

Guideline Development for the Evaluation of Visual Impairment in Korea

This guideline is developed to provide criteria for evaluating permanent impairment of the visual system as it affects an individual's ability to perform activities of daily living. This new assessment system is based on the 5th and 6th edition of American Medical Association and McBride impairment assessment system but revised on the consideration of Korean culture and simple application. This evaluation of impairment is based on an assessment of visual acuity and visual field. Especially it weighs binocular vision and binocular visual fields and the binocular vision and binocular visual fields provide 50% of weight and the right and left eye each contribute 25%. A further adjustment of the impairment rating is included at the final step of this evaluation. Functional deficits for individual adjustments include diplopia, problem of accommodation, abnormality of eyelids, tearing, cosmetic problems from cornea opacity, glare, aphakia, and dark-adaptation. The adjustment can be added to impairment rating up to 15%. Further study is necessary to revise and update of this disability evaluation that have potential problems in actual application.

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INTRODUCTION

The visual system is the key in one's ability to perform activities of daily life. This study provides criteria for evaluating permanent impairment of the visual system. In Korea, several standards have been in use for assessing visual impairment such as the Guarantee of Automobile Accident Compensation Act, Labor Standard Act, Industrial Accident Compensation Insurance Law, Government Employees Pension Act, etc. Each of these laws has their own assessment criteria or modification of the American Medical Association (AMA) and McBride impairment assessment system or both. Therefore they lead to confusion and it is necessary to set a comprehensive and objective standard. Moreover, the social and cultural environments differ between Korea and the Western countries to apply the same standard. This new assessment system we suggest is based on the fifth and sixth edition of AMA Guides and McBride impairment assessment system and revised for the purpose of simple application and setting the appropriate standard for Korea's current culture.

MATERIALS AND METHODS

In this study, four ophthalmologists including specialists

of retina, pediatric ophthalmology, oculoplastics, cornea and low vision developed a new assessment system which is applicable to the current situation of Korea. This work was a part of steering committee of Korean guides for impairment rating in Korean Academy of Medical Sciences.

This evaluation of impairment is based on an assessment of visual acuity and visual field. Especially it weighs binocular vision and binocular visual fields. That makes it closer to visual impairment in real environment. If significant factors remain that affect functional vision and that are not accounted for through visual acuity or visual field loss, a further adjustment of the impairment rating of the visual system may be included at the final step. Functional deficits for individual adjustments include diplopia, problem of accommodation, abnormality of eyelids, tearing, cosmetic problems from cornea opacity, etc.

A permanent visual impairment is defined as a permanent loss of vision that remains after maximal medical improvement of the underlying medical condition has been reached. Most of the tests for the visual acuity or visual field are subjective. Therefore the impairment of vision or visual field should be explained by current medical knowledge and ophthalmologic examinations.

RESULTS

Symptoms and signs

Visual acuity describes the ability of the eye to perceive details. Visual acuity loss will manifest itself in an inability to perform detail-oriented tasks, such as reading and face recognition. Visual acuity loss affects many activities of daily living. Although visual acuity is governed by only a small area of the retina (the fovea, the central-most area), it occupies a major part of the visual cortex.

Visual field refers to the ability to detect objects in the periphery of the visual environment. A lay term for peripheral field loss is tunnel vision. Visual field loss will manifest itself in an inability to detect peripheral objects and, often, in a reduced ability to avoid obstacles. The peripheral visual field occupies the largest part of the retina, but it occupies a smaller part of the visual cortex.

Good visual acuity and good visual field are both needed for the performance of daily living skills. A person with tunnel vision may not notice when someone enters the room. A person with visual acuity loss, on the other hand, may notice the newcomer but may have difficulty recognizing the person's face. Once an object has been detected in peripheral vision, central vision will be used to recognize it. A person with a visual field defect (i.e., tunnel vision) may not notice a sign on the road or on a wall but could read the sign once found, assuming the individual had good visual acuity. A person with normal visual fields but a visual acuity loss will detect the sign but will not be able to read it.

Other symptoms may result from deficits in diplopia, accommodation, abnormality of eyelid, tearing, and cosmetic problems due to corneal opacity, glare sensitivity, color vision, night vision, binocularity, stereopsis, and suppression. If these deficits cause a significant ability loss that is not reflected in a visual acuity or a visual field loss, they may also be handled as adjustments to the impairment ratings.

Clinical studies

To obtain the required information, the physician needs to perform a detailed visual assessment, including the cause, severity, and prognosis of the underlying disorder and the expected or documented effects of the vision loss on the ability to perform activities of daily living. Such a visual assessment includes medical history with particular emphasis on preexisting conditions and treatments and the major cause of the current vision loss, current condition of the eyes and visual system with documentation of relevant anatomic findings, visual acuity measurement with best correction, visual field measurement for each eye and calculation of an initial impairment rating. That also includes other factors that may affect the individual's ability to perform activities of daily living and discussion of factors that might justify and adjust-

ment of the initial ability estimate and apportionment consideration. Visual acuity is measured binocularly and for each eye separately. Accurate measurement of distance visual acuity (letter chart acuity) is mandatory but measurement of near acuity (reading acuity) is optional.

In addition to the equipment needed for a standard ophthalmologic evaluation, the various tools are required for the functional evaluation. A standardized letter chart is essential. A lighted chart in a lighted room is preferred because it is more representative of normal viewing conditions than is a projector chart in a semi-dark room. Charts with five letters per line, proportional spacing, and a geometric progression of letter sizes are preferred. For vision in the normal ranges, testing at 5 m is recommended and in the low-vision range, testing at 1 m is recommended. If a restriction of the visual field is claimed or suspected, formal visual field testing on standardized equipment is required. If no visual field restriction is claimed, a confrontation visual field is acceptable to confirm the absence of field restrictions. Other functional tests, such as contrast sensitivity test or glare test can be added if problems in these areas are reported.

Outline for calculation of the visual impairment rating

To calculate the visual impairment rating, multiple steps are needed. The first step is calculation of Visual Acuity Score (VAS). Visual acuity of each eye and binocular vision are measured. Each of the measured acuity values are converted to a Visual Acuity Score using conversion Table 1. Using the combine formula for VAS, Functional Acuity Score (FAS) is calculated. In this calculation the binocular acuity provides 50% of the weight and the right and left eye each contribute 25%. In the next, Visual Field Score (VFS) are calculated. The visual field of each eye and binocular visual field are measured. Each of the measured visual field values are converted to a VFS. Functional Field Score (FFS) is calculated using the similar formula of Functional Acuity Score. That is, binocular field provides 50% of the weight and each eye contribute 25%. The third step is calculation of Functional Vision Score (FVS). To calculate the Functional Vision Score, the Functional Acuity Score and the Functional Field Score are combined. Finally, impairment rating in visual system can be calculated by subtraction Functional Vision Score from 100.

If significant factors remain that affect visual function and not reflected in the reduction of visual acuity or visual field, a further adjustment can be made at the final step. The adjustment can be added to impairment rating up to 15%. When the impairment rating is adjusted, the reason and evidence should be documented clearly.

Impairment of visual acuity

Test of visual acuity

Charts with a logarithmic progression of letter sizes, 5 let-

ters on each row, and letter spacing that is equal to the letter size (often referred to as ETDRS-type charts or Yong-Han Jin Charts) are the preferred standard. Charts with a decimal progression of letter sizes and small numbers of letters on each row (often referred to as Han Chun Suk charts) are not suitable for test. A line is considered read when the patient correctly reads more than half of the characters (eg, 3 of 5). For individuals in the low-vision range (less than 0.1), use of low-vision chart is recommended. If low vision chart is not available, individual can be brought to closer distance.

Visual acuity should be measured with best correction for the right eye, for the left eye and with both eyes open. Under most circumstances, best-corrected visual acuity measured binocularly will be determined by the acuity of the better eye. There are exceptions, however. People with latent nystagmus may have better eye stability, and hence better acuity, when viewing binocularly than when one eye is occluded. Some people with diplopia or with distortions in one eye may see better when the poorer eye is occluded.

Steps for assigning a visual acuity-based impairment rating

Visual acuity score (VAS, Table 1)

After the best-corrected visual acuity values for binocular vision (OU), for the right eye (OD), and for the left eye (OS) have been obtained and converted to Visual Acuity Scores using Table 1. The impairment rating, which is a scale of abil-

Table 1. Impairment of visual acuity

Logarithmic progression of letter sizes (ETDRS-type Charts or Yong Han Chin Charts)	Decimal progression of letter sizes (Cheon Suk Han Charts)	Visual acuity score	Impairment rating (%)
20/20	1	100	0
20/25	0.8	95	5
20/32	0.63	90	10
20/40	0.5	85	15
20/50	0.4	75	25
20/63	0.32	65	35
20/80	0.25	60	40
20/100	0.2	55	45
20/125	0.16	50	50
20/160	0.125	45	55
20/200	0.1	40	60
20/250	0.08	35	65
20/320	0.063	30	70
20/400	0.05	25	75
20/500	0.04	20	80
20/630	0.032	15	85
20/800	0.025		
20/1,000	0.02	10	90
20/1,250	0.016		
20/1,600	0.0125		
20/2,000 or less	0.01 or less	5	95
No light perception	No light perception	0	100

ity loss, is obtained by subtracting the VAS from 100. On the charts with a decimal progression of letter sizes that have no lines between 0.1 and 0.2, and between 0.2 and 0.3, there is a problem that increases difference between VAS of one line.

Functional acuity score (FAS)

VAS of the right eye (OD), the left eye (OS) and binocular vision (OU) need to be combined to a single FAS. The formula for FAS is combining the VAS for OU, OD, and OS:

$$FAS = (VAS_{OD} + VAS_{OS} + VAS_{OU} \times 2) / 4$$

Testing reading acuity

Determination of reading acuity (near vision) is optional. If the reading acuity is significantly worse than the letter chart acuity, the FAS may be adjusted to the average of the letter chart (distance) acuity score and the reading (or near) acuity score. The probable reason for the discrepancy should be explored and explained.

Impairment of the visual field

Test of visual field

If no visual field impairment is claimed or suspected, a confrontation visual field may be used to confirm a normal field. In all other circumstances, formal visual field tests should be performed by qualified personnel according to the instructions provided with the equipment.

The Goldmann visual field equipment is the preferred standard although automated perimetry (commonly used equipment includes Humphrey, Octopus etc.) is possible. Most clinical automated static perimetry tests are limited to the central 30° radius. For the functional assessment of visual field loss, however, testing to a 60 radius or beyond is mandatory. When kinetic perimetry is used, the III4e isopter should be plotted. When automated, static perimetry is used, the results are displayed as a gray scale, not as isopters. Therefore, a pseudoisopter equivalent to the Goldmann III4e isopter must be constructed. On the Humphrey equipment, this would be the isopter for a 10-dB stimulus and 7-dB stimulus on the Octopus equipment. Considering of both monocular and binocular function is important. Direct testing of the binocular visual field presents problems, however, because the amount of convergence in a bowl perimeter can not be monitored and fixation monitoring devices will not work when the head is centered. Therefore, the fields of each eye should be measured separately, and a binocular field plot should be derived from the superimposition of the two monocular field plots.

Steps for assigning visual field-based impairment rating

Visual field score (VFS, Fig. 1)

VFS is measured from the result of field test using the testing grid (Fig. 1). It is constructed by drawing 10 meridians: 4 lines of horizontal and vertical meridians, 1 in each of the upper quadrants (spaced 45° apart) and 2 in each of the lower

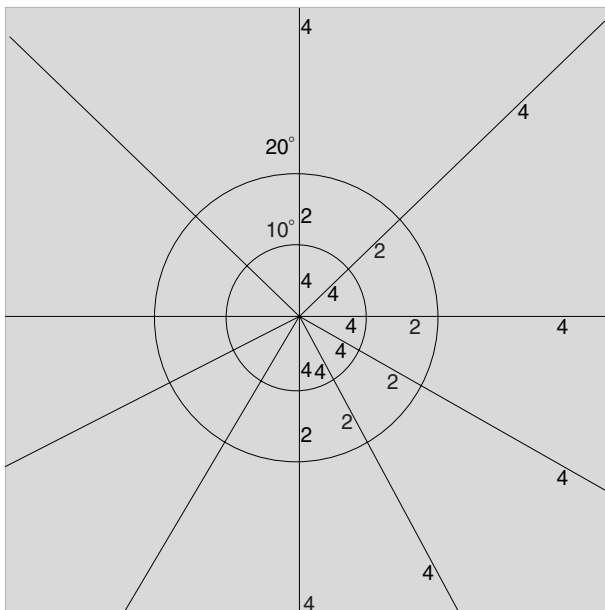


Fig. 1. Distribution of the Grid Points for Visual Field Evaluation. The first circle from center represent a 10° radius and the second one indicates 20° radius. Total visual field score is 40 points within the inner 10° and 60 points within the 20° range. Also 40 points are assigned to the upper half of field and 60 points are assigned to the lower half. The average normal field will score about 100 points.

quadrants (spaced 30° apart). Along these meridians, 4 points (2 points each 5° spaced apart) are assigned to the central 10°, 2 points (1 point each 5° spaced apart) are assigned from 10° to 20° and 1 point is assigned to each 10° from 20° to 60°; thus, a 60° radius will represent 10 points. Each upper half and lower half of field have total 40 points and 60 points and the average normal field will score about 100 points.

When Humphrey visual field test is used, at least two different plots are required including 60° field plot although we recommend Goldman n visual field test. Humphrey 10-2 plot corresponds to the inner 40 VFS points. Humphrey 24-2 plot covers middle 20 VFS points from 10° to 20° visual field area and inner 40 points. If a 10-2 plot is available (preferable) only the 20 middle points (10° to 20°) are counted from this grid. Humphrey 60-4 plot covers outermost 40 VFS points.

Functional field scores (FFS)

FFS is calculated by combining the VFS. The binocular field is determined by superimposing the monocular fields. The VFS values are combined for the binocular field, for the right eye, and for the left eye. The formula is:

$$FFS = (VFS_{OD} + VFS_{OS} + VFS_{OU} \times 2) / 4$$

Impairment of the visual system

Calculation an impairment rating for the visual system

The preceding calculations have provided us with two sep-

arate impairment estimates: FAS and FFS. To obtain an overall estimate of visual impairment, the two impairment estimates must be combined to a single FVS. Visual acuity-related functions and visual field-related functions are largely independent. Good visual acuity cannot compensate for a loss of visual field, and vice versa.

The basic rule for calculating the FVS is that the FAS and the FFS are multiplied as if they represented percentage scores:

$$FVS = (FAS \times FFS) / 100$$

For example, if the FAS is 70 (a 30% impairment) and the FFS is 80 (a 20% impairment), the FVS is calculated as follows: $70 \times 80 / 100 = 56$ (a 44% impairment). This calculation can be performed only on the basis of the residual ability scores. Any calculations based on the impairment ratings (which indicate ability loss) would give erroneous answers.

Additional Rules for FVS are also important. The Functional Acuity and Functional Field Scores that are greater than 100 are regarded as if they were 100. Because the average performance of healthy eyes often is better than the performance standard. When there is no clinical reason to suspect visual field loss, the FFS may be assumed to be 100.

When field loss and acuity loss are not independent, rule for central scotoma can be applied. If the scotoma is central (i.e., it covers the point of fixation), it affects both visual acuity and visual field and the two impairment ratings can no longer be treated as independent. Using the basic formula, central scotoma would be counted twice. Therefore stronger impairment is included in calculation, and weaker impairment is ignored.

Other factors affecting on visual function

Although visual acuity loss and visual field loss represent significant aspects of visual impairment, they are not the only factors that can lead to a loss of functional vision and to a limitation in the ability to perform activities of daily living (ADLs). If significant factors remain that affect visual function and not reflected in the reduction of visual acuity or visual field, a further adjustment can be made at the final step. The reason for the adjustment must be well documented. Such factors are diplopia, accommodation error, eyelid disorders, epiphora, media (cornea, lens, vitreous) opacities, aphakia, glare sensitivity etc. But factors such as contrast sensitivity, color vision defects, binocularity (stereopsis, suppression) are excluded in adjustment. There are three basic conditions to adjust impairment. First, evaluation of impairment is always performed after all available surgical/medical treatment. Secondly, the adjustment should be limited to an increase in the impairment rating of the visual system by, at most, 15%. Thirdly, the adjustment is excluded when factors have influence upon visual acuity or visual field (for the exception of counting twice).

When diplopia is remained permanently despite of ophthalmological surgery or treatment and lead to a limitation in the ability to perform ADLs, the examiner can adjust rat-

ing points up to 15% based on reasonable judgement. Maximal impairment rating points are like following;

1) Diplopia within central 20° and more than 5 prism diopter: maximum 15%.

2) Diplopia within central 20°, less than 5 prism diopter and corrected with prism glasses: maximum 10%.

3) Diplopia beyond central 20°: maximum 5%.

Adjustment by diplopia is always under consideration of remaining visual function. That is, in proportion to the impairment of visual function, the impairment rating by diplopia must be subtracted.

Accommodation error including cycloplegia and iridoplegia can be given additional rating up to 5% on affected eye. Eyelid disorders are also adjusted including entropion, ectropion, lagophthalmus and so on. It can be added 5% to total impairment rating. Disfiguration is calculated separately. Epiphora is considered as impairment when symptom is remained despite surgical treatment. It may get 5% to total impairment rating.

Visual functional impairment due to media opacity is not considered for adjustment because it has been already reflected in visual score and field score. If corneal opacity is very severe to recognize easily, adjustment can be made. It can get additional 5% to total impairment rating in adjustment. Adjustment is not required in case of corneal tattooing or good tolerability with cosmetic contact lenses. Some situations causing glare like aniridia or refractive surgery can be adjusted. In the case of aniridia, adjustment can be done only cases that surgical treatment or cosmetic contact lenses are impossible, and it is difficult to perform ADLs. Adjustment of additional 5% to total impairment rating can be made. After refractive surgery, adjustment can be done when the glare is too severe to perform ADLs. The medical data including difference of pupil size between light and dark place, data of surgery (calculation of ablation), analysis of ORB scan before and after surgery should be considered for adjustment. In these cases, additional 5% to total impairment rating can be made. Aphakia can be adjusted only in case that use of contact lenses or secondary intraocular lens implantation is impossible and add 5% to total impairment rating. Dark adaptation is also adjustment factor. In case of retinitis pigmentosa, visual acuity and visual field are already reflected in visual function. Therefore in that case, dark-adaptation dysfunction is not considered for the adjustment. Adjustment can be considered in case of reduced or delayed dark adaptation with normal visual acuity and visual field and add 5% to total impairment rating.

There are some other factors excluding from adjustment. Few hospitals are existing in Korea that can evaluate contrast sensitivity, and up to the present the result may not be objectified. Color vision defects are uncommon and usually do not interfere significantly with generic ADLs. Severe color vision defects are very rare and usually accompanied by visual acuity loss. Binocularity (steropsis, suppression) vary in their effect

on ADLs and have difficulty in express numerical value.

Impairment of visual acuity at near (reading acuity)

If the reading acuity is significantly worse than the letter chart acuity, the FAS may be adjusted to the average of the letter chart (or distance) acuity score and the reading (or near) acuity score.

$$FAS = (FAS_{\text{letter chart}} + FAS_{\text{reading}}) / 2$$

DISCUSSION

In Korea, many different laws stipulate the visual impairment rating, however, each law applies different criteria. In this study, we suggested the new criteria on the evaluation of visual impairment which is fundamentally based on the fifth and sixth edition of AMA Guide and McBride impairment assessment system and modified it for easier application.

The key factors regarding the impairment ratings were visual acuity and field. However the most important difference of this guideline from other existing standards (such as Welfare Law for the Disabled) is that it emphasizes on binocular vision and binocular visual fields which makes it more realistic in evaluation of visual impairment. Considering cultural and social differences between Korea and the Western countries, we modified the visual acuity score (Table 1) and visual field score (Fig. 1). It is hard to precisely evaluate visual acuity less than 20/1,000 (legal blindness in Korea) in practice, therefore, some intervals less than 20/1,000 were amalgamated. Also important point as a way to offset the disabling effects of the impairment is vision rehabilitation. Vision rehabilitation includes vision enhancement, vision substitution, human environment and physical environments. In Korea, the social infrastructures for the low vision people are still insufficient and actual difficulties caused by visual impairment are more common than those in Western countries. For that reasons, we lowered the visual acuity score and increased the impairment rating than those of AMA Guides especially in the range of low vision. Similar to AMA Guides, this new assessment also used Functional Acuity Score, Functional Field Score, and Functional vision Score. However, the contributing factor in the calculation was modified so that the binocular function contributed 50% and each eye contributed 25% in the calculation. Welfare Law for the Disabled in Korea, that is commonly used until now does not consider binocular visual function as a criterion. Binocular view represents the most common viewing condition in daily life, the impairment rating should consider the best-corrected binocular visual acuity and binocular visual field.

If significant factors other than visual activity or field loss affect functional vision, a further adjustment of the impairment rating may be included at the final step. We provide additional adjustment factors in further adjustment of impair-

ment rating of visual system, including diplopia, accommodation error, eyelid disorders, epiphora, media (cornea, lens, vitreous) opacities, cosmetic problem due to corneal opacity, aphakia and glare-sensitivity. The adjustment should be limited to an increase in the impairment rating of the visual system from 5% to 15%. We made a rule for the adjustment score by 5% point interval (that is, 5%, 10%, and 15%). However, factors such as contrast sensitivity, color vision defects and binocularity (stereopsis, suppression) are excluded in adjustment of this assessment. The reason for the exclusion is that there are few hospitals that can evaluate contrast sensitivity in Korea and the result may not be objective. Also severe color vision defect that can affect visual acuity is very rare and stereopsis or suppression is difficult to express numerically. Disfiguration related with eye is also excluded in this impairment rating and it would be discussed in the impairment evaluation disfigurement in skin and appearance.

Suggesting the rational and comprehensive standard for rating impairment is difficult, and problems should occur when this rating system is applied in real situation. Therefore it is required to update constantly through further studies.

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