

NÖROANESTEZİ VE NÖROŞİRÜRJİDE ULTRASONOGRAFİK İNCELEME

Dr. Gözde İnan
Dr. Zerrin Özköse Şatırlar

Beynin ultrasonografik görüntülenmesi kafatasının yüksek akustik empedansı nedeni ile sınırlıdır. Beyin ultrasonografik görüntülemesinde transkraniyal Doppler ultrasonografiden (TKD), transkraniyal renk kodlu dupleks sonografi (TCCS)'ye ve iki boyutlu ultrasonografi (2D US) veya iki boyutlu kontrastlı ultrasonografiye (2D CEUS) kadar farklı frekanslarda çeşitli ultrasonografi teknikleri kullanılmaktadır.

Optik sinir kılıfı çapının ultrasonografisi, sadece anlık artan İKB'yi değil, aynı zamanda travmatik beyin hasarı devam eden hastalarda İKB'deki ani değişiklikleri saptamak için de doğru, basit ve hızlı bir ölçüm olarak düşünülebilir. Bu tekniği öğrenmek kolaydır, beyin ödeminde etkilenmez ve travmada olduğu gibi invaziv İKB monitörizasyonunun mümkün olmadığı koşullarda yararlıdır. Çalışmalarda optik sinir kılıfı çapının normal üst sınırı tartışmaya açık olsa da, genel olarak kabul edilen 5.0 ila 5.7 mm arasında değişmekte olduğu, 5.0 mm üzerinde ölçülmesinin İKB artışını (>20 mm Hg) işaret ettiği (56). İKB, beyin ölümünde de son derece yüksek olduğundan, OSKÇ'nin de artması şaşırtıcı olmaz. OSKÇ ultrasonografisi ile artmış KİB ölçümü beyin ölümü tanısına spesifik olmamakla beraber pratik, kolay ve yatak başı uygulanabilen bir tetkik olduğu için bu amaçla da uygulanmaktadır (57).

Yoğun bakım hastaları dışında da ameliyathane şartlarında özellikle laparoskopik robotik cerrahiler gibi derin Trendelenburg pozisyonu uygulanan ve İKB artışına neden olabilecek cerrahilerde sonografik OSKÇ'nin izlenmesi, İKB'deki değişiklikler hakkında faydalı bilgiler sağlayabilir (58, 59).

Kaynaklar

1. Bilotta F, Dei Giudici L, Lam A, Rosa G: Ultrasound-based imaging in neurocritical care patients: a review of clinical applications. *Neurol Res*, 2013;35(2):149-158.
2. Miyazaki M, Kato K: Measurement of cerebral blood flow by ultrasonic Doppler technique. *Jpn Circ J*, 1965;29:375-382.
3. Aaslid R, Markwalder TM, Nornes H: Non-invasive transcranial Doppler ultrasound recording of flow velocity in basal cerebral arteries. *J Neurosurg*, 1982;57(6):769-774.
4. Markus HS: Transcranial Doppler Ultrasound. *Br Med Bulletin*, 2000;56(2):378-388.
5. White H, Venkatesh B: Applications of transcranial Doppler in the ICU: a review. *Intensive Care Med*, 2006;32:981-994.
6. Aaslid R. The Doppler principle applied to measurement of blood flow velocity in cerebral arteries. In: *Transcranial Doppler Sonography*. Aaslid R.ed., Springer, Vienna, pp 22-38, 1986.

7. Tegeler C, Ratanakorn D. Physics and principles. In: Physics and principles. Babikian V, Wechsler L., eds., Butterworth-Heinemann, Woburn, pp 3-13, 1999.
8. Harris C: Neuromonitoring indications and utility in the intensive care unit. *Crit Care Nurse*, 2014;34(3):30-39.
9. Williams D, Ludbrook G: Transcranial Doppler Ultrasound. *Australasian Anaesthesia*, 127-135, 2003.
10. Werner C: Transcranial Doppler sonography: Trend monitor of cerebral hemodynamics? *J Neurosurg Anesth*, 1991;3(1):73-76.
11. Moppett IK, Mahajan RP: Transcranial Doppler ultrasonography in anaesthesia and intensive care. *Br J Anaesth*, 2004;93(5):710-724.
12. Lindegaard KF, Nornes H, Bakke SJ, Sorteberg W, Nakstad P: Cerebral vasospasm after subarachnoid haemorrhage investigated by means of transcranial Doppler ultrasound. *Acta Neurochir Suppl (Wien)*, 1988;42:81-84.
13. Gosling RG, King DH: Arterial assessment by Doppler-shift ultrasound. *Proc R Soc Med*, 1974;67:447-449.
14. Topçuoğlu MA: Transcranial Doppler ultrasound in neurovascular disease: *Journal of Neurochemistry*, 2012;123(2):39-51.
15. Garami Z, Alexandrov AV: *Neurosonology*, 2009;27(1):89-108.
16. Topcuoglu MA, Unal A, Arsava EM: Advances in transcranial Doppler clinical applications. *Expert Opin Med Diagn*, 2010;4(4):343-358.
17. Alexandrov AV, Sloan MA, Tegeler CH, Newell DN, Lumsden A; American Society of Neuroimaging Practice Guidelines Committee: Practice standards for transcranial Doppler (TCD) ultrasound. Part II. Clinical indications and expected outcomes. *J Neuroimaging*, 2012;22(3):215-224.
18. Wijnhoud AD, Franckena M, van der Lugt A, Koudstaal PJ, Dippel ED: Inadequate acoustical temporal bone window in patients with a transient ischemic attack or minor stroke: role of skull thickness and bone density. *Ultrasound Med Biol*, 2008;34(6):923-929.
19. Droste DW: Clinical utility of contrast-enhanced ultrasound in neurosonology. *Eur Neurol*, 2008;59(1):2-8.

20. Van den Noort S, Caplan LR, Dyck P, Wechsler LR Assessment: Transcranial Doppler. Report of the American Academy of Neurology, Therapeutics and Technology Assessment Subcommittee. *Neurology*, 1990;40(4):680-681.
21. Babikian VL, Feldmann E, Wechsler LR, Newell DW, Gomez CR: Transcranial Doppler Ultrasonography: Year 2000 Update. *J Neuroimaging*, 2000;10:101-115.
22. Sloan MA, Alexandrov AV, Tegeler CH, Spencer MP, Caplan LR: Assessment: transcranial Doppler ultrasonography: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. *Neurology*, 2004;62:1468-1481.
23. Treggiari-Venzi MM, Suter PM, Romand JA: Review of medical prevention of vasospasm after aneurysmal subarachnoid hemorrhage: a problem of neurointensive care. *Neurosurgery*, 2001;48(2):249-261.
24. Oyama K, Criddle L: Vasospasm after aneurysmal subarachnoid hemorrhage. *Crit Care Nurse*, 2004;24(5):58-60,62,64-67.
25. Coley BD, Fordham LA, Hashimoto BE, Hernanz-Schulman M, Rumack CM: American Institute of Ultrasound in Medicine. AIUM practice guideline for the performance of a transcranial Doppler ultrasound examination for adults and children. *J Ultrasound Med*, 2012;31(9):1489-1500.
26. Marshall SA, Nyquist P, Ziai WC: The role of transcranial Doppler ultrasonography in the diagnosis and management of vasospasm after aneurysmal subarachnoid hemorrhage. *Neurosurg Clin North Am*, 2010;21(2):291-303.
27. Tsivgoulis G, Alexandrov AV, Sloan MA: Advances in transcranial Doppler ultrasonography. *Curr Neurol Neurosci Rep*, 9(1):46-54, 2009.
28. Markus HS: Transcranial Doppler Ultrasound. *Br Med Bulletin*, 2000;56(2):378-388.
29. Moppett IK, Mahajan RP: Transcranial Doppler ultrasonography in anaesthesia and intensive care. *British J Anaesthesia*, 2004;93(5); 710-724.
30. Qureshi AI, Sung GY, Razumovsky AY, Lane K, Straw RN: Early identification of patients at risk for symptomatic vasospasm after aneurysmal subarachnoid hemorrhage. *Crit Care Med*, 2000;28(4):984-990.

31. Lysakowski C, Walder B, Costanza MC, Tramer MR: Transcranial Doppler versus angiography in patients with vasospasm due to a ruptured cerebral aneurysm: A systematic review. *Stroke*, 2001;32(10):2292-2298.
32. Sloan MA, Burch CM, Wozniak MA, Rothman MI, Rigamonti D: Transcranial Doppler detection of vertebrobasilar vasospasm following subarachnoid hemorrhage. *Stroke*, 1994;25(11):2187-2197.
33. Connolly ES, Rabinstein AA, Carhuapoma JR, Derdeyn CP, Dion J: 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): 1711-1737.
34. Zurynski YA, Dorsch NW, Fearnside MR: Incidence and effects of increased cerebral blood flow velocity after severe head injury: a transcranial Doppler ultrasound study II. Effect of vasospasm and hyperemia on outcome. *J Neurol Sci*, 1995;134(1-2):41-46.
35. Santbrink H van, Schouten JW, Steyerberg EW, Avezaat CJ, Maas AI: Serial transcranial Doppler measurements in traumatic brain injury with special focus on the early posttraumatic period. *Acta Neurochir (Wien)*, 2002;144(11):1141-1149.
36. Klingelhofer J, Conrad B, Benecke R, Sander D: Intracranial flow patterns at increasing intracranial pressure. *Klin Wochenschr*, 1987;65(12):542-545.
37. Bellner J, Romner B, Reinstrup P, Kristiansson KA, Ryding E: Transcranial Doppler sonography pulsatility index (PI) reflects intracranial pressure (ICP). *Surg Neurol*, 2004;62(1):45-51.
38. Compton JS, Teddy PJ: Cerebral arterial vasospasm following severe head injury: a transcranial Doppler study. *Br J Neurosurg*, 1987;1(4):435-439.
39. Soustiel JF, Shik V, Feinsod M: Basilar vasospasm following spontaneous and traumatic subarachnoid haemorrhage: clinical implications. *Acta Neurochir (Wien)*, 2002;144(2):137-144.
40. Rasulo FA, De Peri E, Lavinio A: Transcranial Doppler ultrasonography in intensive care. *Eur J Anaesthesiol Suppl*, 2008;42:167-73.
41. Reinhard M, Rutsch S, Lambeck J, Wihler C, Czosnyka M: Dynamic cerebral autoregulation associates with infarct size and outcome after ischemic stroke. *Acta Neurol Scand*, 2012;125(3):156-162.

42. Rivera-Lara L, Zorrilla-Vaca A, Geocadin RG, Healy RJ, Ziai W: Cerebral Autoregulation-oriented Therapy at the Bedside: A Comprehensive Review. *Anesthesiology*, 2017;126(6):1187-1199.
43. Lang EW, Lagopoulos J, Griffith J, Yip K, Mudaliar Y: Noninvasive cerebrovascular autoregulation assessment in traumatic brain injury: validation and utility. *J Neurotrauma*, 2003;20(1):69-75.
44. Prunet B, Asencio Y, Lacroix G, Montcriol A, Dagain A: Noninvasive detection of elevated intracranial pressure using a portable ultrasound system. *Am J Emerg Med*, 2012;30(6):936-941.
45. Niesen WD, Rosenkranz M, Schummer W, Weiller C, Sliwka U: Cerebral venous flow velocity predicts poor outcome in subarachnoid hemorrhage. *Stroke*, 2004;35(8):1873-1878.
46. Eze KC, Enukegwu SU: Transfontanelle ultrasonography of infant brain: analysis of findings in 114 patients in Benin City, Nigeria. *Niger J Clin Pract*, 2010;13(2):179-182.
47. Veyrac C, Couture A, Saguintaah M, Baud C: Brain ultrasonography in the premature infant. *Pediatr Radiol*, 2006;36(7):626-635.
48. Strowitzki M, Komenda Y, Eymann R, Steudel WI: Accuracy of ultrasound-guided puncture of the ventricular system. *Childs Nerv Syst*, 2008;24(1):65-69.
49. Antonelli M, Azoulay E, Bonten M, Chastre J, Citerio G: Year in review in intensive care medicine, 2008: I. Brain injury and neurology, renal failure and endocrinology, metabolism and nutrition, sepsis, infections and pneumonia. *Intensive Care Med*, 2009;35(1):30-44.
50. Newman WD, Hollman AS, Dutton GN, Carachi R: Measurement of optic nerve sheath diameter by ultrasound: a means of detecting acute raised intracranial pressure in hydrocephalus. *Br J Ophthalmol*, 2002;86(10):1109-1113.
51. Blaivas M, Theodoro D, Sierzenski PR: Elevated intracranial pressure detected by bedside emergency ultrasonography of the optic nerve sheath. *Acad Emerg Med*, 2003;10(4):376-381.
52. Helmke K, Burdelski M, Hansen HC: Detection and monitoring of intracranial pressure dysregulation in liver failure by ultrasound. *Transplantation*, 2000;70(2):392-395.

53. Tayal VS, Neulander M, Norton HJ, Foster T, Saunders T: Emergency department sonographic measurement of optic nerve sheath diameter to detect findings of increased intracranial pressure in adult head injury patients. *Ann Emerg Med*, 2007;49(4):508-514.
54. Hansen HC, Helmke K: The subarachnoid space surrounding the optic nerves. An ultrasound study of the optic nerve sheath. *Surg Radiol Anat*, 1996;18(4):323-328.
55. Dubourg J, Javouhey E, Geeraerts T, Messerer M, Kassai B: Ultrasonography of optic nerve sheath diameter for detection of raised intracranial pressure: a systematic review and meta-analysis. *Intensive Care Med*, 2011;37(7):1059-1068.
56. Maissan IM, Dirven PJ, Haitzma IK, Hoeks SE, Gommers D: Ultrasonographic measured optic nerve sheath diameter as an accurate and quick monitor for changes in intracranial pressure. *J Neurosurg*, 2015;123(3):743-747.
57. Topcuoglu MA, Arsava EM, Bas DF, Kozak HH: Transorbital Ultrasonographic Measurement of Optic Nerve Sheath Diameter in Brain Death. *J Neuroimaging*, 2015;25(6):906-909.
58. Chin JH, Seo H, Lee EH, Lee J, Hong JH: Sonographic optic nerve sheath diameter as a surrogate measure for intracranial pressure in anesthetized patients in the Trendelenburg position. *BMC Anesthesiol*, 2015;31;15:43.
59. Verdonck P, Kalmar AF, Suy K, Geeraerts T, Vercauteren M: Optic nerve sheath diameter remains constant during robot assisted laparoscopic radical prostatectomy. *PLoS One*, 2014;4;9(11):e111916.