

## Tiroid Nodüllerinde Tanısal Yaklaşım: Ultrasonografi ve Konvansiyonel Görüntüleme

- Prof. Dr. Bekir ÇAKIR
- Prof. Dr. Didem ÖZDEMİR

### Özet

Ultrasonografi (US), tiroid bezinin ve nodüllerinin değerlendirilmesinde kullanılan en önemli görüntüleme yöntemidir. Nodüllerin saptanmasını ve özelliklerinin belirlenmesini sağlar ve hangi nodüllerin ince iğne aspirasyon biyopsisi (İİAB) ile değerlendirilmesi gerektiğine karar vermede rol oynar. Ayrıca İİAB ve lokal tedaviler US eşliğinde yapılmalıdır. US ile nodüllerin boyutu, ekojenitesi, yapısı, mikro ve makrokalsifikasyon varlığı, kenar düzeni, periferik halo varlığı, biçimi ve kanlanması belirlenebilir. Bu özelliklerden hipoekojenite, mikrokalsifikasyon varlığı ve kenar düzensizliği malignite ile en çok ilişkilendirilmiş özelliklerdir. Tiroid US sırasında sadece tiroid bezinin değil, boyundaki diğer yapıların da görüntülenmesi nodüllerin ayırıcı tanısında önemlidir. Ultrasonografik olarak şüpheli bir nodül varlığında boyunda patolojik görünümlü lenf nodu saptanması veya boyundaki diğer dokularda invazyon lehine görünüm olması nodülün malign olduğunu düşündürür. US bulgularının hiçbiri tek başına malign tiroid nodülünü saptamada yeterli değildir. Bu nedenle günümüze kadar birçok yazar ve kuruluş tarafından US bulgularının kullanıldığı farklı risk sınıflama sistemleri geliştirilmiştir. Bu risk sınıflamaları ile bir nodülün malign olma riskinin ve hangi nodüllerin İİAB ile değerlendirilmesi gerektiğinin belirlenmesi amaçlanmıştır. Son yıllarda geliştirilen elastosonografi (ESG), dokuların sertliğinin kalitatif ve kantitatif değerlendirilmesini sağlayan ultrasonografik bir yöntemdir. Malign lezyonların benign lezyonlara göre palpasyonla daha sert olması esasının ultrasonografik olarak yansıtılmasını sağlar. Tiroid nodüllerinin ayırıcı tanısında son 15 yıldır kullanılan bu yöntem diğer gri-skala US bulguları ile birleştirildiğinde yüksek sensitivite ve spesifiteye sahiptir. Bilgisayarlı tomografi ve manyetik rezonans görüntülemenin tiroid nodüllerin rutin tanı ve takibinde yeri yoktur. Bununla birlikte preoperatif dönemde tiroid kanserine bağlı lenf nodu metastazlarının belirlenmesi, cerrahi öncesi invaziv hastalık değerlendirilmesi ve postoperatif dönemde boyunda rekürrenslerin saptanmasında US'ye yardımcı olarak kullanılabilirler.

## Kaynaklar

- Tan GH, Gharib H. Thyroid incidentalomas: management approaches to nonpalpable nodules discovered incidentally on thyroid imaging. *Ann Intern Med* 1997;126:226-31.
- Guth S, Theune U, Aberle J, et al. Very high prevalence of thyroid nodules detected by high frequency (13 MHz) ultrasound examination. *Eur J Clin Invest* 2009;39:699-706.
- Frates MC, Benson CB, Charboneau JW, et al. Management of thyroid nodules detected at US: Society of Radiologists in Ultrasound consensus conference statement. *Radiology* 2005;237(3):794-800.
- Haugen BR, Alexander EK, Bible KC, et al. 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer: The American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer. *Thyroid* 2016;26(1):1-133.
- AIUM practice guideline for the performance of ultrasound examinations of the head and neck. *J Ultrasound Med* 2014;33:366-82.
- Frates MC, Benson CB, Doubilet PM, et al. Prevalence and distribution of carcinoma in patients with solitary and multiple thyroid nodules on sonography. *J Clin Endocrinol Metab* 2006;91:3411-7.
- Dirikoç A, Faki S, Başer H, et al. Thyroid malignancy risk in different clinical thyroid diseases. *Turk J Med Sci* 2017;47(5):1509-19.
- Kuru B, Gulcelik NE, Gulcelik MA, et al. The false negative rate of fine-needle aspiration cytology for diagnosing thyroid carcinoma in thyroid nodules. *Langenbecks Arch Surg* 2010;395:127-32.
- Shrestha M, Crothers BA, Burch HB. The impact of thyroid nodule size on the risk of malignancy and accuracy of fineneedle aspiration: A 10-year study from a single institution. *Thyroid* 2012;22:1251-6.
- Bestepe N, Ozdemir D, Tam AA, et al. Malignancy risk and false-negative rate of fine needle aspiration cytology in thyroid nodules  $\geq 4.0$  cm. *Surgery* 2016;160(2):405-12.
- Kamran SC, Marqusee E, Kim MI, et al. Thyroid nodule size and prediction of cancer. *J Clin Endocrinol Metab*. 2013;98(2):564-70.
- Tessler FN, Middleton WD, Grant EG, et al. Thyroid imaging, reporting and data system (TI-RADS): white paper of the ACR TI-RADS committee. *J Am Coll Radiol* 2017;14(5):587-95.
- Erdogan MF, Gursoy A, Erdogan G. Natural course of benign thyroid nodules in a moderately iodine-deficient area. *Clin Endocrinol (Oxf)* 2006;65:767-771
- Ajmal S, Rapoport S, Ramirez Battle H, et al. The natural history of the benign thyroid nodule: what is the appropriate follow-up strategy? *J Am Coll Surg* 2015;220:987-92.
- Türkiye Endokrinoloji ve Metabolizma Derneği, Tiroid Hastalıkları Tanı ve Tedavi Kılavuzu. 4. baskı. Ankara: Türkiye Klinikleri;2019
- Moon WJ, Jung SL, Lee JH, et al. Benign and malignant thyroid nodules: US differentiation—multicenter retrospective study. *Radiology* 2008;247:762-70.
- Na DG, Baek JH, Sung JY, et al. Thyroid Imaging Reporting and Data System Risk Stratification of Thyroid Nodules: Categorization Based on Solidity and Echogenicity. *Thyroid*. 2016;26(4):562-72.
- Salmaslioglu A, Erbil Y, Dural C, et al. Predictive value of sonographic features in preoperative evaluation of malignant thyroid nodules in a multinodular goiter. *World J Surg* 2008;32:1948-54.
- Gul K, Ersoy R, Dirikoc A, et al. Ultrasonographic evaluation of thyroid nodules: Comparison of ultrasonographic, cytological and histopathological findings. *Endocrine* 2009;36(3):464-72.
- Gürsoy A, Erdoğan MF. Tiroid Ultrasonografisi. *A'dan Z'ye Klinik Tiroidoloji*. 1. baskı. İstanbul:Ömür Matbaacılık;2012. p.52-58
- Song JSA, Dmytriw AA, Yu E, et al. Investigation of thyroid nodules: A practical algorithm and review of guidelines. *Head Neck* 2018;40(8):1861-73.
- Remonti LR, Kramer CK, Leitao CB, et al. Thyroid ultrasound features and risk of carcinoma: a systematic review and meta-analysis of observational studies. *Thyroid* 2015;25:538-50.
- Woliński K, Szkudlarek M, Szczepanek-Parulska E, et al. Usefulness of different ultrasound features of malignancy in predicting the type of thyroid lesions: a meta-analysis of prospective studies. *Pol Arch Med Wewn* 2014;124(3):97-104.
- Lee MJ, Kim EK, Kwak JY, et al. Partially cystic thyroid nodules on ultrasound: probability of malignancy and sonographic differentiation. *Thyroid* 2009;19:341-6.
- Melany M, Chen S. Thyroid Cancer: Ultrasound Imaging and Fine-Needle Aspiration Biopsy. *Endocrinol Metab Clin North Am*. 2017;46(3):691-711.
- Henrichsen TI, Reading CC, Charboneau JW, et al. Cystic change in thyroid carcinoma: prevalence and estimated volume in 360 carcinomas. *J Clin Ultrasound* 2010;38:361-6.
- Shin JH, Baek JH, Chung J, et al. Ultrasonography diagnosis and imaging-based management of thyroid nodules: revised Korean Society of Thyroid Radiology consensus statement and recommendations. *Korean J Radiol* 2016;17:370-95.
- Gul K, Ersoy R, Dirikoc A, et al. Ultrasonographic evaluation of thyroid nodules: comparison of ultrasonographic, cytological, and histopathological findings. *Endocrine* 2009;36:464-72.
- Nam-Goong IS, Kim HY, Gong G, et al. Ultrasonography-guided fine needle aspiration of thyroid incidentaloma: correlation with pathological findings. *Clin Endocrinol (Oxf)* 2004;60:21-28.
- Bonavita JA, Mayo J, Babb J, et al. Pattern recognition of benign nodules at ultrasound of the thyroid: which nodules can be left alone? *AJR Am J Roentgenol* 2009;193:207-13.
- Moon WJ, Kwag HJ, Na DG. Are there any specific ultrasound findings of nodular hyperplasia ("leave me alone" lesion) to differentiate it from follicular adenoma? *Acta Radiol* 2009;50:383-8.
- Kim JY, Jung SL, Kim MK, et al. Differentiation of benign and malignant thyroid nodules based on the proportion of sponge-like areas on ultrasonography: imaging pathologic correlation. *Ultrasonography* 2015;34:304-11.

33. Papini E, Guglielmi R, Bianchini A, et al. Risk of malignancy in nonpalpable thyroid nodules: predictive value of ultrasound and color-Doppler features. *J Clin Endocrinol Metab* 2002;87:1941-6.
34. Kim DW, Lee EJ, In HS, et al. Sonographic differentiation of partially cystic thyroid nodules; a prospective study. *AJNR Am J Neuroradiol* 2010;31:1961-6.
35. Topaloglu O, Baser H, Cuhaci FN, et al. Malignancy is associated with microcalcification and higher AP/T ratio in ultrasonography, but not with Hashimoto's thyroiditis in histopathology in patients with thyroid nodules evaluated as Bethesda Category III (AUS/FLUS) in cytology. *Endocrine* 2016;54(1):156-68.
36. Gul K, A. Dirikoc, G. Kiyak, et al. The association between thyroid carcinoma and hashimoto's thyroiditis: the ultrasonographic and histopathologic characteristics of malignant nodules. *Thyroid* 2010;8:873-8
37. Pyo JS, Kang G, Kim DH, et al. The prognostic relevance of psammoma bodies and ultrasonographic intratumoral calcifications in papillary thyroid carcinoma. *World J Surg* 2013;37(10):2330-5.
38. Cai YF, Wang QX, Ni CJ, et al. The Clinical Relevance of Psammoma Body and Hashimoto Thyroiditis in Papillary Thyroid Carcinoma: A Large Case-control Study. *Medicine (Baltimore)* 2015;94(44):e1881.
39. Baser H, Ozdemir D, Cuhaci N, et al. Hashimoto's Thyroiditis Does Not Affect Ultrasonographical, Cytological, and Histopathological Features in Patients with Papillary Thyroid Carcinoma. *Endocr Pathol* 2015;26(4):356-64.
40. Ozdemir D, Ersoy R, Cuhaci N, et al. Classical and follicular variant papillary thyroid carcinoma: comparison of clinical, ultrasonographical, cytological, and histopathological features in 444 patients. *Endocr Pathol* 2011;22(2):58-65.
41. Malhi H, Beland MD, Cen SY, et al. Echogenic foci in thyroid nodules: significance of posterior acoustic artifacts. *AJR Am J Roentgenol* 2014;203(6):1310-6.
42. Taki S, Terahata S, Yamashita R, et al. Thyroid calcifications: Sonographic patterns and incidence of cancer. *Clin Imaging* 2004;28(5):368-71.
43. Park YJ, Kim JA, Son EJ, et al. Thyroid nodules with macrocalcification: sonographic findings predictive of malignancy. *Yonsei Med J* 2014;55:339-44.
44. Seiberling KA, Dutra JC, Grant T, et al. Role of intrathyroidal calcifications detected on ultrasound as a marker of malignancy. *Laryngoscope* 2004;114(10):1753-7.
45. Kim BK, Choi YS, Kwon HJ, Lee JS, Heo JJ, Han YJ, et al. Relationship between patterns of calcification in thyroid nodules and histopathologic findings. *Endocr J* 2013;60(2):155-60.
46. Yoon DY, Lee JW, Chang SK, et al. Peripheral calcification in thyroid nodules: ultrasonographic features and prediction of malignancy. *J Ultrasound Med* 2007;26(10):1349-55.
47. Kim BM, Kim MJ, Kim EK, et al. Sonographic differentiation of thyroid nodules with eggshell calcifications. *J Ultrasound Med* 2008;27(10):1425-30.
48. Arpacı D, Ozdemir D, Cuhaci N, et al. Evaluation of cytopathological findings in thyroid nodules with macrocalcification: macrocalcification is not innocent as it seems. *Arq Bras Endocrinol Metabol* 2014;58(9):939-45.
49. Khoo ML, Asa SL, Witterick IJ, et al. Thyroid calcification and its association with thyroid carcinoma. *Head Neck* 2002;24(7):651-5.
50. Hoang JK, Lee WK, Lee M, et al. US Features of thyroid malignancy: pearls and pitfalls. *Radiographics* 2007;27:847-60.
51. Chan BK, Desser TS, McDougall IR, et al. Common and uncommon sonographic features of papillary thyroid carcinoma. *J Ultrasound Med* 2003;22(10):1083-90.
52. Hoang JK, Lee WK, Lee M, et al. Ultrasound features of thyroid malignancy: pearls and pitfalls. *Radiographics* 2007;27:847-65.
53. Russ G, Bonnema SJ, Erdogan MF, et al. European Thyroid Association Guidelines for Ultrasound Malignancy Risk Stratification of Thyroid Nodules in Adults: The EU-TIRADS. *Eur Thyroid J* 2017;6(5):225-37.
54. Moon HJ, Kwak JY, Kim EK, et al. A taller-than-wide shape in thyroid nodules in transverse and longitudinal ultrasonographic planes and the prediction of malignancy. *Thyroid* 2011;21:1249-53.
55. Chen SP, Hu YP, Chen B. Taller-than-wide sign for predicting thyroid microcarcinoma: Comparison and combination of two ultrasonographic planes. *Ultrasound Med Biol* 2014;40:2004-11.
56. Langer JE. Sonography of the Thyroid. *Radiol Clin North Am* 2019;57(3):469-83.
57. Blum M. Ultrasonography of the Thyroid. In: Feingold KR, Anawalt B, Boyce A, et al, editors. *Endotext* [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000. 2015 Sep 28.
58. Maxwell C, Sipos JA. Clinical Diagnostic Evaluation of Thyroid Nodules. *Endocrinol Metab Clin North Am* 2019;48(1):61-84.
59. Moon HJ, Kwak JY, Kim MJ, et al. Can vascularity at power Doppler US help predict thyroid malignancy? *Radiology* 2010;255:260-9.
60. Yang GCH, Fried KO. Most thyroid cancers detected by sonography lack intranodular vascularity on color Doppler imaging: review of the literature and sonographic-pathologic correlations for 698 thyroid neoplasms. *J Ultrasound Med* 2017;36(1):89-94.
61. Aydin C, Ozdemir D, Sacikara M, et al. A new approach for standardization and increased accuracy of lymph node washout thyroglobulin in patients with differentiated thyroid carcinoma. *Diagn Cytopathol* 2016;44(3):177-86.
62. Andersen PE, Kinsella J, Loree TR, et al. Differentiated carcinoma of the thyroid with extrathyroidal extension. *Am J Surg* 1995;170:467-70.
63. Ito Y, Tomoda C, Uruno T, et al. Prognostic significance of extrathyroid extension of papillary thyroid carcinoma: massive but not minimal extension affects the relapse-free survival. *World J Surg* 2006;30:780-6.
64. Lee CY, Kim SJ, Ko KR, et al. Predictive factors for extrathyroidal extension of papillary thyroid carcinoma based on preoperative sonography. *J Ultrasound Med* 2014;33:231-8.
65. Kwak JY, Kim EK, Youk JH, et al. Extrathyroid extension of well-dif-

- ferentiated papillary thyroid microcarcinoma on US. *Thyroid* 2008;18:609-14.
66. Moon SJ, Kim DW, Kim SJ, et al. Ultrasound assessment of degrees of extrathyroidal extension in papillary thyroid microcarcinoma. *Endocr Pract* 2014;20:1037-43.
  67. Liu Q, Cheng J, Li J, et al. The diagnostic accuracy of contrast-enhanced ultrasound for the differentiation of benign and malignant thyroid nodules: A PRISMA compliant meta-analysis. *Medicine (Baltimore)*. 2018;97(49):e13325.
  68. Bartolotta TV, Midiri M, Galia M, et al. Qualitative and quantitative evaluation of solitary thyroid nodules with contrast-enhanced ultrasound: initial results. *Eur Radiol* 2006;16(10):2234-41.
  69. Deng J, Zhou P, Tian SM, et al. Comparison of diagnostic efficacy of contrast-enhanced ultrasound, acoustic radiation force impulse imaging, and their combined use in differentiating focal solid thyroid nodules. *PLoS One* 2014;9:e90674.
  70. Wu Q, Wang Y, Li Y, et al. Diagnostic value of contrast-enhanced ultrasound in solid thyroid nodules with and without enhancement. *Endocrine* 2016;53:480-8.
  71. Ma X, Zhang B, Ling W, et al. Contrast-enhanced sonography for the identification of benign and malignant thyroid nodules: Systematic review and meta-analysis. *J Clin Ultrasound* 2016;44:199-209.
  72. Jiang J, Shang X, Wang H, et al. Diagnostic value of contrast-enhanced ultrasound in thyroid nodules with calcification. *The Kaohsiung Journal of Medical Sciences* 2015;31(3):138-44.
  73. Brito JP, Gionfriddo MR, Al Nofal A, et al. The accuracy of thyroid nodule ultrasound to predict thyroid cancer: systematic review and metaanalysis. *J Clin Endocrinol Metab* 2014;99:1253-63.
  74. Campanella P, Ianni F, Rota CA, et al. Quantification of cancer risk of each clinical and ultrasonographic suspicious feature of thyroid nodules: a systematic review and meta-analysis. *Eur J Endocrinol* 2014;170:R203-R211
  75. Horvath E, Majlis S, Rossi R, et al. An ultrasonogram reporting system for thyroid nodules stratifying cancer risk for clinical management. *J Clin Endocrinol Metab* 2009;94:1748-51.
  77. American College of Radiology, BI-RADS Committee 2003 ACR BI-RADS®-ultrasound. In: ACR BI-RADS breast imaging and reporting data system:breast imaging atlas. 4th ed. Reston,VA:American College of Radiology; 1-86.
  78. Horvath E, Silva CF, Majlis S, et al. Prospective validation of the ultrasound based TIRADS (Thyroid Imaging Reporting And Data System) classification: results in surgically resected thyroid nodules. *Eur Radiol* 2016;27(6):2619-28.
  79. Baser H, Cakir B, Topaloglu O, et al. Diagnostic accuracy of Thyroid Imaging Reporting and Data System in the prediction of malignancy in nodules with atypia and follicular lesion of undetermined significance cytologies. *Clin Endocrinol (Oxf)*. 2017;86(4):584-90.
  80. Kwak JY, Han KH, Yoon JH, et al. Thyroid imaging reporting and data system for US features of nodules: a step in establishing better stratification of cancer risk. *Radiology*. 2011;260(3):892-9.
  81. Migda B, Migda M, Migda MS, et al. Use of the Kwak Thyroid Image Reporting and Data System (K-TIRADS) in differential diagnosis of thyroid nodules: systematic review and meta-analysis. *Eur Radiol* 2018;28(6):2380-8.
  82. Grani G, Lamartina L, Ascoli V, et al. Reducing the number of unnecessary thyroid biopsies while improving diagnostic accuracy: towards the “right” TIRADS. *J Clin Endocrinol Metab* 2019;104(1):95-102.
  83. Shen Y, Liu M, He J, et al. Comparison of Different Risk-Stratification Systems for the Diagnosis of Benign and Malignant Thyroid Nodules. *Front Oncol* 2019;9:378.
  84. Middleton WD, Teefey SA, Reading CC, et al. Multiinstitutional analysis of thyroid nodule risk stratification using the American College of Radiology thyroid imaging reporting and data system. *AJR Am J Roentgenol* 2017;208(6):1331-41.
  85. Tang AL, Falciglia M, Yang H, et al. Validation of American Thyroid Association ultrasound risk assessment of thyroid nodules selected for ultrasound fine needle aspiration. *Thyroid* 2017;27(8):1077-82.
  86. Persichetti A, Di Stasio E, Guglielmi R, et al. Predictive value of malignancy of thyroid nodule ultrasound classification systems: a prospective study. *J Clin Endocrinol Metab* 2018;103(4):1359-68.
  87. Yoon JH, Lee HS, Kim EK, Moon HJ, Kwak JY. Malignancy Risk Stratification of Thyroid Nodules: Comparison between the Thyroid Imaging Reporting and Data System and the 2014 American Thyroid Association Management Guidelines. *Radiology* 2016;278(3):917-24.
  88. Gharib H, Papini E, Garber JR, et al. American Association of Clinical Endocrinologists American College of Endocrinology and Associazione Medici Endocrinologi medical guidelines for clinical practice for the diagnosis and management of thyroid nodules-2016 Update. *Endocr Pract* 2016;22(5):622-39.
  89. Perros P, Colley S, Boelaert K, et al. Guidelines for the management of thyroid cancer. *Clin Endocrinol (Oxf)* 2014;81(Suppl):1e122.
  90. Ghossein R, Ganly I, Biagini A, et al. Prognostic factors in papillary microcarcinoma with emphasis on histologic subtyping: a clinicopathologic study of 148 cases. *Thyroid* 2014;24:245-53.
  91. Jeon MJ, Kim WG, Choi YM, et al. Features predictive of distant metastasis in papillary thyroid microcarcinomas. *Thyroid* 2016;26:161-8.
  92. Ahmadi S, Oyekunle T, Jiang X, et al. A direct comparison of the ATA and TI-RADS ultrasound scoring systems. *Endocr Pract* 2019;25(5):413-422.
  93. Lauria Pantano A, Maddaloni E, Briganti SI, et al. Differences between ATA, AACE/ACE/AME and ACR TI-RADS ultrasound classifications performance in identifying cytological high-risk thyroid nodules. *Eur J Endocrinol*. 2018;178(6):595-603.
  94. Yang GCH, Fried KO, Scognamiglio T. Sonographic and cytologic differences of NIFTP from infiltrative or invasive encapsulated follicular variant of papillary thyroid carcinoma: A Review of 179 Cases. *Diagn Cytopathol*. 2017;45(6):533-541.
  95. Brandler TC, Yee J, Zhou F, et al. Does noninvasive follicular thy-

- roid neoplasm with papillary-like nuclear features have distinctive features on sonography? *Diagn Cytopathol.* 2018;46(2):139-147.)
96. Li Q, Lin X, Shao Y, et al. Imaging and Screening of Thyroid Cancer. *Radiol Clin North Am.* 2017;55(6):1261-71.
  97. Jeh SK, Jung SL, Kim BS, et al. Evaluating the degree of conformity of papillary carcinoma and follicular carcinoma to the reported ultrasonographic findings of malignant thyroid tumor. *Korean J Radiol* 2007;8:192-7.
  98. Lee S, Shin JH, Han BK, et al. Medullary thyroid carcinoma: comparison with papillary thyroid carcinoma and application of current sonographic criteria. *AJR Am J Roentgenol* 2010;194(4):1090-4
  99. Liu MJ, Liu ZF, Hou YY, et al. Ultrasonographic characteristics of medullary thyroid carcinoma: a comparison with papillary thyroid carcinoma. *Oncotarget* 2017;8(16):27520-8
  100. Dighe M, Barr R, Bojunga J, et al. Thyroid Ultrasound: State of the Art. Part 2- Focal Thyroid Lesions. *Med Ultrason* 2017;19(2):195-210.
  101. Andrioli M, Trimboli P, Amendola S, et al. Elastographic presentation of medullary thyroid carcinoma. *Endocrine* 2014;45:153-55.,
  102. Cakir B, Cuhaci FN, Topaloglu O, Ozdemir D, Dirikoc A, Aydin C, et al. Ultrasound elastography score and strain index in different parathyroid lesions. *Endocr Connect.* 2019 Nov 1. pii: EC-19-0443.R1. doi: 10.1530/EC-19-0443.
  103. Gültekin S. *Ultrasonografide Yeni Uygulamalar Trd Sem* 2014;2:158-70.
  104. Itoh A, Ueno E, Tohno E, et al. Breast disease: clinical application of US elastography for diagnosis. *Radiology* 2006; 239: 341-350.
  105. Hu X, Liu Y, Qian L. Diagnostic potential of real-time elastography (RTE) and shear wave elastography (SWE) to differentiate benign and malignant thyroid nodules: A systematic review and meta-analysis. *Medicine (Baltimore)* 2017;96(43):e8282.
  106. Kwak JY, Kim EK. Ultrasound elastography for thyroid nodules: recent advances. *Ultrasonography* 2014;33:75-82.
  107. Bojunga J, Dauth N, Berner C, et al. Acoustic radiation force impulse imaging for differentiation of thyroid nodules. *PLoS One* 2012;7(8):e42735.
  108. Monpeyssen H, Tramalloni J, Poirée S, et al. Elastography of the thyroid. *Diagn Interv Imaging* 2013;94(5):535-44.
  109. Rago T, Santini F, Scutari M, et al. Elastography: new developments in ultrasound for predicting malignancy in thyroid nodules. *J Clin Endocrinol Metab* 2007;92:2917-22.
  110. Moon HJ, Sung JM, Kim EK, et al. Diagnostic performance of gray-scale US and elastography in solid thyroid nodules. *Radiology* 2012;262(3):1002-13.
  111. Azizi G, Keller J, Lewis M, et al. Performance of elastography for the evaluation of thyroid nodules: a prospective study. *Thyroid* 2013;23:734-40.
  112. Unluturk U, Erdogan MF, Demir O, et al. Ultrasound elastography is not superior to grayscale ultrasound in predicting malignancy in thyroid nodules. *Thyroid* 2012;22:1031-38.
  113. Cakir B, Aydin C, Korukluoglu B, et al. Diagnostic value of elastosonographically determined strain index in the differential diagnosis of benign and malignant thyroid nodules. *Endocrine* 2011;39(1):89-98.
  114. Bojunga J, Herrmann E, Meyer G, et al. Real-time elastography for the differentiation of benign and malignant thyroid nodules: a meta-analysis. *Thyroid* 2010;20:1145.
  115. Razavi SA, Haddock TA, Sadigh G, Dwamena BA. Comparative effectiveness of elastographic and B-mode ultrasound criteria for diagnostic discrimination of thyroid nodules: a meta-analysis. *AJR Am J Roentgenol* 2013;200:1317-26.
  116. Veer V, Puttagunta S. The role of elastography in evaluating thyroid nodules: a literature review and meta-analysis. *Eur Arch Otorhinolaryngol.* 2015;272(8):1845-55.
  117. Sun J, Cai J, Wang X. Real-time ultrasound elastography for differentiation of benign and malignant thyroid nodules: a meta-analysis. *J Ultrasound Med* 2014;33(3):495-502.
  118. Rago T, Scutari M, Santini F, et al. Real-time elastosonography: useful tool for refining the presurgical diagnosis in thyroid nodules with indeterminate or nondiagnostic cytology. *J Clin Endocrinol Metab* 2010; 95:5274-80.
  119. Tuzun D, Ersoy R, Kilicyazgan A, Kiyak G, Yalcin S, Cakir B. Elastosonography scoring and strain index of thyroid nodules with Hurthle cells. *Minerva Endocrinol.* 2016;41(2):157-65.
  120. Cakir B, Ersoy R, Cuhaci FN, et al. Elastosonographic strain index in thyroid nodules with atypia of undetermined significance. *J Endocrinol Invest.* 2014;37(2):127-33
  121. Zhang B, Ma X, Wu N, et al. Shear wave elastography for differentiation of benign and malignant thyroid nodules: a meta-analysis. *J Ultrasound Med* 2013;32:2163.
  122. Lin P, Chen M, Liu B, et al. Diagnostic performance of shear wave elastography in the identification of malignant thyroid nodules: a meta-analysis. *Eur Radiol* 2014;24:2729-38.
  123. Sebag F, Vaillant-Lombard J, Berbis J, et al. Shear wave elastography: a new ultrasound imaging mode for the differential diagnosis of benign and malignant thyroid nodules. *J Clin Endocrinol Metab* 2010;95:5281-8.
  124. Trimboli P, Guglielmi R, Monti S, et al. Ultrasound sensitivity for thyroid malignancy is increased by real-time elastography: a prospective multicenter study. *J Clin Endocrinol Metab* 2012;97:4524-30.
  125. Russ G, Royer B, Bigorgne C, et al. Prospective evaluation of thyroid imaging reporting and data system on 4550 nodules with and without elastography. *Eur J Endocrinol* 2013;168:649-55.
  126. Tian W, Hao S, Gao B, et al. Comparing the Diagnostic Accuracy of RTE and SWE in Differentiating Malignant Thyroid Nodules from Benign Ones: a Meta-Analysis. *Cell Physiol Biochem* 2016;39(6):2451-63.
  127. Hoang JK, Langer JE, Middleton WD, et al. Managing incidental thyroid nodules detected on imaging: white paper of the ACR Incidental Thyroid Findings Committee. *J Am Coll Radiol.* 2015;12:143-150.

128. Starker LF, Prieto PA, Liles JS, et al. Endocrine incidentalomas. *Curr Probl Surg*. 2016;53:219-246.
129. Farrá JC, Picado OZ, Liu S, et al. Clinically significant cancer rates in incidentally discovered thyroid nodules by routine imaging. *J Surg Res* 2017;219:341-6.
130. Shie P, Cardarelli R, Sprawls K, et al. Systematic review: prevalence of malignant incidental thyroid nodules identified on fluorine-18 fluorodeoxyglucose positron emission tomography. *Nucl Med Commun* 2009;30:742-8.
131. Hoang JK, Raduazo P, Yousem DM, et al. What to do with incidental thyroid nodules on imaging? An approach for the radiologist. *Semin Ultrasound CT MR*. 2012;33:150-7.
132. Russ G, Leboulleux S, Leenhardt L, et al. Thyroid incidentalomas: epidemiology, risk stratification with ultrasound and workup. *Eur Thyroid J* 2014;3(3):154-63.
133. Shetty SK, Maher MM, Hahn PF, et al. Significance of incidental thyroid lesions detected on CT: correlation among CT, sonography, and pathology. *AJR Am J Roentgenol* 2006;187:1349-56.
134. Shie P, Cardarelli R, Sprawls K, et al. Systematic review: prevalence of malignant incidental thyroid nodules identified on fluorine-18 fluorodeoxyglucose positron emission tomography. *Nucl Med Commun* 2009;30(9):742-8.
135. Tanpitukpongse TP, Grady AT, Sosa JA, et al. Incidental thyroid nodules on CT or MRI: discordance between what we report and what receives workup. *AJR Am J Roentgenol* 2015;205:1281-7.
137. Fisher SB, Perrier ND. The incidental thyroid nodule. *CA Cancer J Clin* 2018;68(2):97-105.
138. Erdoğan MF, Demir Ö, Gürsoy A. Tiroid nodüllerine yaklaşım. Gürsoy A, Erdoğan MF, editörler. *Adan Z'ye Klinik Tiroidoloji*. 1. baskı. İstanbul:Ömür Matbaacılık;2012. p.108-120.
139. Nachiappan AC, Metwalli ZA, Hailley BS, et al. The thyroid: review of imaging features and biopsy techniques with radiologic-pathologic correlation. *Radiographics* 2014;34(2):276-93.
140. Lee C, Chalmers B, Treister D, et al. Thyroid lesions visualized on CT: sonographic and pathologic correlation. *Acad Radiol* 2015;22(2):203-9.
141. Ní Mhuircheartaigh JM, Siewert B, Sun MR. Correlation between the size of incidental thyroid nodules detected on CT, MRI or PET-CT and subsequent ultrasound. *Clin Imaging* 2016;40(6):1162-6.
142. Wilhelm S. Evaluation of thyroid incidentaloma. *Surg Clin North Am* 2014;94:485-97.
143. Lee JH, Jeong SY, Kim YH. Clinical significance of incidental thyroid nodules identified on low-dose CT for lung cancer screening. *Multidiscip Respir Med* 2013;8:56.
144. Yoon DY, Chang SK, Choi CS, et al. The prevalence and significance of incidental thyroid nodules identified on computed tomography. *J Comput Assist Tomogr* 2008;32:810-5.
145. Kim DW, Jung SJ, Baek HJ. Computed tomography features of benign and malignant solid thyroid nodules. *Acta Radiol* 2015;56(10):1196-202.
146. Li M, Zheng X, Li J, et al. Dual energy computed tomography imaging of thyroid nodule specimens: comparison with pathologic findings. *Invest Radiol* 2012;47(1):58-64.
147. Gao SY, Zhang XY, Wei W, et al. Identification of benign and malignant thyroid nodules by in vivo iodine concentration measurement using single-source dual energy CT: A retrospective diagnostic accuracy study. *Medicine (Baltimore)* 2016;95(39):e4816.
148. Koh DM, Collins DJ. Diffusion-weighted MRI in the body: applications and challenges in oncology. *AJR Am J Roentgenol* 2007;188:1622-35.
149. Erdem G, Erdem T, Muammer H, et al. Diffusion-weighted images differentiate benign from malignant thyroid nodules. *J Magn Reson Imaging* 2010;31(1):94-100.
150. Aghaghazvini L, Sharifian H, Yazdani N, et al. Differentiation between benign and malignant thyroid nodules using diffusion-weighted imaging, a 3-T MRI study. *Indian J Radiol Imaging* 2018;28(4):460-4.
151. Wu Y, Yue X, Shen W, et al. Diagnostic value of diffusion-weighted MR imaging in thyroid disease: application in differentiating benign from malignant disease. *BMC Med Imaging* 2013;13:23.
152. Chen L, Xu J, Bao J. Diffusion-weighted MRI in differentiating malignant from benign thyroid nodules: a meta-analysis. *BMJ Open* 2016;6(1):e008413.
153. Wang H, Wei R, Liu W, et al. Diagnostic efficacy of multiple MRI parameters in differentiating benign vs. malignant thyroid nodules. *BMC Med Imaging* 2018;18(1):50.
154. Orloff LA, Randolph GW. Preoperative Imaging for Thyroid Cancer: Beyond Ultrasonography. *JAMA Otolaryngol Head Neck Surg* 2016;142(6):515-6.
155. Hoang JK, Branstetter BF 4th, Gafton AR et al. Imaging of thyroid carcinoma with CT and MRI: approaches to common scenarios. *Cancer Imaging* 2013;13:128-39.
156. Seo YL, Yoon DY, Lim KJ, et al. Locally advanced thyroid cancer: can CT help in prediction of extrathyroidal invasion to adjacent structures? *AJR Am J Roentgenol* 2010;195:W240244.
157. Yu Q, Wang P, Shi H, et al. Carotid artery and jugular vein invasion of oral-maxillofacial and neck malignant tumors: diagnostic value of computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2003;96:368372.
158. Choi JS, Kim J, Kwak JY, et al. Preoperative staging of papillary thyroid carcinoma: comparison of ultrasound imaging and CT. *AJR Am J Roentgenol*. 2009;193(3):871-8.
159. Lesnik D, Cunnane ME, Zurakowski D, et al. Papillary thyroid carcinoma nodal surgery directed by a preoperative radiographic map utilizing CT scan and ultrasound in all primary and reoperative patients. *Head Neck* 2014;36(2):191-202.