6 BÖLÜM

İNDOSİYANİN YEŞİLİ ANJİYOGRAFİ

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1. Giriş

İndosiyanin yeşili anjiyografi (İYA) ilk defa 1970'lerin başında Flower ve Hochheimer tarafından kullanıma girmiş ve 1975'de Amerikan İlaç ve Gıda Komitesi (FDA) onayı almıştır (1). İlk İYA kamera 1980'de, ilk video anjiyografi ise 1990'da piyasaya sürülmesine rağmen İYA'nın dünyada yaygın kullanıma girmesi 2000'li yıllardan sonra olmuştur. Kızılötesi dijital fotoğrafın ve tarayıcı lazer oftalmoskopun sisteme dahil olması ile görüntü çözünürlüğü ve kontrastı belirgin şekilde artmıştır. 2000'li yılların başından itibaren İYA kullanım alanı giderek artmış, koryoretinal hastalıkların patofizyolojisini anlamada ve tedavi takibinde önemli bir konuma gelmiştir. İndosiyanin yeşili anjiyografi, koroidal kan akımını görüntülemede optik koherens tomografi (OKT), fundus floresein anjiyografi (FFA) ve otofloresans görüntülemeye üstün olmakla birlikte yüksek maliyetli ve girişimsel olma gibi dezavantajları bulunmaktadır. İndosiyanin yeşili anjiyografinin fiziksel özellikleri nedeniyle melanin ve ksantofil pigmentine, seröz-anjinöz sıvıya ve lipid eksüdaya nüfuz ederek koroidin net şekilde görüntülenmesini sağlamaktadır (2). Diğer taraftan polipoidal koroidal vaskülopati, retinal anjiomatöz proliferasyon (RAP), sessiz koroidal neovasküler membran (KNV) gibi retinal ve koroidal hastalıkların takibinde halen değerli bir görüntüleme yöntemidir.

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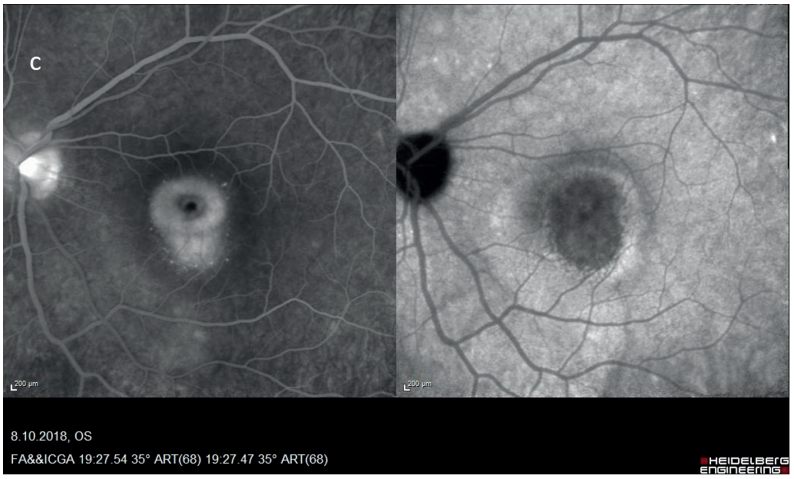

Şekil 11: Subfoveal koroidal sarkoidoz granülomu tanılı bir olgunun erken (a), orta (b) ve geç fazda (c) FFA (soldaki görüntüler) ile eşzamanlı İYA (sağdaki görüntüler) görüntüleri izlenmekte. Subfoveal alandaki odak; FFA'da hiperfloresan, İYA'da ise hipofloresan olarak izlenmekte. Ayrıca, İYA'da FFA'da dikkati çekmeyen periferal hipofloresan noktasal tutulumlar da görülebilmektedir. (Bursa Retina Göz Hastanesi Arşivi'nden alınmıştır.)

7. Özet

Son dönemde; OKTA gibi noninvazif görüntüleme yöntemlerinin kullanıma girmesi ve koroidal neovasküler membran tedavisinde anti-VEGF ajanların ön plana çıkması ile İYA'da lezyon lokalizasyonu öneminin azalmasına ragmen, koroidal vasküler yapının görüntülenmesinde ve PKV tanısında altın standart halen İYA'dır.

Kaynaklar

1. Flower RW, Hochheimer BF. Clinical infrared absorption angiography of the choroid. Am J Ophthalmol. 1972;73:458–9.
2. Cohen SY, Dubois L, Quentel G, et al. Is indocyanine green angiography still relevant? Retina 2011;31:209–21.
3. Ott P. Hepatic elimination of indocyanine green with special reference to distribution kinetics and the influence of plasma protein binding. Pharmacol Toxicol 1998;83(2):1–48.
4. Lutty GA. The acute intravenous toxicity of biological stains, dyes, and other fluorescent substances. Toxicol Appl Pharmacol 1978;44:225–49.
5. Bischoff PM, Flower RW. Ten years experience with choroidal angiography using indocyanine green dye: a new routine examination or an epilogue? Doc Ophthalmol

1985;60:235–91.

6. Geeraets WJ, Berry ER. Ocular spectral characteristics as related to hazards from lasers and other light sources. Am J Ophthalmol 1968;66:15–20.
7. Caesar J, Shaldon S, Chiandussi L, et al. The use of indocyanine green in the measurement of hepatic blood flow and as a test of hepatic function. Clin Sci 1961;21:43–57.
8. Leevy CM, Bender J. Physiology of dye extraction by the liver: comparative studies of sulfobromophtthalein and indocyanine green. Ann N Y Acad Sci 1963;111:161–76.
9. Costa DL, Huang SJ, Orlock DA, et al. Retinal-choroidal indocyanine green dye clearance and liver dysfunction. Retina 2003;23:557–61.
10. Hope-Ross M, Yannuzzi LA, Gragoudas ES, et al. Adverse reactions due to indocyanine green. Ophthalmology 1994;101:529–33.
11. Speich R, Saesseli B, Hoffmann U, et al. Anaphylactoid reactions after indocyanine-green administration. Ann Intern Med 1988;109:345–6.
12. Benya R, Quintana J, Brundage B. Adverse reactions to indocyanine green: a case report and a review of the literature. Cathet Cardiovasc Diagn 1989;17:231–3.
13. Iseki K, Onoyama K, Fujimi S, et al. Shock caused by indocyanine green dye in chronic hemodialysis patients. Clin Nephrol 1980;14:210.
14. Flower RW, Csaky KG, Murphy RP. Disparity between fundus camera and scanning laser ophthalmoscope indocyanine green imaging of retinal pigment epithelium detachments. Retina 1998;18:260–8.
15. Wolf S, Wald KJ, Elsner AE, et al. Indocyanine green choroidal videoangiography: a comparison of imaging analysis with the scanning laser ophthalmoscope and the fundus camera. Retina 1993;13:266–9.
16. Stanga PE, Lim JI, Hamilton P. Indocyanine green angiography in chorioretinal diseases: indications and interpretation: an evidence-based update. Ophthalmology 2003;110:15–21;quiz 22–3.
17. Yannuzzi LA, Flower RW, Slakter JS. Indocyanine green angiography. St Louis: Mosby Year Book; 1997: 46.
18. Hayreh SS. Physiological anatomy of the choroidal vascular bed. Int Ophthalmol 1983;6:85–93.
19. Mutoh T, Sakurai M, Tamai M. Indocyanine green fundus angiography of retrobulbar vasculature. Arch Ophthalmol 1995;113:631–3.
20. Ohno-Matsui K, Morishima N, Ito M, et al. Indocyanine green angiography of retrobulbar vascular structures in severe myopia. Am J Ophthalmol 1997;123:494–505.
21. Gass JD. Biomicroscopic and histopathologic considerations regarding the feasibility of surgical excision of subfoveal neovascular membranes. Am J Ophthalmol 1994;118:285–98.
22. Macular Photocoagulation Study Group. Subfoveal neovascular lesions in age-related macular degeneration. Guidelines for evaluation and treatment in the macular photocoagulation study. Arch Ophthalmol 1991;109:1242–57.

23. Sadda SR, Liakopoulos S, Keane PA, et al. Relationship between angiographic and optical coherence tomographic (OCT) parameters for quantifying choroidal neovascular lesions. Graefes Arch Clin Exp Ophthalmol 2010;248:175–84.
24. Freund KB, Ho IV, Barbazetto IA, et al. Type 3 neovascularization: the expanded spectrum of retinal angiomatous proliferation. Retina 2008;28: 201–11.
25. Olsen TW, Feng X, Kasper TJ, et al. Fluorescein angiographic lesion type frequency in neovascular age-related macular degeneration. Ophthalmology 2004;111:250–5.
26. Guyer DR, Yannuzzi LA, Slakter JS, et al. Classi cation of choroidal neovascularization by digital indocyanine green videoangiography. Ophthalmology 1996;103:2054–60.
27. Yannuzzi LA, Hope-Ross M, Slakter JS, et al. Analysis of vascularized pigment epithelial detachments using indocyanine green videoangiography. Retina 1994;14:99–113.
28. Rosenfeld PJ, Brown DM, Heier JS, et al. Ranibizumab for neovascular age- related macular degeneration. N Engl J Med 2006;355:1419–31.
29. Massacesi AL, Sacchi L, Bergamini F, et al. The prevalence of retinal angio- matous proliferation in age-related macular degeneration with occult choroi- dal neovascularization. Graefes Arch Clin Exp Ophthalmol 2008;246:89–92.
30. Shiraga F, Ojima Y, Matsuo T, et al. Feeder vessel photocoagulation of subfo- veal choroidal neovascularization secondary to age-related macular degenera- tion. Ophthalmology 1998;105:662–9.
31. Staurenghi G, Orzalesi N, La Capria A, et al. Laser treatment of feeder vessels in subfoveal choroidal neovascular membranes: a revisitation using dynamic indocyanine green angiography. Ophthalmology 1998;105:2297–305.
32. Bottoni F, Massacesi A, Cigada M, et al. Treatment of retinal angiomatous proliferation in age-related macular degeneration: a series of 104 cases of retinal angiomatous proliferation. Arch Ophthalmol 2005;123:1644–50.
33. Schmidt-Erfurth U, Kriechbaum K, Oldag A. Three-dimensional angiography of classic and occult lesion types in choroidal neovascularization. Invest Ophthalmol Vis Sci 2007;48:1751–60.
34. Watzke RC, Klein ML, Hiner CJ, et al. A comparison of stereoscopic fluorescein angiography with indocyanine green videoangiography in age-related macular degeneration. Ophthalmology 2000;107:1601–6.
35. Hlushchuk R, Baum O, Gruber G, et al. The synergistic action of a VEGF-receptor tyrosine-kinase inhibitor and a sensitizing PDGF-receptor blocker depends upon the stage of vascular maturation. Microcirculation 2007;14:813–25.
36. Massacesi AL, Sacchi L, Bergamini F, et al. The prevalence of retinal angiomatous proliferation in age-related macular degeneration with occult choroidal neovascularization. Graefes Arch Clin Exp Ophthalmol 2008;246:89–92.
37. Hartnett ME, Weiter JJ, Staurenghi G, et al. Deep retinal vascular anomalous complexes in advanced age-related macular degeneration. Ophthalmology 1996;103:2042–53.
38. Massacesi AL, Sacchi L, Bergamini F, et al. The prevalence of retinal angiomatous

proliferation in age-related macular degeneration with occult choroidal neovascularization. Graefes Arch Clin Exp Ophthalmol 2008;246:89–92.

39. Viola F, Massacesi A, Orzalesi N, et al. Retinal angiomatous proliferation: natural history and progression of visual loss. Retina 2009;29:732–9.
40. Rouvas AA, Papakostas TD, Vavvas D, et al. Intravitreal ranibizumab, intravitreal ranibizumab with PDT, and intravitreal triamcinolone with PDT for the treatment of retinal angiomatous proliferation: a prospective study. Retina 2009;29:536–44.
41. Saito M, Shiragami C, Shiraga F, et al. Comparison of intravitreal triamcinolone acetonide with photodynamic therapy and intravitreal bevacizumab with photodynamic therapy for retinal angiomatous proliferation. Am J Ophthalmol 2010;149:472–81.
42. Yannuzzi LA, Sorenson J, Spaide RF, et al. Idiopathic polypoidal choroidal vasculopathy (IPCV). Retina 1990;10:1–8.
43. Spaide RF, Yannuzzi LA, Slakter JS, et al. Indocyanine green videoangiography of idiopathic polypoidal choroidal vasculopathy. Retina 1995;15:100–10.
44. Yannuzzi LA, Wong DW, Sforzolini BS, et al. Polypoidal choroidal vasculopathy and neovascularized age-related macular degeneration. Arch Ophthalmol 1999;117:1503–10.
45. Ahuja RM, Stanga PE, Vingerling JR, et al. Polypoidal choroidal vasculopathy in exudative and haemorrhagic pigment epithelial detachments. Br J Ophthalmol 2000;84:479–84.
46. Ahuja RM, Downes SM, Stanga PE, et al. Polypoidal choroidal vasculopathy and central serous chorioretinopathy. Ophthalmology 2001;108:1009–10.
47. Yannuzzi LA, Freund KB, Goldbaum M, et al. Polypoidal choroidal vasculopathy masquerading as central serous chorioretinopathy. Ophthalmology 2000;107:767–77.
48. Maruko I, Iida T, Saito M, et al. Combined cases of polypoidal choroidal vasculopathy and typical age-related macular degeneration. Graefes Arch Clin Exp Ophthalmol 2010;248:361–8.
49. Lai TY, Chan WM, Liu DT, et al. Intravitreal bevacizumab (Avastin) with or without photodynamic therapy for the treatment of polypoidal choroidal vasculopathy. Br J Ophthalmol 2008;92:661–6.
50. Eandi CM, Ober MD, Freund KB, et al. Selective photodynamic therapy for neovascular age-related macular degeneration with polypoidal choroidal neovascularization. Retina 2007;27:825–31.
51. Guyer DR, Yannuzzi LA, Slakter JS, et al. Digital indocyanine green videoangiography of central serous chorioretinopathy. Arch Ophthalmol 1994;112:1057–62.
52. Yannuzzi LA, Slakter JS, Gross NE, et al. Indocyanine green angiography-guided photodynamic therapy for treatment of chronic central serous chorioretinopathy: a pilot study. Retina 2003;23:288–98.
53. Piccolino FC, Borgia L. Central serous chorioretinopathy and indocyanine green angiography. Retina 1994;14:231–42.

54. Reibaldi M, Cardascia N, Longo A, et al. Standard-fluence versus low-fluence photodynamic therapy in chronic central serous chorioretinopathy: a nonrandomized clinical trial. Am J Ophthalmol 2010;149:307–15.
55. Inoue R, Sawa M, Tsujikawa M, et al. Association between the efficacy of photodynamic therapy and indocyanine green angiography findings for central serous chorioretinopathy. Am J Ophthalmol 2010;149:441–6.
56. Tsujikawa A, Ojima Y, Yamashiro K, et al. Punctate hyperfluorescent spots associated with central serous chorioretinopathy as seen on indocyanine green angiography. Retina 2010;30:801–9.
57. Kitaya N, Nagaoka T, Hikichi T, et al. Features of abnormal choroidal circulation in central serous chorioretinopathy. Br J Ophthalmol 2003;87:709–12.
58. Prunte C, Flammer J. Choroidal capillary and venous congestion in central serous chorioretinopathy. Am J Ophthalmol 1996;121:26–34.
59. Shields JA, Shields CL. Vascular tumors and malformations of the uvea. In: Atlas of Intraocular Tumors. Philadelphia: Lippincott, Williams & Wilkins; 2008:230–51.
60. Mashayekhi A, Shields CL. Circumscribed choroidal hemangioma. Curr Opin Ophthalmol 2003;14:142–9.
61. Mantelli F, Bruscolini A, La Cava M, Abdolrahimzadeh S, Lambiase A. Ocular manifestations of Sturge-Weber syndrome: pathogenesis, diagnosis, and management. Clin Ophthalmol 2016;10:871–8.
62. Singh AD, Kaiser PK, Sears JE. Choroidal hemangioma. Ophthalmol Clin North Am 2005;18:151–61.
63. Arevalo JF, Shields CL, Shields JA, et al. Circumscribed choroidal hemangioma: characteristic features with indocyanine green videoangiography. Ophthalmology 2000;107:344–50.
64. Sallet G, Amoaku WM, Lafaut BA, et al. Indocyanine green angiography of choroidal tumors. Graefes Arch Clin Exp Ophthalmol 1995;233:677–89.
65. Andersen MV, Scherfig E, Prause JU. Differential diagnosis of choroidal melanomas and nevi using scanning laser ophthalmoscopical indocyanine green angiography. Acta Ophthalmol Scand 1995;73:453–6.
66. Mueller AJ, Bartsch DU, Folberg R, et al. Imaging the microvasculature of choroidal melanomas with confocal indocyanine green scanning laser ophthalmoscopy. Arch Ophthalmol 1998;116:31–9.
67. Mueller AJ, Freeman WR, Schaller UC, et al. Complex microcirculation patterns detected by confocal indocyanine green angiography predict time to growth of small choroidal melanocytic tumors: MuSIC Report II. Ophthalmology 2002;109:2207–14.
68. Schaller UC, Mueller AJ, Bartsch DU, et al. Choroidal melanoma microcirculation with confocal indocyanine green angiography before and 1 year after radiation brachytherapy. Retina 2000;20:627–32.
69. Krause L, Bechrakis NE, Heinrich S, et al. Indocyanine green angiography and fluorescein angiography of malignant choroidal melanomas following proton beam

irradiation. Graefes Arch Clin Exp Ophthalmol 2005;243:545–50.

70. Midena E, Pilotto E, de Belvis V et al. Choroidal vascular changes after transpupillary thermotherapy for choroidal melanoma. Ophthalmology 2003;110:2216–22.
71. Annesley WHJ. Peripheral exudative hemorrhagic chorioretinopathy. Trans Am Ophthalmol Soc 1980;78:321–64.
72. Shields CL, Salazar PF, Mashayekhi A, et al. Peripheral exudative hemorrhagic chorioretinopathy simulating choroidal melanoma in 173 eyes. Ophthalmology 2009;116:529–35.
73. Shields JA, Mashayekhi A, Ra S, Shields CL. Pseudomelanomas of the posterior uveal tract: the 2006 Taylor R. Smith Lecture. Retina. 2005;25(6):767-71.
74. Ghassemi F, Bazvand F, Hosseini SS. Pseudomelanoma at a referral center in iran. J Ophthalmic Vis Res. 2014;9(1):50–3.
75. Gross NE, Yannuzzi LA, Freund KB, et al. Multiple evanescent white dot syndrome. Arch Ophthalmol 2006;124:493–500.
76. Dell'omo R, Wong R, Marino M, et al. Relationship between different fluorescein and indocyanine green angiography features in multiple evanescent white dot syndrome. Br J Ophthalmol 2010;94:59–63.
77. Slakter JS, Giovannini A, Yannuzzi LA et al. Indocyanine green angiography of multifocal choroiditis. Ophthalmology 1997;104:1813–9.
78. Fardeau C, Herbort CP, Kullmann N, et al. Indocyanine green angiography in birdshot chorioretinopathy. Ophthalmology 1999;106:1928–34.
79. Trinh L, Bodaghi B, Fardeau C et al. Clinical features, treatment methods, and evolution of birdshot chorioretinopathy in 5 different families. Am J Ophthalmol 2009;147:1042–7.
80. Park D, Schatz H, McDonald HR, et al. Indocyanine green angiography of acute multifocal posterior placoid pigment epitheliopathy. Ophthalmology 1995;102:1877–83.
81. Howe LJ, Woon H, Graham EM, et al. Choroidal hypoperfusion in acute posterior multifocal placoid pigment epitheliopathy. An indocyanine green angiography study. Ophthalmology 1995;102:790–8.
82. Schneider U, Inhoffen W, Gelisken F. Indocyanine green angiography in a case of unilateral recurrent posterior acute multifocal placoid pigment epitheliopathy. Acta Ophthalmol Scand 2003;81:72–5.
83. Giovannini A, Mariotti C, Ripa E, et al. Indocyanine green angiographic findings in serpiginous choroidopathy. Br J Ophthalmol 1996;80:536–40.
84. Amer R, Lois N. Punctate inner choroidopathy. Surv Ophthalmol 2011;56:36–53.
85. Tiffin PA, Maini R, Roxburgh ST, et al. Indocyanine green angiography in a case of punctate inner choroidopathy. Br J Ophthalmol 1996;80:90–1.
86. Rothova A. Ocular involvement in sarcoidosis. Br J Ophthalmol 2000;84(1):110–16.
87. Heiligenhaus A, Wefelmeyer D, Wefelmeyer E, et al. The eye as a common site for the early clinical manifestation of sarcoidosis. Ophthalmic Res 2011;46(1):9–12.
88. Letocha CE, Shields JA, Goldberg RE. Retinal changes in sarcoidosis. Can J Ophthalmol 1975;10(2):184–92.