Frequency Doubling Technology Perimetry in Age-related Macular Degeneration

Shwu-Jiuan Sheu¹,³, Ying-Ying Chen¹, Li-Chen Chou¹, Tsung-Tien Wu¹, Kwok-Kei Cheng²

¹Department of Ophthalmology, ²Department of Surgery, Kaohsiung Veterans General Hospital, Kaohsiung; and ³National Yang-Ming University School of Medicine, Taipei, Taiwan, R.O.C.

Key Words
age-related macular degeneration; frequency doubling technology perimetry; macula; visual acuity

Background. The role of frequency doubling technology perimetry (FDT) in glaucoma has been promising in terms of speed and simplicity as well as its high sensitivity and specificity compared to conventional automatic perimetry. In this study, we investigated the possible role of FDT in exudative type age-related macular degeneration (ARMD).

Methods. FDT using full-threshold C-20 mode was performed in patients with ARMD. The macula was classified into 3 zones by the distance from the fovea center (zone I: central 1°, zone II: central 3° except zone I, zone III: central 5° except zones I & II). The lesion was scored into 3 ranks by the area ratio of involvement in each zone. The retinal scores, visual acuity and disease duration were compared with the FDT scores of the central target, which was graded into 5 ranks according to the probability level of abnormal points on total deviation plots using Spearman’s rank correlation method.

Results. Measurements from 32 eyes (30 patients) with exudative ARMD were collected. The FDT scores of the central target correlated significantly with the lesion scores in zone III (p = 0.033), but not with the lesion scores in central 3° (zone I: p = 0.383, zone II: p = 0.077). Visual acuity was weakly correlated with the FDT scores of the central target (p = 0.022), and the lesion scores in zone III (p = 0.038), but strongly correlated with the lesion scores in zone III and zone II (p < 0.001). The FDT scores of the central target were within normal limit in 20 eyes.

Conclusions. Our results suggest that FDT using full-threshold C-20 mode is not sensitive enough for the detection of small macular lesions in ARMD. Therefore, it might not be a useful functional evaluation in ARMD. Further modification of the central target of FDT is necessary to detect small macular lesions in ARMD. [Chin Med J (Taipei) 2002;65:435-440]
Frequency doubling technology perimetry (FDT) is based upon a unique and innovative advance in visual field stimulus technology called Frequency Doubling. \(^{17-23}\) It is outstanding in speed and simplicity, which makes perimetry less in timing for patients. Reports had shown that it can detect glaucomatous visual field loss with high sensitivity and specificity compared to conventional automated perimetry. \(^{24,25}\) Its potential in quantifying pathologic change looks quite promising as well. \(^{26,27}\) Will it be helpful in the field of ARMD in which visual field defect is also regarded as an important pathognomonic sign? In our previous study, which scored the fundus according to the area ratio of lesion alone, we concluded the FDT might be a useful and simple technique for functional evaluation in rhegmatogenous retinal detachment, but had limited value in ARMD. \(^{28}\) The purpose of this study was to re-evaluate the role of FDT in exudative type ARMD, which is the target of treatment in ARMD, with a different scoring system according to the distance from the fovea center. Other possible relating factors, including visual acuity and disease duration, were also analyzed.

Methods

FDT using full threshold C-20 mode was performed in patients with exudative ARMD, confirmed by fundus fluorescein angiogram. Those who had significant cataract which was expected to interfere with the visual field (nuclerosclerosis: ++ or more, posterior subcapsular opacity: prominent, 2 mm in diameter or more, partial, 4 mm in diameter or more), history of glaucoma, diabetes and other ocular diseases, were excluded. All patients received detailed ophthalmological examination, including visual acuity, slit lamp biomicroscopy, intraocular pressure, indirect ophthalmoscopy, contact lens biomicroscopy, and fundus fluorescein angiogram.

The FDT perimeter (full-threshold test C-20 mode) were presented with 16 targets arranged in a 4-by-4 grid, plus 1 target in the macula. Each peripheral square is 10 degrees x 10 degrees, and the central stimulus is a 5-degree circle. The FDT for threshold test is performed by determining the contrast threshold for each of the target locations in the display. A 0.25 cyc/deg sinusoidal grating undergoing 25 Hz counterphase flicker (contrast reversal of light and dark bars, 50 times/sec) was generated on the monitor for all stimuli, except for the central pattern, which used a 0.5 cyc/deg sinusoidal grating with 25 Hz counterphase flicker. The visual field indices mean deviation and pattern standard deviation, and their significance, are included along with a raw data plot in decibels. Other reliability data, such as fixation errors, false positives and negatives, are also provided. According to the correlation of the retinal topographic construction and the total deviation plots in FDT, the macula was classified by the distance from the fovea center (Fig. 1). Zone I represented central 1°, zone II represented central 3° except zone I, and zone III represented central 5° except zone I & II. The lesion on fluorescein angiogram was scored into 3 ranks by the area ratio of involvement in each zone (1: free of lesion, 2: less than half, 3: more than half). As the
thresh old level on FDT pres ents as deci bels (dB),
but not ac tu ally the dif fer ence in the age-matched
groups, prob a bil ity is more re li able data to com pare
be tween dif fer ent in di vid uals. Our pre vi ous ex peri-
ence showed that a prob a bil ity be tween 2% and 5%
could be nor mal vari a tion in an aged group.20 We
graded the FDT scores of the cen tral tar get into five
ranks ac cord ing to the prob a bil ity level of ab nor mal
points on to tal de vi a tion plots in FDT full thresh old
C-20 mode (1: > 2%, 2: < 2%, 3: < 1%, 4: < 0.5%, 5: max).
The visual acuity was scored into 4 ranks
(rank 1 ≥ 6/12, 6/12 > rank 2 ≥ 6/20, 6/20 > rank 3 ≥
6/60, rank 4 < 6/60). The ret i nal scores, vi sual acu-
ity and dis ease du ra tion were com pared with the
FDT scores of the cen tral tar get us ing Spearsman’s
rank corre la tion method.

Results

Mea sure ments from 32 eyes (30 pa tients) with
exudative ARMD were col lect ed, in clud ing 27 men
and 3 women. The 30 pa tients had a mean (± SD) age
of 70.83 ± 7.69 years, with a range from 50 to 85
years. The diag no sis was made by fluo resecin
angiography. The ini tial vi sual acuity ranged from
1/200 to 20/20. The dis ease du ra tion was el i gi ble in 30
eyes (1-108 months). The FDT scores of the cen tral
target corre la ted sign if i cantly with the pres ence of
macular le sions in zone III (r = 0.329, p = 0.033), but
not with the pres ence of le sions in cen tral 3° (zone I,
r = 0.055, p = 0.383; zone II, r = 0.259, p = 0.077) (Fig. 2).
Vi sual acuity weakly corre la ted with the FDT scores
of the cen tral tar get (r = 0.360, p = 0.022), and the
le sion scores in zone III (r = 0.319, p = 0.038), but
strongly corre la ted with the le sion scores in zone I and
zone II (p < 0.001) (Fig. 3).

No sig nif i cant corre la tion was found be tween dis-
ease du ra tion and cen tral vi sual field de fect on FDT (r
= -0.060, p = 0.376), yet corre la tion exis ted be tween
disease du ra tion and best cor rect ed vi sual acuity (r =
-0.472, p = 0.004). The FDT scores of the cen tral tar-
get were within nor mal lim it in 20 eyes. Take for ex-
ample, Case 8, he had a small cen tral macular le sion in
his right eye, whose le sion score was zone I:3, zone
II:2, zone III:1, yet there was no ab nor mal point on
FDT in spite of 6/60 vi sion (Fig. 4).
Discussion

With its rapid testing speed and convenience of use, FDT scores high on its "creature comforts".\(^{17-23}\) Moreover, it showed high sensitivity and high specificity in patients with glaucoma.\(^{24-27}\) It will be great if it can be used as a functional evaluation tool in ARMD patients, who usually behave worse during conventional automated perimetry.

In our previous study, visual field defect correlated strongly with the extent of retinal involvement in patients with rhegmatogenous retinal detachment, but was limited in patients with ARMD.\(^{28}\) Our speculation was that the scoring system according to the area ratio of involvement in whole macula alone did not fully reflect the intensity of macular disease. Other factors, such as distance from the fovea center, disease duration, and type of ARMD might be related to the visual field change as well. As exudative type ARMD is the main cause of significant visual loss and is the target of treatment in ARMD, we excluded the dry type ARMD in this study and tried to use a different scoring system according to the distance from the fovea center and an analysis of other possible factors. The idea of our scoring system came from the fact that the distribution of photoreceptors varies in a concentric pattern away from the fovea. With this new scoring system, the central visual field defect correlated significantly with the lesion scores in zone III, but not with the lesion scores in central 3° (zone I and II). The results suggested that FDT using full-threshold C-20 mode is not sensitive enough for the detection of small

---

Fig. 3. Correlation between visual acuity (VA) and the lesion scores in different zones. A. zone I, \(p < 0.001\); B. zone II, \(p < 0.001\); C. zone III, \(p = 0.038\). The visual acuity correlated strongly with the scores of lesions in central 3°, but not so in zone III.

Fig. 4. A 70-year-old man had a small central macular lesion with visual acuity of 6/60 in his right eye. The lesion score was zone I:3, zone II:2, zone III:1. Nevertheless, there was no abnormal point on the total deviation plots in FDT in spite of the poor vision and central scotoma on the Amsler grid chart.
macular lesions (within central 3°) in patients with ARMD. As the FDT full-threshold C-20 mode presents with 16 targets, arranged in a 4-by-4 grid, plus 1 target in the macula. The target gets correctly responded to the retina within 20° of subjective angle, indicating the whole posterior pole and limited nasal retina. The macular area was evaluated by 1 target only, which consisted of the central 5-degree radius. This might explain why central visual field in FDT full-threshold C-20 mode would not be able to allow less than 1.3 lesions to be detected. The visual acuity correlated significantly with the lesion scores in zone I, II, and III, especially zone I and II. As we know, central visual acuity and exudative type ARMD has the tendency to grow into the fovea center. It is quite natural that visual acuity correlates strongly with the lesion scores in zone I, II, and III, especially zone I and II. As we know, central visual acuity and exudative type ARMD has the tendency to grow into the foveal center. It is quite natural that visual acuity correlates strongly with the lesion scores in zone I, II, and III, especially zone I and II. As we know, central visual acuity and exudative type ARMD has the tendency to grow into the foveal center. It is quite natural that visual acuity correlates strongly with the lesion scores in zone I, II, and III, especially zone I and II.

Acknowledgements

This study was supported in part by grants No. VTY-90-P3-20 and VGHKS-90-74 from Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan.

References