An Overview of Spaeth/Richman Contrast Sensitivity (SPARCS): A Web-based, Contrast Sensitivity Testing Tool

Parul Ichhpujani[1] and Sahil Thakur[2]

1. Glaucoma Service, Department of Ophthalmology, Government Medical College and Hospital, Chandigarh, India; 2. Ocular Epidemiology and Data Science Research Group, Singapore Eye Research Institute, Singapore, Singapore

This review article highlights the extensive applicability and efficacy of the Spaeth Richman Contrast Sensitivity (SPARCS) test, which is a novel web-based contrast sensitivity tool, across a spectrum of eye diseases, focusing on its diagnostic and prognostic capabilities. Highlighting its utility in glaucoma, the article explores how SPARCS has been used in assessing both open-angle and closed-angle glaucoma, as well as in post-treatment cases, such as those undergoing laser peripheral iridotomy and using prostaglandin eyedrops. The tool has demonstrated a high correlation between activities of daily life of patients and patient-reported outcome measures, thereby showcasing its potential to enhance patient-centric care. Additionally, the article delves into the potential utilization of SPARCS in neuro-ophthalmology clinics, highlighting its role in garnering vital information about the optic nerve head as in the case of idiopathic intracranial hypertension. This comprehensive updated article can serve as a valuable resource for clinicians and researchers, shedding light on the versatility and clinical implications of SPARCS in managing and understanding a variety of ophthalmic conditions.

Contrast sensitivity (CS), which is an important element of functional vision, helps in differentiating an object from its background. CS affects several aspects of vision, such as acuity, dark adaptation, visual field, motion detection and pattern recognition.[1] A decline in spatial CS occurs in several ophthalmic disorders, including cataract, glaucoma, diabetic retinopathy and age-related macular degeneration.

Commonly, CS tests measure central contrast, as they traditionally use paper charts and cards (e.g. Pelli-Robson [PR] chart, Mars Letter Contrast Sensitivity Test, Regan low-contrast letter acuity charts, Vistech VCTS 6500 charts and Hamilton–Veale CS card test). The drawbacks with chart-based tests are that they can easily be memorized due to pattern recognition, are vulnerable to reflections from the surface, have uneven illumination, are prone to fading of print and provide information only on central CS.[2]

The Spaeth/Richman Contrast Sensitivity (SPARCS) test is an internet-based low-cost test (developed by Dr George Spaeth, patent no. 8042946) that measures CS in both central and peripheral vision, independent of optotypes with global accessibility.[3] In this short article, we will discuss CS pathways, techniques of assessing CS using SPARCS and its practical applications in clinical practice.

Contrast sensitivity pathways

In the visual system, CS is mediated by two main cellular pathways: the magnocellular (MC) and parvocellular (PC) pathways. The MC pathway has a high contrast gain, implying that the pathway is highly sensitive to changes in contrast, making it capable of detecting even small differences in luminance. However, this sensitivity has a limitation, and the pathway can become saturated or maxed out in its response at lower levels of contrast compared with other visual pathways. On the other hand, in the PC pathway, as the contrast in a visual stimulus increases, the neural response of the PC pathway increases in a fairly linear manner.[4] This characteristic results in a graded and detailed representation of contrast differences. The MC pathway can be important for tasks, such as detecting motion or low-contrast objects, but it may not be as effective for distinguishing fine details in high-contrast scenes where other visual pathways, such as the PC pathway, may excel.[4] The detection and discrimination of short, achromatic patterns of low contrast are processed by the MC pathway, while the PC pathway is involved in the mediation of visual resolution and chromatic processing.

McKendrick et al. have shown that the low-spatial-frequency-sensitive channels of both MC and PC pathways, which are mediated by cells with larger receptive fields, are almost equivalently impaired in early glaucoma.[5]

Spaeth/Richman Contrast Sensitivity test

The use of the SPARCS test requires a standard computer with a display monitor set to a resolution of 1,024×768, 256 grey levels and a screen size of at least 22 cm width and 26.5 cm height. The test requires internet access and is available via their website.[6] Every patient gets a unique identification number after registration on this platform. This facilitates data management and follow-up testing. All patients are provided instructions on how to perform the test; this also includes the demonstration of the actual procedure. The examination display spans 30° horizontally and 23.5° vertically when viewed from 50 cm. The central region is about 5° across and 3.5° vertically. The patient is instructed to lock their gaze on this central region and spot any differences in the surrounding regions. Once ready, they click on the central area to start the test. Striped patterns (gratings) with a rate of 0.4 lines for every degree briefly emerge in one of the five zones for 0.3 seconds. After spotting the pattern, patients shift their focus momentarily to choose the testing area. After that, they refocus on the central region and tap to proceed to the next image. The region where the gratings appear is random, and responses are monitored by the software till it determines the CS in each area. The process is usually completed within 5–10 minutes for each eye.

The threshold for contrast is ascertained through a stepwise method using a staircase strategy with reversals.[7] Initially, accurate answers move the test up four stages until a mistake occurs. Following an error, the test eases by two stages. After that, it either steps up or down incrementally until there are two consecutive mistakes at a certain stage, marking the threshold. If patients repeatedly tap the same area without attempting to identify the pattern, the test stops and advises them to try locating the gratings. The test examines contrast levels between 100 and 0.45% (log CS range: 0.00–2.35), with an average decrease of 0.15 log units between steps. The Weber contrast formula is used to compute the contrast value. Scores are assigned individually to the central area and the four outer areas. The cumulative SPARCS score is the sum of all five areas, with 100 being the highest possible combined score.[7]

Normative database

CS involves both optical and neurological processing and declines with increasing age. Gupta et al. have documented the normative values of SPARCS in the Caucasian population. The total SPARCS scores ranged from 86.37 (±1.09) for the young (20–29 years age group) to 70.71 (±2.64) for the elderly (80–87 years age group) population.[8] Bariya et al. documented a normative database for the Asian Indian population. They also found a statistically significant decline in average SPARCS scores as age increases. In their study, SPARCS scores ranged from 86.68 (20–29 years age group) to 67.44 (70–79 years age group).[9] It has also been shown that CS scores remain stable in patients with different types of refractive errors when they are wearing their routine prescription glasses or contact lenses.[10]

Applications of contrast sensitivity assessment
Cataract

Depending on its density and subtype, cataract causes a variable reduction in CS Table 1.[7–27,30] The study by Bernth-Petersen has shown that nearly one-fifth (20%) of individuals with cataract and a relatively good visual acuity (VA) report a significant visual disability.[31] The difference might arise because Snellen VA evaluates primarily high spatial frequencies,

whereas the functional issues might stem from diminished low-spatial-frequency CS. Low-spatial-frequency CS can better reflect the impact of wide-angle scattering and forward light scattering on cataracts. However, while both the PR chart test and SPARCS are low-spatial-frequency CS tests, SPARCS is more adept at identifying a decline in CS with an increasing cataract severity. Gupta et al. have shown that in patients with nuclear sclerosis grade 2+ or 3+ (Lens Opacity Classification System [LOCS]), SPARCS can detect a statistically significant reduction in CS when compared with non-cataractous controls, unlike the PR chart test that could detect CS differences only when nuclear sclerosis grade was 3+ or more.[25]

Glaucoma

CS has been shown to be a robust measure of the function of ganglion cells. In eyes with glaucomatous optic neuropathy, CS measures reflect the state of retinal ganglion cells (RGCs) and can also be sensitive to the magnitude or severity of damage.

Early detection, structure–function correlation and pre-perimetric glaucoma

Richman et al. studied the role of SPARCS in glaucoma patients and found that in the Caucasian population a total SPARCS score of <70 had a sensitivity of 79.7% and a specificity of 92.8% in the identification of glaucoma.[7] The sensitivity and reliability of SPARCS scores in patients with varying severity of glaucoma have also been demonstrated by Thakur et al.[23] The authors noted that SPARCS outperformed (sensitivity=84.4% and specificity =70%) the PR chart scores (sensitivity =80% and specificity =65.6%) for the detection of glaucoma. SPARCS was found to be more sensitive to glaucomatous damage compared with the PR test and had a better test–retest repeatability.

Changes in CS in glaucoma have been found to occur faster than normal ageing across the frequency range for both steady-pedestal tasks (exploring the spatial CS frequency, luminance and adaptation on CS) and pulsed-pedestal tasks (exploring both spatial and temporal CS, flicker sensitivity and adaptation dynamics), thereby suggesting a reduction in sensitivity that is not selective for MC or PC pathways.[28] These observations suggest that a reduction in CS, especially in patients with glaucoma, occurs before VA and visual field change.

There is also evidence that correlates structural changes in the retina with functional changes in CS. Amanullah et al. assessed the retinal nerve fibre layer (RNFL) thickness using optical coherence tomography (OCT) and CS measures using SPARCS to demonstrate that CS in the left upper area of both eyes was correlated strongly with inferior quadrant RNFL thickness.[24]

When stratified by clock hours, this relationship was noted at the 7-o'clock sector for the left eye and the 6-o'clock sector for the right eye. This clock-hour position also suggested the consistently significant correlation between the RNFL thickness of the inferior quadrant (which is made up of clock hours 5, 6 and 7) and the SPARCS left upper area of vision. These RNFL fibres project to the temporal portion of the right occipital lobe, thus indicating a potential centre for contrast perception in this area of the brain.[24]

However, a loss of CS is diffuse throughout the field of vision, unlike the clusters of function loss (scotoma) seen on the visual field testing. More research is needed to ascertain how CS reduction is associated with the progressive loss of neural tissues in specific areas of the retina.

Table 1: Summary of studies using Spaeth/Richman Contrast Sensitivity test

Year	Study	Condition	Purpose	Sample size	Design	Main results
2023	Ichhpujani et al.[11]	POAG	CS changes post travoprost 0.004%	33 patients (62 eyes)	6-month follow-up	Total SPARCS CS score improved from 69 ± 10.99 to 74.62 ± 9.50; SPARCS CS scores were correlated with VF indices and OCT
2022	Bariya et al.[9]	Normative database	Normative database in the Indian population	200 patients (400 eyes)	Cross-sectional	Total SPARCS CS scores decreased with age; the mean binocular SPARCS scores at 20–29 years were 86.51 ± 5.18 and at 70–79 years were 75.36 ± 8.99; the test duration increased with age
2022	Rehman et al.[12]	IIH	CS changes in IIH	10 patients (20 eyes)	15- to 24-month follow-up	CS and OCT may be potential indicators to identify the recurrence of IIH
2022	Ichhpujani et al.[13]	LPI in the angle-closure disease spectrum	CS changes post LPI	30 patients (30 eyes)	3-month follow-up	LPI does not affect the SPARCS CS score in patients with PACD
2022	Tsiogka et al.[14]	Refractive surgery techniques	CS changes post PRK or FSLASIK	93 patients (186 eyes) and 31 patients per group	Retrospective	Refractive surgery, especially PRK decreases the SPARCS CS score
2021	Singla et al.[15]	HCQS toxicity	CS changes post HCQS	10 patients (20 eyes)	6-month follow-up	SPARCS CS scores decrease post HCQS and may be a potential indicator to identify the toxicity
2020	Ichhpujani et al.[16]	POAG progression	CS changes in severe POAG	15 patients (30 eyes)	24-month follow-up	SPARCS CS scores may be used along with MD to monitor the glaucoma progression; over the 24-month period, MD changed by 9.46 ± 12.73%, PSD by 0.64 ± 14.03% and average SPARCS by 3.31 ± 12.73%; while SPARCS and MD show a high internal correlation, PSD has a poor correlation
2020	Rao et al.[17]	Glaucoma staging	CS changes in glaucoma	47 patients (50 eyes)	Retrospective	Total SPARCS CS scores can predict a change in MD (β=0.5, p<0.001, R^2=61.8%), with a minimal association of other quadrants or PR scores and may have potential utility in staging glaucoma severity
2020	Rehman et al.[18]	IIH	CS changes post IIH treatment	10 patients (20 eyes)	3-month follow-up	SPARCS CS scores increase post-treatment in patients with IIH; the average SPARCS scores pre-treatment, at 1-month post-treatment and at 3-month post-treatment were 68.8 + 10.16, 74.45 + 11.17 and 75.7 + 10.81, respectively
2020	Marino et al.[19]	POAG	CS changes post citicoline, homotaurine and vitamin E supplementation	44 patients in Group 1 (current Rx first) and 65 patients in Group 2 (supplementation first)	8-month follow-up with a randomized cross-over design (4-month current Rx and 4-month supplementation)	SPARCS CS and GQL-15 findings improve in patients treated with citicoline, homotaurine and vitamin E supplementation

Continued

Table 1: Continued

Year	Study	Condition	Purpose	Sample size	Design	Main results
2019	Reighard et al.[20]	Glaucoma	Validation of CAARV in Indian patients with glaucoma	145 patients	Cross-sectional	Rasch-calibrated scores on the I-CAARV were significantly correlated with Rasch-calibrated IND-VFQ scores (r=-0.54) and with MD, presenting VA, best-corrected VA and SPARCS CS scores in both the better-seeing eye (r=0.60, -0.51, -0.53 and 0.76, respectively) and the worse-seeing eye (r=0.48, -0.61, -0.46 and 0.69, respectively)
2019	Eshraghi et al.[21]	Glaucoma	CS and ADL/QOL in POAG, PACG and PXG	161 patients (322 eyes)	Cross-sectional	SPARCS CS scores were correlated with VF, CAARV and NEIVFQ-25
2019	Waisbourd et al.[22]	Glaucoma	CS in rapid progression (MD loss >2.0 dB/year)	22 patients out of 153 patients	Longitudinal	SPARCS CS scores show a significant reduction in rapid progressors
2019	Gupta et al.[8]	Normative database	Normative database	205 patients	Cross-sectional	Total SPARCS scores range at 20–29 years: 86.37 ± 1.09 and at 80–89 years: 70.71 ± 2.64; SPARCS scores decline with an advanced age and an increased cataract severity ($p<0.0001$)
2018	Thakur et al.[23]	Glaucoma	SPARCS across varying severity of glaucoma	135 patients (135 eyes)	Cross-sectional	ICCs for PR were 0.952 and 0.988 for SPARCS; COR for the mean SPARCS score was 5.65%, while COR for PR was 12.44%; PR had a sensitivity of 80% and a specificity of 65.6% for detecting patients with glaucoma as compared with 84.4 and 70% for SPARCS
2017	Amanullah et al.[24]	Glaucoma	CS and RNFL correlation	161 patients	4-year follow-up	SPARCS score in the left upper area was correlated with inferior RNFL
2017	Gupta et al.[25]	Cataract	CS in normal controls and patients with cataract	84 patients (162 eyes); 23 cataract patients (43 eyes) and 61 controls (119 eyes)	Cross-sectional	There is a significant influence of cataract on CS; the SPARCS mean scores centrally were 13.4 and 14.5 in the cataract and control groups ($p=0.001$)
2016	Sun et al.[10]	Refractive errors	CS in myopes, emmetropes and hyperopes	93 patients (182 eyes)	Cross-sectional	There is no difference in CS among myopes, emmetropes and hyperopes wearing their habitual correction
2015	Ekici et al.[26]	Glaucoma	Clinical visual assessments and both a vision-related performance (CAARV) and two QOL instruments (NEIVFQ25 and MGSS)	161 patients	4-year follow-up	CS and MD were correlated highly with CAARV and QOL
2015	Waisbourd et al.[27]	Glaucoma	Study design	161 patients	4-year follow-up	Study design for the studies reported earlier[28,29]
2015	Faria et al.[30]	ARMD	CS in ARMD	69 patients (120 eyes); ARMD: 35 patients (54 eyes) and controls: 34 patientss (66 eyes)	Cross-sectional	SPARCS CS scores were significantly lower for patients with ARMD versus controls ($p<0.001$)

Continued

Table 1: Continued

Year	Study	Condition	Purpose	Sample size	Design	Main results
2015	Richman et al.[7]	Glaucoma	SPARCS introduced as an alternative to CS testing	91 patients (136 eyes)	Cross-sectional	ICCs for SPARCS were 0.97 and 0.98 for PR; CORs for SPARCS were ±6.7% and ±6.4% for PR; SPARCS identified patients with glaucoma with 79% sensitivity and 93% specificity

ADL = activities of daily life; ARMD = age-related macular degeneration; CAARV = compressed assessment of activities related to vision; COR = coefficient of repeatability; CS = contrast sensitivity; FSLASIK = femtosecond laser-assisted laser in situ *keratomileusis; GQL-15 = glaucoma quality of life; HCQS = hydroxychloroquine; I-CAARV = Indian CAARV; ICC = intraclass correlation coefficient; IIH = idiopathic intracranial hypertension; LPI = laser peripheral iridotomy; MD = mean deviation; MGSS = modified glaucoma symptom scale; NEIVFQ-25 = National Eye Institute Visual Function Questionnaire; OCT = optical coherence tomography; PACD = primary angle-closure disease; PACG = primary angle-closure glaucoma; POAG = primary open-angle glaucoma; PR = Pelli-Robson test; PRK = photorefractive keratectomy; PSD = pattern standard deviation; PXG = pseudoexfoliation glaucoma; QOL = quality of life; RNFL = retinal nerve fibre layer; SPARCS = Spaeth/Richman Contrast Sensitivity; VA = visual acuity; VF = visual fields.*

Regarding changes in CS following the initiation of glaucoma treatment, Ichhpujani et al. have shown that both central and peripheral CS improve following the intraocular pressure (IOP) reduction with a prostaglandin analogue, such as travoprost.[32] Additionally, changes in CS also had a significant correlation with RNFL thickness and the perimetric indices.

Advanced disease, tackling floor effects
CS has been shown to be significantly worse in patients with moderate glaucoma as compared with those with early glaucoma.[29]

In a study conducted by Rao et al., contrast-specific thresholds were established for delineating visual field mean deviation (MD) beyond -20 and -30 dB. At these MD levels, floor effects in structural imaging often impede the accurate detection of glaucoma progression.[17] Their findings underscored the fact that the aggregate SPARCS scores were pivotal in anticipating shifts in MD, with peripheral quadrants or PR scores exerting a minimal influence. Notably, when the cumulative SPARCS scores were decreased below 45 and 38, they were associated with advanced glaucoma stages where MD exceeded -20 dB (sensitivity =70.5% and specificity =80.9%) and -30 dB (sensitivity =79.3% and specificity =77.7%), respectively. This study highlights the potential utility of CS measures in patients with advanced glaucoma. There is also evidence that in patients with rapid progression, there is a significant reduction in CS at 1 year.[22] Future research may evaluate CS loss trajectories in patients with varying rates of glaucoma progression to assess the potential of CS scores as markers for identifying patients with high-risk glaucoma.

Quality of life and visual disability in glaucoma
Multiple studies show that CS measured with SPARCS highly correlates with quality of life and actual ability of people to perform activities of daily living. This correlation has been found to surpass that derived from parameters, such as visual field metrics, VA, stereopsis and IOP.[21,26] Furthermore, SPARCS has also been used to validate a new tool for compressed assessment of activities related to vision, named I-CAARV (Indian compressed assessment of activities related to vision), in the Indian population.[20] Such findings underscore the significance of evaluating CS in clinical settings. The rationale is that it aligns closely with patient-reported outcomes and might offer a more authentic representation of patient experiences in comparison with traditional metrics, such as VA and IOP. There is also evidence that SPARCS can detect changes post-treatment and supplementation.[11,19]

Effects of laser procedures on contrast sensitivity
The impact of laser peripheral iridotomy (LPI) on CS is controversial. Anderson et al. reported changes in CS post-argon LPI. They noted a slight increase in CS at low spatial frequencies and a small decrease at high spatial frequencies post-LPI.[33] However, Ichhpujani et al. did not find any change in either central or peripheral CS using SPARCS in patients with primary angle-closure disease post-LPI.[13] More work is, however, needed to evaluate the impact of the location of LPI on CS, as it appears to be the most significant factor in determining post-LPI complications.[34]

Age-related macular degeneration
CS is a valuable indicator of functional damage in patients with AMD.[35] The loss of CS is associated with compromised quality of life in patients with AMD.[36]

Logically, as AMD predominantly affects the central vision, testing contrast thresholds in peripheral visual fields may not be of a great additional value for detecting disease progression. However, as SPARCS tests CS in both central and peripheral areas, there is a reduced use of central vision to resolve letters in patients with AMD, and thus, CS can be ascertained easily.
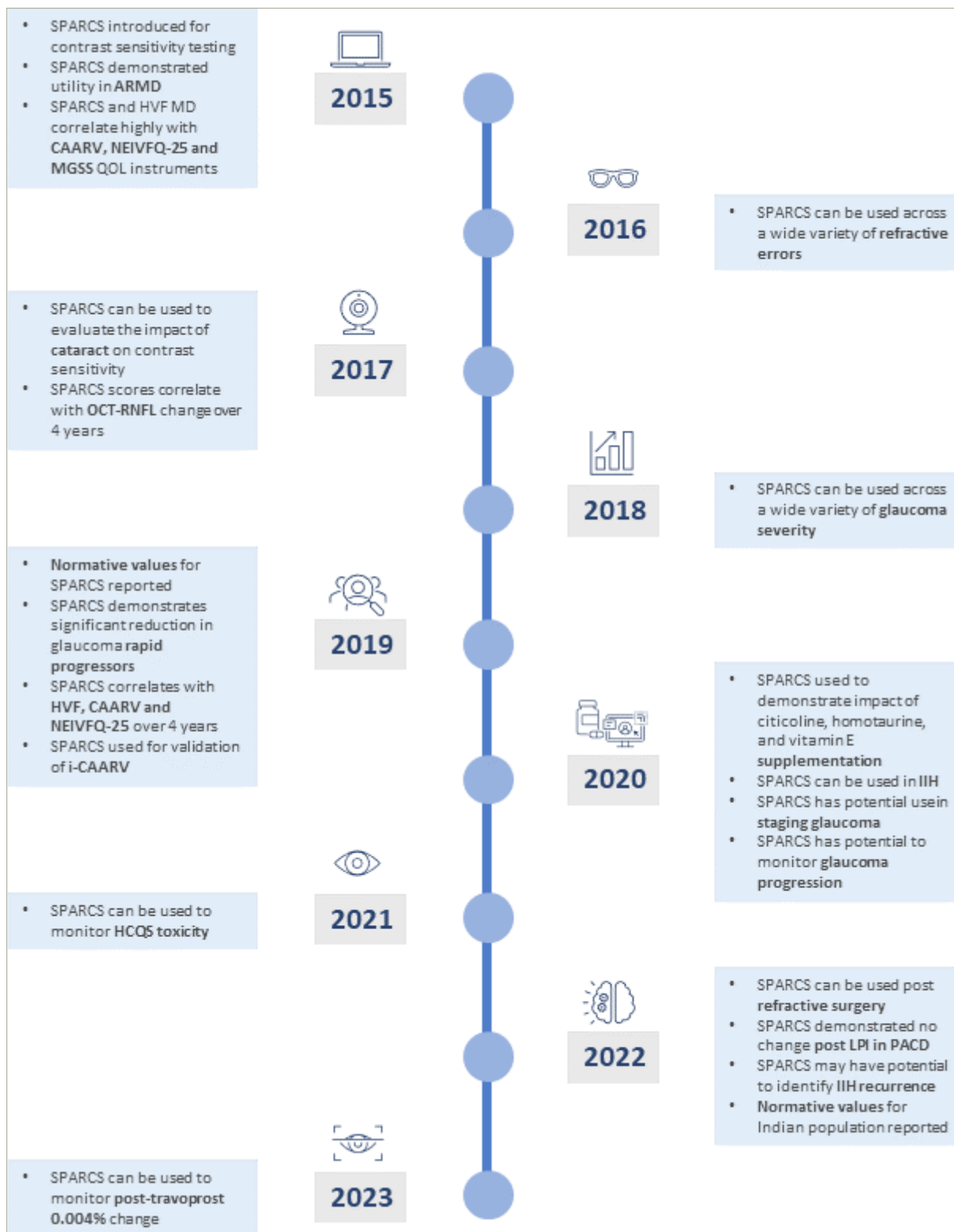
Faria et al. have demonstrated that CS scores for patients with AMD are significantly lower as compared with controls using both PR chart test and SPARCS.[30]

The US Food and Drug Administration (FDA) mandates that CS can only be used as a functional endpoint in clinical trials if significant differences are reported in at least two spatial frequencies when tested with the Pelli-Robson chart, and CS does not fulfil the FDA criteria as a clinical trial endpoint.[37] However, the relationship between CS and quality of life suggests that the benefits of treatment may be underestimated if CS is not considered. Therefore, future research must focus on the use of SPARCS in post-anti-vascular endothelial growth factor (VEGF) monitoring of patients with wet AMD. Such insights might then pave the way for home-based monitoring solutions, further enhancing personalized care strategies for patients with AMD.

Idiopathic intracranial hypertension
Idiopathic intracranial hypertension (IIH) is a persistent condition characterized by episodes of relapse and recovery and, thus, requires monitoring despite papilloedema resolution. Contrast deficits have been reported with intact visual acuity in patients with IIH.[38] Rehman et al. used SPARCS and found decreased central and peripheral CS scores in IIH.[18] In a comparative assessment between eyes that experienced recurrence and those that did not, no notable difference in CS was observed via PR chart assessments.[12] However, there was a statistically significant difference in the total SPARCS score, especially in the peripheral superonasal, inferonasal and infertemporal regions.

Figure 1: Infographic showing the utility of Spaeth/Richman Contrast Sensitivity test since it was introduced in 2015

2015
- SPARCS introduced for contrast sensitivity testing
- SPARCS demonstrated utility in ARMD
- SPARCS and HVF MD correlate highly with CAARV, NEIVFQ-25 and MGSS QOL instruments

2016
- SPARCS can be used across a wide variety of refractive errors

2017
- SPARCS can be used to evaluate the impact of cataract on contrast sensitivity
- SPARCS scores correlate with OCT-RNFL change over 4 years

2018
- SPARCS can be used across a wide variety of glaucoma severity

2019
- Normative values for SPARCS reported
- SPARCS demonstrates significant reduction in glaucoma rapid progressors
- SPARCS correlates with HVF, CAARV and NEIVFQ-25 over 4 years
- SPARCS used for validation of i-CAARV

2020
- SPARCS used to demonstrate impact of citicoline, homotaurine, and vitamin E supplementation
- SPARCS can be used in IIH
- SPARCS has potential use in staging glaucoma
- SPARCS has potential to monitor glaucoma progression

2021
- SPARCS can be used to monitor HCQS toxicity

2022
- SPARCS can be used post refractive surgery
- SPARCS demonstrated no change post LPI in PACD
- SPARCS may have potential to identify IIH recurrence
- Normative values for Indian population reported

2023
- SPARCS can be used to monitor post-travoprost 0.004% change

ARMD = age-related macular degeneration; CAARV = compressed assessment of activities related to vision; HCQ = hydroxychloroquine; HVF = Humphrey visual field; IIH = idiopathic intracranial hypertension; LPI = laser peripheral iridotomy; MD = mean deviation; MGSS = modified glaucoma symptom scale; NEIVFQ-25 = National Eye Institute Visual Function Questionnaire; OCT = optical coherence tomography; PACD = primary angle-closure disease; QOL = quality of life; RNFL = retinal nerve fibre layer; SPARCS = Spaeth Richman Contrast Sensitivity.

Recurring cases exhibited stability in VA and central CS but a marked decrease in peripheral CS. As the peripheral retina has a lower number of RGCs and is also optically affected by various aberrations, both factors could contribute to a worse peripheral CS than central CS in optic nerve dysfunction following optic disc oedema or glaucoma.[39] Furthermore, due to sparse neural sampling in the peripheral retina, CS exhibits a sharp decrease after reaching a specific spatial frequency threshold.[40]

Refractive surgery

Higher-order aberrations (HOAs) of the eye have been associated with a reduction in CS.[41] Refractive procedures can both reduce and increase HOAs. A recent study has shown that myopic photorefractive keratectomy results in a significant deterioration in CS measured using SPARCS as compared with femtosecond laser-assisted laser *in situ* keratomileusis refractive surgery.[14] This study highlights the potential of SPARCS as an objective tool for evaluating post-refractive surgery outcomes. However, more work is needed to explore its utility across the multitude of refractive procedures available today.

Drug toxicity

Hydroxychloroquine (HCQ) is a drug commonly used for the management of chronic rheumatic disease but has known ocular adverse effects, ranging from non-significant keratopathy to sight-threatening retinopathy. HCQ affects the CS by acting on the retinal bipolar and ganglion cells. In patients with bull's eye maculopathy, the earliest functional changes occur paracentrally. The macula is structurally limited by the small space to perceive contrast because of the limited number of photoreceptors in that area. Therefore, tests that assess only central CS are not doing justice to the value of CS assessment in these patients. SPARCS has been used to demonstrate the decrease in central and peripheral CS in patients taking HCQ. This reduction in CS can be a sign of early visual dysfunction and, hence, may be considered an early indicator of HCQ toxicity.[15] Table 1 summarizes the salient studies using the SPARCS test for various ophthalmic disorders.

Summary

SPARCS has emerged as an effective alternative for CS assessment across a diverse array of eye conditions over the last few years (Figure 1). Distinctively, it can measure not just central but also peripheral CS variations, bridging a critical gap in the current CS evaluation techniques. The potential integration of CS testing into conventional clinical evaluations will thus not merely be a procedural enhancement; it represents a paradigm shift. This is underscored by the strong correlation between CS and the ability of patients to perform daily activities and their perceived quality of life. Hence, using leveraging tests, such as SPARCS, for CS assessment, clinicians will be better equipped to offer comprehensive care. As we stride forward in the field of ophthalmology, such novel tools will play an instrumental role in refining diagnostic and therapeutic strategies and, in turn, elevating the standards of patient care. ❑

1. Owsley C, Sloane ME. Contrast sensitivity, acuity, and the perception of 'real-world' targets. *Br J Ophthalmol*. 1987;71:791–6. DOI: 10.1136/bjo.71.10.791.
2. Richman J, Spaeth GL, Wirostko B. Contrast sensitivity basics and a critique of currently available tests. *J Cataract Refract Surg*. 2013;39:1100–6. DOI: 10.1016/j.jcrs.2013.05.001.
3. Ichhpujani P, Thakur S, Spaeth GL. Contrast sensitivity and glaucoma. *J Glaucoma*. 2020;29:71–5. DOI: 10.1097/IJG.0000000000001379.
4. Leonova A, Pokorny J, Smith VC. Spatial frequency processing in inferred PC- and MC-pathways. *Vision Res*. 2003;43:2133–9. DOI: 10.1016/s0042-6989(03)00333-x.
5. McKendrick AM, Sampson GP, Walland MJ, Badcock DR. Contrast sensitivity changes due to glaucoma and normal aging: Low-spatial-frequency losses in both magnocellular and parvocellular pathways. *Invest Ophthalmol Vis Sci*. 2007;48:2115. DOI: 10.1167/iovs.06-1208.
6. Sparcs. Spaeth/Richman Contrast Sensitivity Test Center. 2020. Available at: www.sparcscontrastcenter.com/home.php (Date last accessed: 20 March 2024).
7. Richman J, Zangalli C, Lu L, et al. The Spaeth/Richman Contrast Sensitivity test (SPARCS): Design, reproducibility and ability to identify patients with glaucoma. *Br J Ophthalmol*. 2015;99:16–20. DOI: 10.1136/bjophthalmol-2014-305223.
8. Gupta L, Waisbourd M, Sanvicente CT, et al. Establishment of a normative database and evaluation of the test-retest repeatability of the Spaeth/Richman Contrast Sensitivity test. *Jpn J Ophthalmol*. 2019;63:73–81. DOI: 10.1007/s10384-018-0640-3.
9. Bariya S, Ichhpujani P, Rehman O, Kumar S. Normative database for Spaeth Richman Contrast Sensitivity test for Indian eyes. *Indian J Ophthalmol*. 2022;70:3476. DOI: 10.4103/ijo.IJO_491_22.
10. Sun Y, Erdem E, Lyu A, et al. The SPARCS: A novel assessment of contrast sensitivity and its reliability in patients with corrected refractive error. *Br J Ophthalmol*. 2016;100:1421–6. DOI: 10.1136/bjophthalmol-2015-307378.
11. Ichhpujani P, Rodrigues AM, Kumar S, Singh RB. Analysing the change in contrast sensitivity post-travoprost treatment in primary open-angle glaucoma patients using Spaeth Richman Contrast Sensitivity test. *Int Ophthalmol*. 2023;43:2037–47. DOI: 10.1007/s10792-022-02603-z.
12. Rehman O, Ichhpujani P, Singla E, et al. Change in contrast sensitivity and OCT parameters in idiopathic intracranial hypertension. *Ophthalmol Eye Dis*. 2022;14:251584142210833. DOI: 10.1177/25158414221083358.
13. Ichhpujani P, Thakur S, Singh T, et al. Effect of laser peripheral iridotomy on contrast sensitivity using Spaeth/Richman Contrast Sensitivity test. *Ophthalmol Eye Dis*. 2022;14:251584142210781. DOI: 10.1177/25158414221078142.
14. Tsiogka A, Karmiris E, Samoli E, Spaeth GL. Comparison of central and peripheral contrast sensitivity between healthy and refractive surgery patients using the Spaeth/Richman Contrast Sensitivity (SPARCS). *J Refract Surg*. 2022;38:128–33. DOI: 10.3928/1081597X-20211123-01.
15. Singla E, Ichhpujani P, Sharma U, Kumar S. Contrast sensitivity assessment for early detection of hydroxychloroquine toxicity. *Eur J Ophthalmol*. 2021;2021:11206721211010612. DOI: 10.1177/11206721211010612.
16. Ichhpujani P, Singh T, Thakur S, et al. Assessing glaucoma deterioration using Spaeth/Richman Contrast Sensitivity test. *Ophthalmol Eye Dis*. 2020;12:251584142097741. DOI: 10.1177/2515841420977412.
17. Rao A, Pal A, Mohapatra S. Spaeth/Richman Contrast Sensitivity in staging glaucoma. *Trans Vis Sci Tech*. 2020;9:39. DOI: 10.1167/tvst.9.13.39.
18. Rehman O, Ichhpujani P, Kumar S. Contrast sensitivity in idiopathic intracranial hypertension. *Rom J Ophthalmol*. 2020;64:380–6. DOI: 10.22336/rjo.2020.59.
19. Marino P, Rossi G, Campagna G, et al. Effects of citicoline, homotaurine, and vitamin E on contrast sensitivity and visual-related quality of life in patients with primary open-angle glaucoma: A preliminary study. *Molecules*. 2020;25:5614. DOI: 10.3390/molecules25235614.
20. Reighard CL, Pillai MR, Shroff S, et al. Glaucoma-associated visual task performance and vision-related quality of life in South India. *Ophthalmol Glaucoma*. 2019;2:357–63. DOI: 10.1016/j.ogla.2019.06.002.
21. Eshraghi H, Sanvicente CT, Gogte P, et al. Measuring contrast sensitivity in specific areas of vision – A meaningful way to assess quality of life and ability to perform daily activities in glaucoma. *Ophthalmic Epidemiol*. 2019;26:301–10. DOI: 10.1080/09286586.2019.1616773.
22. Waisbourd M, Sanvicente CT, Coleman HM, et al. Vision-related performance and quality of life of patients with rapid glaucoma progression. *J Glaucoma*. 2019;28:216–22. DOI: 10.1097/IJG.0000000000001179.
23. Thakur S, Ichhpujani P, Kumar S, et al. Assessment of contrast sensitivity by Spaeth Richman Contrast Sensitivity test and Pelli Robson chart test in patients with varying severity of glaucoma. *Eye*. 2018;32:1392–400. DOI: 10.1038/s41433-018-0099-y.
24. Amanullah S, Okudolo J, Rahmatnejad K, et al. The relationship between contrast sensitivity and retinal nerve fiber layer thickness in patients with glaucoma. *Graefes Arch Clin Exp Ophthalmol*. 2017;255:2415–22. DOI: 10.1007/s00417-017-3789-4.
25. Gupta L, Cvintal V, Delvadia R, et al. SPARCS and Pelli-Robson contrast sensitivity testing in normal controls and patients with cataract. *Eye*. 2017;31:753–61. DOI: 10.1038/eye.2016.319.
26. Ekici F, Loh R, Waisbourd M, et al. Relationships between measures of the ability to perform vision-related activities, vision-related quality of life, and clinical findings in patients with glaucoma. *JAMA Ophthalmol*. 2015;133:1377–85. DOI: 10.1001/jamaophthalmol.2015.3426.
27. Waisbourd M, Parker S, Ekici F, et al. A prospective, longitudinal, observational cohort study examining how glaucoma affects quality of life and visually-related function over 4 years: Design and methodology. *BMC Ophthalmol*. 2015;15:91. DOI: 10.1186/s12886-015-0088-x.
28. Rossetti L, Goni F, Denis P, et al. Focusing on glaucoma progression and the clinical importance of progression rate measurement: A review. *Eye*. 2010;24:S1–7. DOI: 10.1038/eye.2010.112.
29. Bambo MP, Ferrandez B, Güerri N, et al. Evaluation of contrast sensitivity, chromatic vision, and reading ability in patients with primary open angle glaucoma. *J Ophthalmol*. 2016;2016:7074016. DOI: 10.1155/2016/7074016.
30. Faria BM, Duman F, Zheng CX, et al. Evaluating contrast sensitivity in age-related macular degeneration using a novel computer-based test, the Spaeth/Richman Contrast Sensitivity test. *Retina*. 2015;35:1465–73. DOI: 10.1097/IAE.0000000000000474.
31. Bernth-Petersen P. Visual functioning in cataract patients. Methods of measuring and results. *Acta Ophthalmol (Copenh)*. 1981;59:198–205. DOI: 10.1111/j.1755-3768.1981.tb02979.x.
32. Ichhpujani P, Rodrigues AM, Kumar S, Singh RB. Analysing the change in contrast sensitivity post-travoprost treatment in primary open-angle glaucoma patients using Spaeth Richman Contrast Sensitivity test. *Int Ophthalmol*. 2023;43:2037–47. DOI: 10.1007/s10792-022-02603-z.
33. Anderson DR, Knighton RW, Feuer WJ. Evaluation of phototoxic retinal damage after argon laser iridotomy. *Am J Ophthalmol*. 1989;107:398–402. DOI: 10.1016/0002-9394(89)90663-6.
34. Spaeth GL, Idowu O, Seligsohn A, et al. The effects of iridotomy size and position on symptoms following laser peripheral iridotomy. *J Glaucoma*. 2005;14:364–7. DOI: 10.1097/01.ijg.0000177213.31620.02.
35. West SK, Rubin GS, Broman AT. How does visual impairment affect performance on tasks of everyday life *Arch Ophthalmol*. 2002;120:774. DOI: 10.1001/archopht.120.6.774.
36. Bansback N, Czoski-Murray C, Carlton J, et al. Determinants of health related quality of life and health state utility in patients with age related macular degeneration: The association of contrast sensitivity and visual acuity. *Qual Life Res*. 2007;16:533–43. DOI: 10.1007/s11136-006-9126-8.
37. Csaky K, Ferris F, Chew EY, et al. Report from the NEI/FDA endpoints workshop on age-related macular degeneration and inherited retinal diseases. *Invest Ophthalmol Vis Sci*. 2017;58:3456. DOI: 10.1167/iovs.17-22339.
38. Wall M, George D. Idiopathic intracranial hypertension. A prospective study of 50 patients. *Brain*. 1991;114 (Pt 1A):155–80.
39. Rosén R, Lundström L, Venkataraman AP, et al. Quick contrast sensitivity measurements in the periphery. *J Vis*. 2014;14:3. DOI: 10.1167/14.8.3.
40. Venkataraman AP, Lewis P, Unsbo P, Lundström L. Peripheral resolution and contrast sensitivity: Effects of stimulus drift. *Vision Res*. 2017;133:145–9. DOI: 10.1016/j.visres.2017.02.002.
41. Zhao P-F, Li S-M, Lu J, et al. Effects of higher-order aberrations on contrast sensitivity in normal eyes of a large myopic population. *Int J Ophthalmol*. 2017;10:1407–11. DOI: 10.18240/ijo.2017.09.13.