A CASE STUDY ON SENILE MACULAR DEGENERATION

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The most specialized area of the retina is the macula. It occupies only a small part of the retina measuring about 1 mm in diameter and accounts for the central 5^{o} of our visual field. At the center of the macula is the fovea which allows us 20/20 vision. With loss of function of the macula, vision drops off very abruptly. One disease which has a detrimental effect on the macula is known as Senile Macular Degeneration (SMD).

The onset of SMD, in the majority of cases, occurs over the age of 60. SMD is characterized by gradual physiological changes in the retina usually confined to the macular area. These changes occur in the retinal pigment epithelium, choriocapillaris and Bruch's membrane.

The retinal pigment epithelium is an essential part of the visual process. In the macula each pigment epithelial cell is in contact with approximately 25 photoreceptors (rods and cones). The RPE actively transports substances that are essential for metabolism of rods and cones. The RPE is also important in photopigment metabolism. Although the RPE plays a significant role in vision, it is never replaced if diseased or damaged. In SMD this degeneration of the RPE accompanied by changes in the choriocapillaris and Bruch's membrane results in decreased vision.

SMD is first characterized by the formation of drusen (fibrin and collagen formations) between the pigment epithelial cells. They interfere with the integrity of the pigment epithelium which in turn causes damage to the function of the photoreceptors. With the progression of drusen, a disturbance can be seen in the macula as ophthalmoscopically visible pigment clumping. Both

maculae are usually affected and the condition takes on the name SMD.

In the next stage of SMD fluid leaks into the subretinal space because of disturbances in the RPE and alterations occur in Bruch's membrane. These changes are accompanied by neovascularization from the choriocapillaris into the subretinal space. This is an irreversible process that leads to fibrotic scarring and profound loss of central vision.

SMD is the second leading cause of visual loss in the elderly with cataracts being the most common cause.(1) My paper is concerned with patients who were diagnosed with SMD and all ophthalmological medical treatment has been completed.

The final result of SMD is usually a field loss if carefully examined for and a significant decrease in visual acuity. The final acuity achievable is variable but the bottom line is the patient no longer can see 20/20. The progression of this disease doesn't allow the same level of interpretation achieved throughout his or her life, resulting in an obvious disadvantage. To qauntitate this disadvantage would be impossible because every individual adjusts differently. This is where the optometrist plays a vital role. We can allow a patient who is willing to improvise or adjust reach a better level of functioning vision. Functional vision as I define it is mobility, perception, independence and acuity accomplished through whatever means possible.

An optometrist is trained to offer the best vision possible through the techniques available. The use of optical visual aids is the technique he is most qualified to administer. This visual aid adds a great deal to the functional visual picture. Through this aid we add to a person's independence, sometimes mobility, perception and acuity. Through visual aids a patient can again read books and spot distant signs. These tasks, taken for granted in younger years, become impossible without low vision aids for SMD patients.

The SMD patient is a special challenge to the optometrist. In all probability, our patient has been searching for the magic pill to allow him or her to see as they once did. So often after medical treatment such as photocoagulation, counseling, mobility training and the like, the patient ends up in your examination chair with no cure and decreased acuity. Already the disease has changed the person's lifestyle in some form or manner.

The SMD patient in the majority of the cases can be helped through low vision aids. It should be emphasized to the patient in the form of encouragement that there is usually just a central visual loss and the remaining perimacular and peripheral vision won't be affected. The low vision aids can give more use to this residual vision.

The following is a summary of 40 cases of SMD taken from the files of the Optometric Institute and Clinic of Detroit. These cases span a period from 1974-1981. From 394 processed low vision files, there were 40 cases where the diagnosis was SMD. Details

on the classification or type of SMD were not provided. All had exhausted numerous resources concerning their decrease in vision.

The SMD cases diagnosed amounted to 10.4% of all low vision cases processed through the clinic. This is a very significant percentage when considering the number of different diagnoses for low vision, and all groups effected. The following data was derived from the SMD files researched:

RESULTS OF 40 SMD PATIENTS

	# of cases	Central Field Loss Noted	Bilateral Degeneration	Conventional Near R_x Prescribed	Special Near Aids Prescribed	Conventional Distance R_x Prescribed	Special Distance Aids Prescribed	Ability to read Newspaper Print
Distance VA of 10/100 or better	27	16	27	7	20	16	11	27
Distance VA of less than 10/100 up to 10/200	11	6	11	1	9	5	5	8
Distance VA of less than 10/200	2	2	2	0	1	0	1	0

AGES OF SMD PATIENTS

40-49	1
50-59	5
60-69	12
70 and over	22

DATA ON VISUAL AIDS

Special near visual aids prescribed in which patient's distant VA is 10/100 or better:

	Unaided Near VA	Aided VA
Ary Loupe 16D	3 M	.75 M
4.00 x F.D. M.S.	6 M	1 M
6.00 x F.D. M.S.	F 1	F 5
''	F 1	F 5
+10.00 D 12 B.I.	2.5 M	1 M
8.00 x F.D. M.S.	F 1	F 5
''	F 1	F 5
''	F 1	F 5
''	L J 6	F 5
''	--	4 pt
+4.50 add	6 M	2 M
2.0 x M.S.	12 pt	20/20
4.5 D magnifying glass	8 M	.5 M
Pike Illuminated Magnifier	--	.5 M
6.0 x R type M.S.	--	12 pt
+6.00 reading cup on 3.0 x T.S.	L F 1	F 5
Hand held magnifier	--	5 pt
4.0 x R type M.S.	F 1	F 5

Special distant visual aids prescribed in which patient's distant VA is 10/100 or better:

	Best corrested VA	T.S. VA
3.5 x Monocular T.S.	10/80	10/40
3.0 x Bioptic T.S.	10/60	20/20
''	10/50	20/20
''	10/30	20/25
''	--	20/40
''	10/60	20/25
4.0 x Bioptic T.S.	10/60	20/50
''	10/60	20/40
''	10/100	10/60
2.8 x Selsi T.S.	10/60	10/40
6.0 x E.F. T.S.	10/80	20/40

Special near visual aids prescribed in which patient's distant VA is less than 10/100 but up to 10/200:

	Unaided near VA	Aided near VA
8.0 x F.D. M.S.	--	F 5
8.0 x F.D. M.S.	18 pt	10 pt
+ 8.00 add	F 1	F 2
6 x F.D. M.S.	24 pt	5 pt
3.5 x Surgical T.S.	20/150	F 5

M.S. - microscope
T.S. - telescope

	Unaided near VA	Aided near VA
10.0 x M.S.	F 1	F 5
28 D coil stand magnifier	2.5 M	1 M
+ 8.00 press on	F 1	F 5
4.0 x F.D. M.S.	C 20/400	F 4

Special distant visual aids prescribed in which patient's distant VA is less than 10/100 but up to 10/200:

	Best corrected VA	T.S. VA
4.0 X Bino T.S.	10/120	20/20
6.0 x E F T.S.	10/140	20/40
6.0 E.F. T.S.	10/120	20/50
6.0 X E. F. T.S.	10/120	20/80
2.5 X Selsi hand held T.S.	10/225	10/100

Special near visual aids prescribed in which patient's VA is less than 10/200:

	Unaided near VA	Aided near VA
A disc hand held Illam mag.	--	--

Special distant visual aids in which patient's distant VA is less than 10/200:

	Best corrected VA	T.S. VA
6.0 x E.F. T.S.	10/225	10/40

The data on the visual aids pertains to the one most useful device at distance or near for the patient. Some patients were given more than just one visual aid for distance and near but the device which proved most useful for each patient is only recorded.

When considering near visual aids, the majority (33 of 40, 82.5%) chose spectacle mounted aids over hand held aids. Some conclusions can be drawn from this. It is conceivable that patients are willing to sacrifice a normal working distance for increased field of view. The patient may also feel it is an advantage to keep both hands free to position reading material. With a hand held aid the elderly patients fatigue easily because one hand has to maintain proper object to magnifier distance for most efficient use.

One cannot forget the importance of hand held magnifiers even though spectacle mounted aids were prescribed the majority of the time. Some advantages can be attributed to the hand held aid. First, the hand held aid is much less expensive than the spectacle mounted microscope. Secondly, there is an increased working distance. This could prove important for quick checking of prices in the supermarket or for writing purposes.

A practitioner should not preconclude what aid is best for the patient because there are advantages to both systems. The patient should be shown both types of aids and become very instrumental in the final decision.

In the case study, 35 of th 40 (87.5%) of the SMD patients benefitted from a near prescription which allowed them to read newsprint. Twenty-nine of the 36 (80.5%) needed near visual aids of special* Rx design affording high magnification. It can be concluded that a large majority of the patients are willing to adapt to shorter working distances, and decreased field of view in order to read again.

Relative to distance vision, 29 of 40 (72.5%) were helped at distance. Seventeen of the 29 (58.6%) needed a special* distance prescription supplied in the form of a Galilean Telescope. Spectacle mounted telescopes were chosen by 13 of the 17 (76%). It is obvious that more patients were helped at near than at a distance. This could be attributed to the fact that more sacrifices are needed to adapt and properly manage a telescope. A telescope allows approximately 6-12^{o} visual field depending on the telescopic power.

*<u>special</u> - optical device other than conventional spectacle R_x.

The higher the magnification the smaller the field of view. In addition to sacrificing field of view, it takes considerable practice in learning to aim a telescope at the object of interest.

We also see from the study that there is a decrease in the amount of distant prescriptions as distant acuity decreases. Only 7 of 13 (54%) of the patients with less than 10/100 distance vision were prescribed for. Twenty-two of 27 (81%) with VA of 10/100 or better were assisted. Again, there is not just one reason for this. It is a combination of factors involving motivation, interpretation and adaptation to a new form of reading. For example, two SMD patients will demonstrate the same uncorrected visual acuity. When it comes time for the use of a telescope, one can readily adapt and show an increase in VA where as the other patient finds great effort in eliciting similar acuity. We must handle each patient individually.

I also discovered that the optometrists were not concerned with exact central field plotting. The autoplot, tangent screen or amsler grid is needed for accurate central field plotting.

The Biotronic visual field analyzer was used on the patients instead of specific central field testing. From the data available, no correlation can be established between central visual fields and a corresponding visual acuity. There is too much of a random distribution with Biotronic Field analyzer results and distance acuities demonstrated. One patient could show a central field loss and another have no central loss, but both patients have equal measured distant visual acuities.

The only viable evidence available was distant visual acuities along with the plotting of Biotronic peripheral fields. The establishment of best corrected distant visual acuity and the integrity of the visual field from the paramacula to peripheral retina (5^{o} - 80^{o}) will judge the success of the SMD patient.

The distance acuity and the mobility in unfamiliar surroundings helped judge whether low vision aids will prove helpful to the patient. Low vision aids will be beneficial when a patient is mobile, motivated, has good peripheral fields and elicits a visual acuity from a standardized 10 ft. acuity chart. We know the perimacular area is in tact since an acuity was demonstrated, and through magnification we can allow the patient to see smaller print. This is possible because the smaller print is magnified into the para and perimacular areas of the retina.

I feel the optometrists weren't overly concerned with quantitating a specific central field deficit. Their main concern was establishing an unaided distant visual acuity, careful spectacle refraction, an ophthalmologist's report, ophthalmoscopic integrity of the retina and initial responses to magnification. It appears that a proper prescription for a near vision aid as well as a distant visual aid can be arrived at without extensive central field plotting. If the patient's initial response to magnification is positive, you have established that the para or peri-macular area is responsive to visual stimulus. Also, careful documentation of the condition of the retinal fundus and acuity measurement on each visit give the optometrist confidence that central fields need not be taken.

In my opinion, central visual fields give random results because there is not an accurate method to establish fixation. The results are also arbitrary because many SMD patients will eccentrically fixate which is a natural adaptation to their condition. Thus the establishment of visual acuity, along with a good case history of how the patient manages, and an initial response to magnification are more conclusive findings.

Magnification and why it works on SMD patients needs further explanation. Normally, the central macular area (center - 5^{o}) allows for resolvement of fine detail, i.e., newspaper size print. In SMD patients the macula has deteriorated. This establishes a need to magnify small images onto paramacular and perimacular points not affected by the disease process. This can be accomplished by magnification through certain types of visual aids. Near magnification can be provided by spectacle mounted high plus aids, telescopic reading caps and held held high plus magnifiers. Distance magnification is provided by a Galilean telescope.

In considering low vision optical aids, two types of mangification come into the picture. The two types are angular and relative distance magnification. Angular magnification is the ratio of the angle of subtense of the image formed by an optical instrument compared to the angle of subtense of the actual object.[2] Thus angular magnification is the ratio of the size of the image produced by the optical aid compared to the actual size of the object.

Relative distance magnification is the magnification produced when reducing the distance between the object and the eye. When an object is brought closer to the eye; the angle it subtends at the

eye becomes larger. This causes a corresponding increase in the linear size of the retinal image.

With near vision aids such as hand held magnifiers and spectacle microscopes, the total magnification is the product of relative distant magnification. Total magnification will always be constant. Although some angular magnification is induced by microscopic spectacle aids relative distance magnification is the most important factor. Basically, the only reason that the high plus microscopic lens is needed, is that the eye is unable to accommodate for near reading distances required to afford high magnification. This is exactly the case with SMD patients. They do not have the corresponding amplitude of accommodation needed to maintain focus with the induced magnification created by decreased working distance. The shorter working distance allows magnification of the print into para and perimacular points. It must be stressed that for optimum results and designated magnification on the microscope that the object should be held at the anterior focal point of the lens system.

Magnification designated on a microscope or any simple plus magnifier is a relative value. By this I mean it is a comparison value based on the fact that object to eye distance is 25 cm (4 D of accommodation). Thus the magnification is the quotient of power of the lens divided by 4. $M = \frac{p}{4}$ M - magnification; p - power of lens. This can be related to all plus lenses as long as object to lens distance is equal to the anterior focal length of the lens magnifier.

In hand held magnifiers, angular magnification plays a more important role than relative distance magnification. As the lens and object recede from the eye, angular magnification increases and distance magnification decreases.(2) The total magnification remains constant. Thus, for the SMD patient the same strength needed in a spectacle mounted lens to resolve print can be used in a hand magnifier at arm's length without a demand on accommodation. There is no demand on accommodation because the image formed is at infinity. Again, it should be emphasized that to obtain the same magnification as with the microscope the object to lens distance should be equal to the anterior focal length of the lens.

When speaking of distance low vision aids we are referring to the Galilean Telescope. Many SMD patients can benefit from a telescope. It allows them to spot objects at a distance which would otherwise be left unseen unless they walked very close to the object.

Galilean Telescopes consist of a positive objective lens and a negative ocular lens. The lenses are positioned so parallel light rays entering the objective will focus at its secondary focal point which is coincident to the primary focal point of the negative powered ocular lens. The result is parallel light rays leaving the negative lens. Since parallel light enters and leaves we have an afocal system with an image formed at infinity. The emerging rays create an angle larger with the optical axis of the system than did the angle of incident rays. This creates your angular magnification effect. Magnification can be calculated by

$$M = -\left(\frac{Poc}{Pobj}\right)$$

M = magnification; Poc = power of ocular; Pobj = power of object

Another important result of the Galilean Telescope is that the image is erect.

A telescope cannot be used for near point tasks due to the enormous amount of accommodation required to keep the retinal image focused. This can be overcome by the use of a plus lens reading cap inserted on the objective lens of the telescope. This lens acts like a reading add by taking an object at a finite distance and forming an image at infinity. You can now place the telescope behind the reading add and the telescope will have incident parallel lightrays from the image formed at infinity, and thus can focus this image.[3] The magnification created is the product of the telescopic magnification and reading add magnification.

In all the optical aids mentioned there is a benefit through magnification, offered to all the SMD patients where there is a functional para and perimacular area. The laws of optics create restrictions on low vision optical aids such as decreased field of view and lens abberations. I will not go into detail on the abberations and field limitations but just wanted to bring to mind that adaptation and sacrifices are needed to overcome these limitations. This is why the least amount of magnification should be prescribed without sacrificing the patient's goals. The benefits by far outweigh the shortcomings in the majority of the SMD patients; once they have adapted to the optical limitations of their aids.

In summary, I believe the case study has proven that the majority of SMD patients can be helped. They are never cured but will leave your office with more independence and functionability

then when they entered. It is our duty as optometrists to take on this low vision patient. If an optometrist feels he is incompetent in the field of low vision and services available, it is his or her responsibility to refer this individual to someone who can make the deicison on whether they can be helped. There are too many SMD patients or low vision cases in general that end up in a competent low vision practitioner's office by luck. Anyone who deals with the public professionally, on the subject of vision should know the proper channels for this patient to follow. This is the least that should be done and anything less should be considered unexcusable.

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