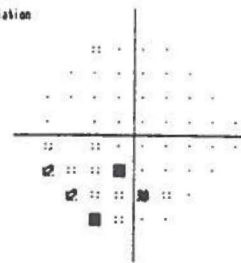
B-Y VF's



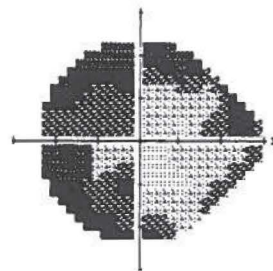
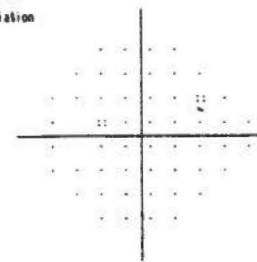
Pattern
Deviation



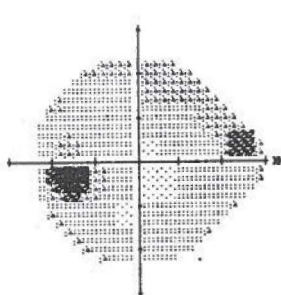
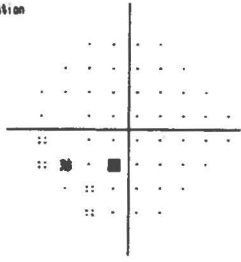
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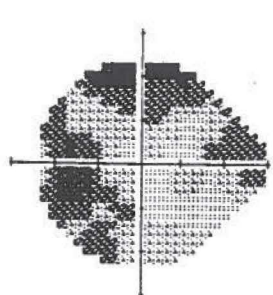
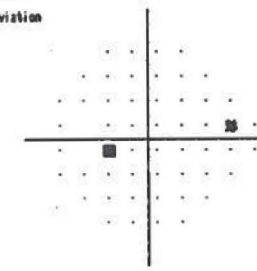
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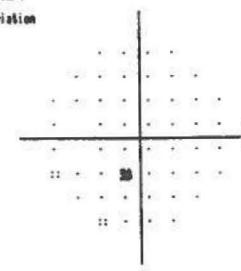


Figure 4B

The top VF's were done at the initial exam. (Please note that a 30-2 was accidentally performed as the initial W-W VF) The middle row of VF's were performed at the 6 month follow-up.

The bottom row was performed after one year.

References

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