

## Shamrock sign: a novel indicator of myopia in nuclear cataracts

## Sinal do trevo: um novo indicador de miopia em cataratas nucleares

Ivan Corso Teixeira<sup>1</sup> , Bernardo Kaplan Moscovici<sup>2</sup> , Luís Armando Vitorino Alves de Souza Gondim<sup>3</sup> , José Maurílio Tavares de Lucena<sup>3</sup> , Roberta Kern Menna Barreto<sup>3</sup> , Mauro Silveira de Queiroz Campos<sup>1,2</sup> 

<sup>1</sup> Hospital de Olhos Paulista, São Paulo, SP, Brazil.

<sup>2</sup> Department of Ophthalmology and Visual Sciences, Universidade Federal de São Paulo, São Paulo, SP, Brazil.

<sup>3</sup> Department of Ophthalmology, Santa Casa de Misericórdia de São Paulo, São Paulo, SP, Brazil.

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**Corresponding author:**  
Bernardo Kaplan Moscovici  
Rua Cayowaá 854 ap 82  
CEP 05018001  
+55 11 996140730  
bernardokaplan@yahoo.com.br

**Institution:**  
Universidade Federal de São Paulo e Hospital de Olhos Paulista, São Paulo, SP, Brasil.

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Ricardo Augusto Paletta Guedes  
Universidade Federal de Juiz de Fora, Juiz de Fora, MG, Brazil  
<https://orcid.org/0000-0002-9451-738X>



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## ABSTRACT

This case series presents the shamrock sign, a novel aberrometry pattern characterized by trefoil and coma, as a potential diagnostic marker for nuclear cataracts associated with myopic shift. This study highlights its clinical relevance and contribution to early detection and management. The primary diagnosis was nuclear cataracts inducing myopic shift. All patients underwent phacoemulsification with intraocular lens implantation. Postoperatively, all cases showed marked reductions in higher-order aberrations, including spherical aberration and trefoil, with complete resolution of the shamrock sign. Visual acuity improved significantly, achieving 20/20 in all patients, underscoring the efficacy of surgery in addressing both visual impairment and aberrometry patterns associated with nuclear cataracts. The shamrock sign, identified via aberrometry, may be a reliable diagnostic marker for nuclear cataracts associated with myopia. Its post-surgical resolution underscores its value in guiding clinical decisions and improving diagnostic precision in cataract management.

## RESUMO

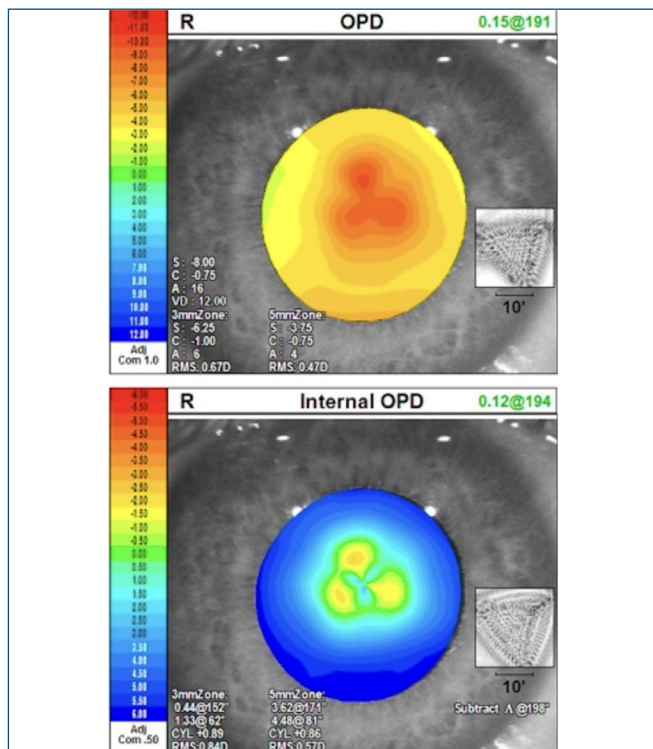
Esta série de casos apresenta o sinal do trevo (*shamrock sign*), um novo padrão em aberrometria caracterizado por trefoil e coma, proposto como possível marcador diagnóstico de catarata nuclear associada a desvio miópico. O estudo destaca sua relevância clínica e contribuição para a detecção precoce e o manejo adequado da condição. O diagnóstico principal foi catarata nuclear induzindo desvio miópico. Todos os pacientes foram submetidos à facoemulsificação com implante de lente intraocular. No pós-operatório, observou-se redução significativa das aberrações de alta ordem – incluindo a aberração esférica e trefoil –, com completa resolução do sinal do trevo. A acuidade visual melhorou expressivamente, atingindo 20/20 em todos os casos, reforçando a eficácia do procedimento, tanto na recuperação visual quanto na normalização dos padrões aberrométricos associados à catarata nuclear. O sinal do trevo, identificado por meio de aberrometria, pode representar um marcador diagnóstico confiável de catarata nuclear associada à miopia. Seu desaparecimento após a cirurgia enfatiza seu valor como ferramenta auxiliar na tomada de decisões clínicas e na maior precisão diagnóstica no manejo da catarata.

## INTRODUCTION

Cataract remains a predominant cause of blindness worldwide. While myopia is not commonly recognized as a predisposing factor for cataract development, the progression of cataracts, particularly nuclear sclerosis, frequently results in a myopic shift. This myopic shift often precedes cataract formation, especially in patients over the age of 55. However, established clinical signs or objective diagnostic tools to identify nuclear cataracts are limited.<sup>(1,2)</sup>

The aberrometry OPD Scan III (Nidek, Tokyo, Japan) is a multifunctional device that measures corneal shape, curvature, and wavefront aberrations. Its reproducibility in measuring high-order aberrations (HOA) is well established. The device is widely used in the pre- and postoperative periods of cataract surgery.<sup>(3-6)</sup>

The literature reports no signs or diagnostic findings associated with cataract-related myopic shift. We examined three patients diagnosed with nuclear cataracts exhibiting a myopic shift tendency. The internal aberrometry images of all patients showed a consistent pattern of a three-leaf clover, designated as the “shamrock sign” (Figure 1).<sup>(7-10)</sup>



**Figure 1.** Shamrock sign.

Through detailed case analyses, we aim to emphasize the clinical significance of the shamrock sign as a

potential diagnostic marker for nuclear cataracts that induce myopia, even in the very early stages.

Informed consent was obtained from all patients included in this case series, with written authorization for the use of their clinical data and images for research and publication purposes. This study was approved by the Ethics Committee of Hospital de Olhos Paulista, São Paulo, Brazil, under the protocol CAAE number 75264623.0.0000.9867. All procedures adhered to ethical guidelines, ensuring the confidentiality of patient information. Given the nature of this case series, no additional risks were posed to the participants.

## CASE REPORT

### Case 1

A 60-year-old male presented with worsening visual acuity (VA) in both eyes. The initial refractive assessment revealed a spherical correction of -10.00 D in the right eye (OD) and -5.25 D in the left eye (OS). Nuclear cataracts were graded as 2+ in OD and 1+ in OS. Visual acuity improved postoperatively, and the shamrock sign was significantly reduced (Tables 1-3 and Figure 2).

### Case 2

A 42-year-old female presented with complaints of decreased VA. The initial refractive examination showed a spherical correction of -8.00 D in OD and -3.50 D in OS. Nuclear cataracts were graded as 2+ in OD and 1+ in OS. Postoperative assessments revealed a reduction in HOAs and the shamrock sign, with VA improving to 1.0 in both eyes.

### Case 3

A 55-year-old male patient presented with complaints of blurred vision in both eyes. Preoperative refraction measurements indicated -1.50 diopters of spherical correction in the right eye and -1.50 diopters of spherical correction with an additional -0.50 cylindrical correction in the left eye. Biomicroscopic examination identified a nuclear cataract graded 2+/4+ in both eyes. The aberrometry exam further revealed the presence of the “shamrock sign” in both eyes, with greater prominence in the left eye. The patient was advised to undergo phacoemulsification in both eyes, with implantation of a multifocal intraocular lens. Following surgery, the shamrock sign markedly reduced, and the patient achieved a UCVA of 1.0 in both eyes.

## DISCUSSION

The results presented in this case series underscore the significant impact of nuclear cataracts on HOAs and VA.

**Table 1.** Summary of cases

Case	Age (years)	Pre-operative BCVA (OD/OS)	Cataract grade (OD/OS)	Pre-operative HOA total $\mu\text{m}$ (OD/OS)	Pre-operative HOA internal $\mu\text{m}$ (OD/OS)	Pre-operative sphere D (OD/OS)	Post-operative BCVA (OD/OS)	Post-operative HOA $\mu\text{m}$ (OD/OS)	Post-operative HOA internal $\mu\text{m}$ (OD/OS)	Shamrock sign pre (OD/OS)
1	60	0.2/0.7	2+/1+	2.060/0.496	2.462/1.032	-10.00/-5.25	1.0/1.0	0.364/0.239	0.257/0.185	Present/Almost present
2	42	0.5/0.7	2+/1+	1.304/0.833	1.619/1.024	-8.00/-3.50	1.0/1.0	0.393/0.229	0.317/0.298	Present /Present
3	55	0.4 /0.5	2+/2+	0.463/0.298	0.495/0.337	-1.50/-1.50	1.0/1.0	0.203/0.152	0.246/0.173	Present/Present

BCVA: best corrected visual acuity; OD: right eye; OS: left eye; HOA: high-order aberrations.

**Table 2.** Internal aberrations in each case

Case	Eye	Spherical aberration (pre-operative; $\mu\text{m}$ )	Coma (pre-operative; $\mu\text{m}$ )	Trefoil (pre-operative; $\mu\text{m}$ )	Spherical aberration (post-operative; $\mu\text{m}$ )	Coma (post-operative; $\mu\text{m}$ )	Trefoil (post-operative; $\mu\text{m}$ )
1	OD	2.112	1.007	0.705	0.170	0.083	0.100
1	OS	0.843	0.154	0.503	0.143	0.075	0.065
2	OD	1.316	0.250	0.866	0.175	0.120	0.042
2	OS	0.831	0.205	0.529	0.207	0.154	0.069
3	OD	0.322	0.270	0.181	0.045	0.085	0.141
3	OS	0.249	0.070	0.172	0.079	0.016	0.085 $\mu\text{m}$

OD: right eye; OS: left eye.

**Table 3.** Aberrometric refraction

Case	Eye	Pre-operative OPD spherical refraction center	Pre-operative OPD spherical refraction total	Pos-operative OPD spherical refraction center	Pos-operative OPD spherical refraction total
1	OD	-10.25	-5.00 (7.90mm)	+0.00	-0.25 (5.92 mm)
1	OS	-4.75	-4.50 (7.90 mm)	+0.25	-0.50 (5.38mm)
2	OD	-8.00	-3.00 (6.40mm)	+0.25	+0.00 (5.68 mm)
2	OS	-3.50	-0.25 (5.98mm)	+0.00	-0.25 (5.70 mm)
3	OD	-2.00	+0.25 (4.63mm)	+0.25	+0.25 (4.06mm)
3	OS	-2.25	-0.75 (4.67mm)	-0.25	+0.00 (4.28mm)

OD: right eye; OS: left eye.

Cases that underwent surgical intervention showed substantial improvements in VA and reductions in the shamrock sign and internal HOAs. <sup>(1-3)</sup>

The presence of the shamrock sign appears to be associated with more negative spherical refractive values in the central cornea, as indicated by aberrometric measurements. This observation may be attributed to the specific optical configuration induced by nuclear cataracts, in which the progression of nuclear sclerosis increases lens density, disproportionately affecting the central refraction. This finding is particularly relevant in cases in which the shamrock sign was identified, as these cases consistently exhibited more negative central aberrometric refractive values than those in broader regions. <sup>(4-7)</sup>

### Comparison between central and total aberrometry refraction

Cases 1 and 2 showed a marked difference between the preoperative central and total spherical refraction. For instance, in case 1, the central spherical refraction in the OD was -10.25D, while the total refraction was -5.00D. This discrepancy can be directly linked to the presence of the shamrock sign, which characterizes aberrations that predominantly affect the optical center. <sup>(7-10)</sup>

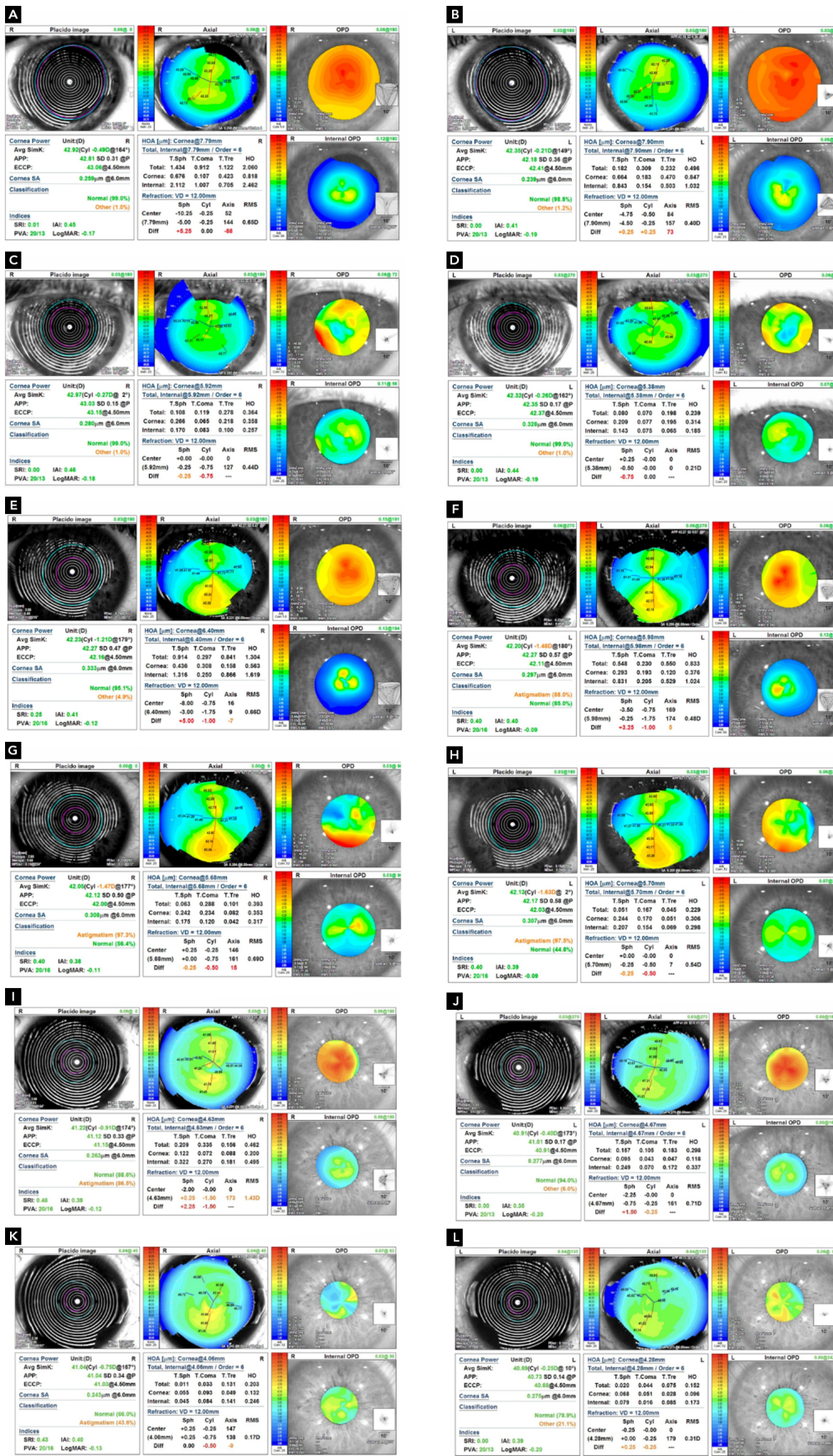
Following surgery, the central spherical refraction in the same eye was corrected to +0.00D, and the total refraction to -0.25D, demonstrating an effective correction of the central aberration induced by the nuclear cataract. Similarly, in case 2, the central spherical refraction in the OD was -8.00D, and the total refraction was -3.00D; both were corrected to approximately +0.25D postoperatively, indicating a notable improvement. <sup>(1-3)</sup>

The central spherical refraction was also more negative than the total refraction, confirming the impact of the shamrock sign on central refraction. This suggests that surgical decisions could be strongly influenced by evaluating the shamrock sign and central refraction, as correcting these central aberrations can lead to substantial improvements in VA. <sup>(4-7)</sup>

### High-order aberration analysis

Table 1B provides insight into the specific HOAs in each case, with particular emphasis on spherical aberration, coma, and trefoil, both preoperatively and postoperatively. Comparing these aberrations with the grade of nuclear cataracts or the presence of the shamrock sign reveals notable patterns. <sup>(1-3)</sup>

Spherical aberration and trefoil were particularly elevated in cases with more advanced nuclear cataracts. For instance, in case 1, the preoperative spherical aberration in the right eye was 2.112  $\mu\text{m}$ , significantly higher than in eyes with less advanced cataracts, such as case 3 (0.322  $\mu\text{m}$  in OD). This correlation suggests that higher grades of nuclear cataract are associated with increased spherical aberration, likely due to the progressive lens opacity that distorts central light transmission. Similarly, trefoil was elevated in cases with more pronounced shamrock sign, suggesting that this aberration may be a marker of the optical irregularities associated with this sign. <sup>(3-5)</sup>



**Figure 2.** (A and B): case 1 pre-operative; (C and D): case 1 post-operative; (E and F): case 2 pre-operative; (G and H): case 2 post-operative; (I and J): case 3 pre-operative; (K and L): case 3 post-operative.

Postoperatively, there was a marked reduction in both spherical aberration and trefoil, particularly in eyes where the shamrock sign was present preoperatively. For example, in case 1, the spherical aberration in OD decreased from 2.112  $\mu\text{m}$  to 0.170  $\mu\text{m}$  postoperatively, and the trefoil decreased from 0.705  $\mu\text{m}$  to 0.100  $\mu\text{m}$ . This significant reduction underscores the efficacy of cataract surgery in addressing the central optical aberrations associated with nuclear cataracts and the shamrock sign. This case series demonstrated that the shamrock sign was consistently present in all three patients with nuclear cataracts and associated myopic shift. In patients who underwent cataract surgery, there was a significant reduction in the shamrock sign postoperatively, accompanied by an improvement in VA to 1.0. The findings suggest that the shamrock sign could be an important diagnostic marker for nuclear cataracts that induce myopia, potentially aiding in early detection and management.

## AUTHORS' CONTRIBUTION

Substantial contribution to conception and design: BKM, LAVASG, ICT, MC; acquisition of data: LAVASG, RKMB, JM TL, MC, ICT; analysis and interpretation of data: BKM, LAVASG, ICT, MC; drafting of the manuscript: LAVASG, RKMB, JM TL, ICT; critical revision of the manuscript for important intellectual content: BKM ICT, MC; have given final approval of the submitted manuscript (mandatory participation for all authors): BKM, LAVASG, RKMB,

JM TL, ICT, MC; administrative, technical, or material support supervision: ICT: research group leadership: ICT, BKM, MC.

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