

BÖLÜM 1

İNTRAKRANİAL ANEVİRİZMA VE ENDOVASKÜLER ANEVİRİZMA TEDAVİSİ

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1. ANEVİRİZMANIN PATOFİZYOLOJİSİ

İntrakraniyal anevrizma (İA) yıkıcı sonuçları olabilen serebral vasküler bir hastalıktır. Sıklığı yaş, cinsiyet ve etnik kökene bağlı olarak değişmekle birlikte genel popülasyonda %3 oranında görülür [1]. İa arterial duvarın elastik lamina-sında kayıp ve media tabakasının morfolojik yapısının bozulması sonucu oluş-maktadır [2]. Arter duvarında ki anevrizmatik genişleme ve anevrizma rüptürüne neden olan patofizyolojik süreçler hala net olarak anlaşılamamıştır. Ancak yapı-lan çalışmalar ışığında ki en olası teori inflamasyon teorisi-dir. İnflamasyon teori-si; arteriyel duvarda lokal matriks kaybı ile beraber inflamatuvar birtakım süreci içermektedir. Anevrizma formasyonu, hemodinamik etkiler (sheer stress, yüksek tansiyon) sonucu oluşan endotel disfonksiyonu ile başlar [3]. Endotel disfonksi-yonu ile tetiklenen arter duvarındaki inflamasyon süreci, klasik inflamasyonun ana komponentleri olan lökositler, kompleman faktörleri, immünoglobulinler ve sitokinleri içermektedir [3]. Anevrizma oluşmasında ve progresyonunda bu infla-masyon sürecindeki makrofaj kaynaklı matriks metalloproteazları (MMP 2 ve 9) önemli rol almaktadır [4]. MMP 2 ve 9 enzimleri, arter duvarını oluşturan ve ana matriks sentezleyicisi olarak görev yapan düz kas hücrelerinin disfonksiyonuna ve ekstrasellüler matriksin dejenerasyonuna neden olmaktadır [4, 5]. Sonuçta arter duvarında oluşan fokal bir zayıflık ve hemodiamik süreçler özellikle yüksek tan-siyon arter duvarında anevrizmatik genişlemeye neden olmaktadır. İnflamasyon teorisini destekleyen diğer bir bulgu da aspirin kullanımı ve anevrizma rüptürü arasındaki ilişkidir. Haftada 3 kez aspirin alan ve İA' sı olan hastalarda anevrizma rüptürü önemli ölçüde azalmaktadır [6]. Aspirinin antiinflamatuvar etkisi, anev-rizma mikroçevresinde ki inflamasyonu baskılayabilir.

İA'lar genellikle sporadik olup hastaların çok az bir kısmında herediter geçiş mevcuttur. Birinci derece akrabalarından birinde anevrizma olan hastalarda İA sıklığı %4' e, ikisinde anevrizma olan hastalarda ise İA sıklığı %8' e kadar çıkmak-

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KAYNAKÇA

1. Etminan, N. and G.J. Rinkel, Unruptured intracranial aneurysms: development, rupture and preventive management. *Nature Reviews Neurology*, 2016. 12(12): p. 699.
2. Brisman, J.L., J.K. Song, and D.W. Newell, Cerebral aneurysms. *N Engl J Med*, 2006. 355(9): p. 928-39.
3. Chalouhi, N., B.L. Hoh, and D. Hasan, Review of Cerebral Aneurysm Formation, Growth, and Rupture. *Stroke*, 2013. 44(12): p. 3613-3622.
4. Aoki, T., et al., Macrophage-Derived Matrix Metalloproteinase-2 and -9 Promote the Progression of Cerebral Aneurysms in Rats. *Stroke*, 2007. 38(1): p. 162-169.
5. Kanematsu, Y., et al., Critical roles of macrophages in the formation of intracranial aneurysm. *Stroke*, 2011. 42(1): p. 173-8.
6. Hasan, D.M., et al., Aspirin as a Promising Agent for Decreasing Incidence of Cerebral Aneurysm Rupture. *Stroke*, 2011. 42(11): p. 3156-3162.
7. Chalouhi, N., et al., The case for family screening for intracranial aneurysms. *Neurosurg Focus*, 2011. 31(6): p. E8.
8. Vlak, M.H., et al., Prevalence of unruptured intracranial aneurysms, with emphasis on sex, age, comorbidity, country, and time period: a systematic review and meta-analysis. *Lancet Neurol*, 2011. 10(7): p. 626-36.
9. Chalouhi, N., et al., Cigarette smoke and inflammation: role in cerebral aneurysm formation and rupture. *Mediators of inflammation*, 2012. 2012.
10. Moriwaki, T., et al., Impaired Progression of Cerebral Aneurysms in Interleukin-1 β -Deficient Mice. *Stroke*, 2006. 37(3): p. 900-905.
11. Ortiz, R., et al., Cigarette smoking as a risk factor for recurrence of aneurysms treated by endosaccular occlusion. *Journal of neurosurgery*, 2008. 108(4): p. 672-675.
12. Sakamoto, N., T. Ohashi, and M. Sato, Effect of fluid shear stress on migration of vascular smooth muscle cells in cocultured model. *Annals of biomedical engineering*, 2006. 34(3): p. 408.
13. Meng, H., et al., Progressive aneurysm development following hemodynamic insult. *Journal of neurosurgery*, 2011. 114(4): p. 1095-1103.
14. Investigators, U.J., The natural course of unruptured cerebral aneurysms in a Japanese cohort. *New England Journal of Medicine*, 2012. 366(26): p. 2474-2482.
15. Wiebers, D.O. and I.S.o.U.I.A. Investigators, Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. *The Lancet*, 2003. 362(9378): p. 103-110.
16. Dhar, S., et al., Morphology parameters for intracranial aneurysm rupture risk assessment. *Neurosurgery*, 2008. 63(2): p. 185-197.
17. Huang, Z.-Q., et al., Geometric Parameter Analysis of Ruptured and Unruptured Aneurysms in Patients with Symmetric Bilateral Intracranial Aneurysms: A Multicenter CT Angiography Study. *American Journal of Neuroradiology*, 2016. 37(8): p. 1413-1417.
18. Baharoglu, M.I., et al., Aneurysm Inflow-Angle as a Discriminant for Rupture in Sidewall Cerebral Aneurysms. *Stroke*, 2010. 41(7): p. 1423-1430.
19. Kashiwazaki, D. and S. Kuroda, Size Ratio Can Highly Predict Rupture Risk in Intracranial Small ($\leq 5\text{ mm}$) Aneurysms. *Stroke*, 2013. 44(8): p. 2169-2173.
20. Rahman, M., et al., Size Ratio Correlates With Intracranial Aneurysm Rupture Status. *Stroke*, 2010. 41(5): p. 916-920.
21. Zanaty, M., et al., Aspirin associated with decreased rate of intracranial aneurysm growth. *Journal of neurosurgery*, 2019. 1(aop): p. 1-8.
22. Hasan, D.M., et al., Macrophage imaging within human cerebral aneurysms wall using ferumoxylol-enhanced MRI: a pilot study. *Arteriosclerosis, thrombosis, and vascular biology*, 2012. 32(4): p. 1032-1038.
23. Brinjikji, W., et al., Risk Factors for Growth of Intracranial Aneurysms: A Systematic Review and Meta-Analysis. *American Journal of Neuroradiology*, 2016. 37(4): p. 615-620.

24. Villablanca, J.P., et al., Natural History of Asymptomatic Unruptured Cerebral Aneurysms Evaluated at CT Angiography: Growth and Rupture Incidence and Correlation with Epidemiologic Risk Factors. *Radiology*, 2013. 269(1): p. 258-265.
25. Zhang, J.-Y., et al., Lipid-soluble smoke particles damage endothelial cells and reduce endothelium-dependent dilatation in rat and man. *BMC cardiovascular disorders*, 2006. 6(1): p. 3.
26. Hillbom, M. and H. Numminen, Alcohol and stroke: pathophysiologic mechanisms. *Neuroepidemiology*, 1998. 17(6): p. 281-287.
27. Vlak, M.H., et al., Trigger factors and their attributable risk for rupture of intracranial aneurysms: a case-crossover study. *Stroke*, 2011. 42(7): p. 1878-1882.
28. Nieuwkamp, D.J., et al., Changes in case fatality of aneurysmal subarachnoid haemorrhage over time, according to age, sex, and region: a meta-analysis. *Lancet Neurol*, 2009. 8(7): p. 635-42.
29. Connolly Jr, E.S., et al., Guidelines for the management of aneurysmal subarachnoid hemorrhage: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*, 2012. 43(6): p. 1711-1737.
30. Hunt, W.E. and R.M. Hess, Surgical risk as related to time of intervention in the repair of intracranial aneurysms. *J Neurosurg*, 1968. 28(1): p. 14-20.
31. Hacin-Bey, L. and J.M. Provenzale, Current imaging assessment and treatment of intracranial aneurysms. *American Journal of Roentgenology*, 2011. 196(1): p. 32-44.
32. Koopman, I., et al., Aneurysm characteristics and risk of rebleeding after subarachnoid haemorrhage. *European stroke journal*, 2019. 4(2): p. 153-159.
33. Naidech, A.M., et al., Predictors and impact of aneurysm rebleeding after subarachnoid hemorrhage. *Archives of neurology*, 2005. 62(3): p. 410-416.
34. Post, R., et al., Short-term tranexamic acid treatment reduces in-hospital mortality in aneurysmal sub-arachnoid hemorrhage: A multicenter comparison study. *PloS one*, 2019. 14(2): p. e0211868.
35. Phillips, T.J., et al., Does treatment of ruptured intracranial aneurysms within 24 hours improve clinical outcome? *Stroke*, 2011. 42(7): p. 1936-1945.
36. Wong, G.K.C., et al., Ultra-early (within 24 hours) aneurysm treatment after subarachnoid hemorrhage. *World neurosurgery*, 2012. 77(2): p. 311-315.
37. Tack, R.W., et al., Preventable poor outcome from rebleeding by emergency aneurysm occlusion in patients with aneurysmal subarachnoid haemorrhage. *European Stroke Journal*, 2019. 4(3): p. 240-246.
38. Oudshoorn, S.C., et al., Aneurysm treatment < 24 versus 24–72 h after subarachnoid hemorrhage. *Neurocritical care*, 2014. 21(1): p. 4-13.
39. Sonig, A., et al., Better Outcomes and Reduced Hospitalization Cost are Associated with Ultra-Early Treatment of Ruptured Intracranial Aneurysms: A US Nationwide Data Sample Study. *Neurosurgery*, 2017. 82(4): p. 497-505.
40. Guglielmi, G., et al., Endovascular treatment of posterior circulation aneurysms by electrothrombosis using electrically detachable coils. *Journal of neurosurgery*, 1992. 77(4): p. 515-524.
41. Lin, N., et al., Treatment of ruptured and unruptured cerebral aneurysms in the USA: a paradigm shift. *Journal of NeuroInterventional Surgery*, 2018. 10(Suppl 1): p. i69-i76.
42. Zhao, J., et al., Current treatment strategies for intracranial aneurysms: An overview. *Angiology*, 2018. 69(1): p. 17-30.
43. Pierot, L., et al., Endovascular treatment of unruptured intracranial aneurysms: comparison of safety of remodeling technique and standard treatment with coils. *Radiology*, 2009. 251(3): p. 846-55.
44. Dayawansa, S., et al., Endosurgical Remodeling of Wide-Necked Bifurcation Aneurysms. *Frontiers in Neurology*, 2019. 10: p. 245.
45. Wakhloo, A.K., et al., Stent-assisted reconstructive endovascular repair of cranial fusiform atherosclerotic and dissecting aneurysms: long-term clinical and angiographic follow-up. *Stroke*, 2008. 39(12): p. 3288-3296.
46. Piotin, M., et al., Stent-Assisted Coiling of Intracranial Aneurysms. *Stroke*, 2010. 41(1): p. 110-115.

47. Saatci, I., et al., X-configured stent-assisted coiling in the endovascular treatment of complex anterior communicating artery aneurysms: a novel reconstructive technique. *American Journal of Neuroradiology*, 2011. 32(6): p. E113-E117.
48. Cagnazzo, F., et al., Y-Stent-Assisted Coiling of Wide-Neck Bifurcation Intracranial Aneurysms: A Meta-Analysis. *AJNR Am J Neuroradiol*, 2019. 40(1): p. 122-128.
49. Gawlitza, M., et al., Aneurysm characteristics, study population, and endovascular techniques for the treatment of intracranial aneurysms in a large, prospective, multicenter cohort: results of the analysis of recanalization after endovascular treatment of intracranial aneurysm study. *American Journal of Neuroradiology*, 2019. 40(3): p. 517-523.
50. Ryu, C.-W., et al., Complications in stent-assisted endovascular therapy of ruptured intracranial aneurysms and relevance to antiplatelet administration: a systematic review. *American Journal of Neuroradiology*, 2015. 36(9): p. 1682-1688.
51. Zuo, Q., et al., Safety of coiling with stent placement for the treatment of ruptured wide-necked intracranial aneurysms: a contemporary cohort study in a high-volume center after improvement of skills and strategy. *Journal of neurosurgery*, 2018. 131(2): p. 435-441.
52. Cagnazzo, F., et al., Treatment of Intracranial Aneurysms with Self-Expandable Braided Stents: A Systematic Review and Meta-Analysis. *American Journal of Neuroradiology*, 2018. 39(11): p. 2064-2069.
53. Bruening, R., et al., Intraprocedural thrombus formation during coil placement in ruptured intracranial aneurysms: treatment with systemic application of the glycoprotein IIb/IIIa antagonist tirofiban. *American Journal of Neuroradiology*, 2006. 27(6): p. 1326-1331.
54. Briganti, F., et al., Treatment of intracranial aneurysms by flow diverter devices: long-term results from a single center. *European journal of radiology*, 2014. 83(9): p. 1683-1690.
55. D'Urso, P.I., et al., Flow diversion for intracranial aneurysms: a review. *Stroke*, 2011. 42(8): p. 2363-2368.
56. Piano, M., et al., Midterm and long-term follow-up of cerebral aneurysms treated with flow diverter devices: a single-center experience: Special topic. *Journal of neurosurgery*, 2013. 118(2): p. 408-416.