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Resources. Day 4

Musculoskeletal Cancer and Imaging.

The following is a non-exhaustive bibliography of systematic reviews that are free to access, published years 2021-2024, on the field of [Musculoskeletal Cancer and Imaging](#).

1

The Effect of Skeletal Muscle Mass on Dose-Limiting Toxicities During (Chemo)Radiotherapy in Patients with Head and Neck Cancer: a Systematic Review and Meta-Analysis

Schaeffers AWMA, Scholten HA, van Beers MA, Meussen BW, Smid EJ, van Gils CH, Devriese LA, de Bree R. *Oral Oncol* (2024); 157:106978. doi: 10.1016/j.oraloncology.2024.106978. Epub 2024 Aug 6. PMID: 39111144. Review.

Abstract

Radiotherapy (RT) is a standard treatment for head and neck cancer (HNC) and chemoradiotherapy (CRT) is indicated for patients with locally advanced disease. Toxicities during treatment are common and can lead to early cessation of chemotherapy and radiotherapy (RT) interruptions, which can affect oncologic outcomes. Skeletal muscle mass (SMM) is a new biomarker to predict toxicities and overall survival. The aim of this systematic review is to provide an overview of studies towards the associations between SMM and dose limiting toxicity (DLT) and/or RT interruptions in HNC patients. A systematic literature search was conducted and yielded 270 studies. Inclusion criteria were articles published in English that investigated the effect of low SMM measured in humans with HNC on toxicities during CRT or RT. Studies that did not investigate oral cavity, oropharynx, larynx, hypopharynx, nasopharynx cancers or carcinoma of unknown primary were excluded. This led to the inclusion of 22 original studies. The prevalence of low SMM ranged from 19.7 % to 74.7 %. SMM was often assessed by measuring the cross-sectional muscle area at the level of the third cervical vertebra on computed tomography scans. Cut-off values used to categorize patients in SMM groups varied. In the meta-analyses heterogeneity was moderate ($I^2 = 68\%$ and 50% respectively). Patients with low SMM had higher, but only borderline significant, odds of DLT during CRT (OR 1.60; 95 % CI 1.00-2.58; $p = 0.0512$) and RT interruptions (OR 1.89; 95 % CI 1.00-3.57; $p = 0.0510$) compared to patients without low SMM. To conclude, in HNC patients low SMM, defined with different methods and cut-off values, is associated with DLT and RT interruptions during (C)RT, although the difference is only borderline statistically significant.

2

Barriers to Care for Musculoskeletal Sarcoma Patients: a Public Health Perspective

Syros A, Baron MC, Adalbert J, Remer HB, Heng M, Crawford B. *Front Public Health* (2024); 12:1399471. doi: 10.3389/fpubh.2024.1399471. eCollection 2024. PMID: 39234070. Review.

Abstract

Introduction: This study seeks to investigate the barriers to care that exist for patients presenting with sarcomas of musculoskeletal origin. Understanding the roots of delays in care for patients with musculoskeletal sarcoma is particularly important given the necessity of prompt treatment for oncologic diagnoses. Investigators reviewed relevant studies of publications reporting barriers to care in patients undergoing diagnosis and treatment of musculoskeletal tumors.

Conclusion: After identifying the most significant barriers in this study, we can target specific public health issues within our community that may reduce delays in care. The assessment of barriers to care is an important first step for improving the delivery of oncologic patient care to this patient population.



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3 Low Skeletal Muscle Mass and Treatment Outcomes Among Adults with Haematologic Malignancies: A Systematic Review and Meta-Analysis

Anabtawi NM, Pasala MS, Grimshaw AA, Kharel P, Bal S, Godby K, Siwakoti A, Buford TW, Bhatia S, Costa LJ, Williams GR, Giri S.J Cachexia Sarcopenia Muscle (2024); 15(3):1084-1093. doi: 10.1002/jcsm.13446. Epub 2024 Apr 1.PMID: 38558541.

Abstract

Background: Low skeletal muscle mass (LSMM) and/or, function associated with an increased risk of treatment-related toxicities and inferior overall survival (OS) among adults with solid malignancies. However, the association between LSMM and treatment-related toxicities among adults with haematologic malignancies remains unclear.

Conclusions: LSMM is associated with worse survival outcomes among adults with haematologic malignancies. Further research into understanding the underlying mechanism of this association and mitigating the negative effects of LSMM among adults with haematologic malignancies is needed.

4 Impact of Low Skeletal Muscle Mass On Postoperative Complications in Head and Neck Cancer Patients Undergoing Free Flap Reconstructive Surgery - a Systematic Review and Meta-Analysis

Ansari E, Ganry L, Van Cann EM, de Bree R.Oral Oncol (2023); 147:106598. doi: 10.1016/j.oraloncology.2023.106598. Epub 2023 Oct 18.PMID: 37863016. Review.

Abstract

Low skeletal muscle mass is emerging as an adverse predictive and prognostic factor in cancer patients. The use of this parameter as a risk factor for complications after surgery is not currently used in clinical practice. This meta-analysis aims to assess the association of low skeletal muscle mass defined by radiological criteria and complications after reconstructive microsurgery in head and neck cancer patients. A systematic review for articles was performed using the PubMed, EMBASE database and by manual search. Articles that assessed low skeletal muscle mass and its impact on postoperative complications in head and neck cancer patients undergoing free flap surgery were selected. Pooled estimates of postoperative outcome data were calculated by extracting the odds ratio (OR) and 95% confidence interval (CI). The search strategy returned with 6 studies meeting the inclusion criteria. A total of 1082 patients were analyzed. The prevalence of low skeletal muscle mass between studies ranged from 24.6% to 61.5%. The meta-analysis showed an OR for complications after surgery of 2.42 (95% CI 1.53-3.32, p = 0.00). The study therefore concludes that skeletal muscle mass is an independent risk factor for postoperative complications in head and neck cancer reconstructive surgery patients. This argues for implementing screening for low skeletal muscle in preoperative management to optimize surgical decision making.



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Prevalence and Effect of Low Skeletal Muscle Mass among Hepatocellular Carcinoma Patients Undergoing Systemic Therapy: a Systematic Review and Meta-Analysis

Kuo MH, Tseng CW, Hsu CS, Chen YC, Kao IT, Wu CY, Shao SC. Cancers (Basel) (2023); 15(9):2426. doi: 10.3390/cancers15092426.PMID: 37173893. Review.

Abstract

Low skeletal muscle mass (LSMM) is associated with poor outcomes in hepatocellular carcinoma (HCC) patients. With the emergence of new systemic therapeutics, understanding the effect of LSMM on HCC treatment outcomes is critically important. This systematic review and meta-analysis investigates the prevalence and effect of LSMM among HCC patients undergoing systemic therapy as reported in studies identified in searches of the PubMed and Embase databases published through 5 April 2023. The included studies (n = 20; 2377 HCC patients undergoing systemic therapy) reported the prevalence of LSMM assessed by computer tomography (CT) and compared the survival outcomes [overall survival (OS) or progression-free survival (PFS)] between HCC patients with and without LSMM. The pooled prevalence of LSMM was 43.4% (95% CI, 37.0-50.0%). A random-effects meta-analysis showed that HCC patients receiving systemic therapy with comorbid LSMM had a lower OS (HR, 1.70; 95% CI, 1.46-1.97) and PFS (HR, 1.32; 95% CI, 1.16-1.51) than did those without. Subgroup analysis according to systemic therapy type (sorafenib, lenvatinib, or immunotherapy) yielded similar results. In conclusion, LSMM is prevalent among HCC patients undergoing systemic therapy and is associated with poorer survival. Early intervention or prevention strategies to improve muscle mass may be necessary for this patient population.

6

Low Skeletal Muscle Mass Predicts Relevant Outcomes in Palliative Urological Oncology: a Systematic Review and Meta-Analysis

Meyer HJ, Wienke A, Zamsheva M, Surov A. Urol Int. (2023); 107(3):219-229. doi: 10.1159/000527277. Epub 2022 Dec 1.PMID: 36455534.

Abstract

Introduction: Low skeletal muscle mass (LSMM) can be assessed by cross-sectional imaging. LSMM is associated with several clinically relevant factors in various disorders with predictive and prognostic implications.

Conclusions: CT-defined LSMM predicts OS and PFS in RCC and UC in the palliative setting. The effect was higher in UC. Therefore, LSMM assessment should be included as a relevant prognostic biomarker in clinical routine.



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Applications of Machine Learning for Imaging-Driven Diagnosis of Musculoskeletal Malignancies - a Scoping Review

Hinterwimmer F, Consalvo S, Neumann J, Rueckert D, von Eisenhart-Rothe R, Burgkart R. *Eur Radiol* (2022); 32(10):7173-7184. doi: 10.1007/s00330-022-08981-3. Epub 2022 Jul 19. PMID: 35852574. Review.

Abstract

Musculoskeletal malignancies are a rare type of cancer. Consequently, sufficient imaging data for machine learning (ML) applications is difficult to obtain. The main purpose of this review was to investigate whether ML is already having an impact on imaging-driven diagnosis of musculoskeletal malignancies and what the respective reasons for this might be. A scoping review was conducted by a radiologist, an orthopaedic surgeon and a data scientist to identify suitable articles based on the PRISMA statement. Studies meeting the following criteria were included: primary malignant musculoskeletal tumours, machine/deep learning application, imaging data or data retrieved from images, human/preclinical, English language and original research. Initially, 480 articles were found and 38 met the eligibility criteria. Several continuous and discrete parameters related to publication, patient distribution, tumour specificities, ML methods, data and metrics were extracted from the final articles. For the synthesis, diagnosis-oriented studies were further examined by retrieving the number of patients and labels and metric scores. No significant correlations between metrics and mean number of samples were found. Several studies presented that ML could support imaging-driven diagnosis of musculoskeletal malignancies in distinct cases. However, data quality and quantity must be increased to achieve clinically relevant results. Compared to the experience of an expert radiologist, the studies used small datasets and mostly included only one type of data. Key to critical advancement of ML models for rare diseases such as musculoskeletal malignancies is a systematic, structured data collection and the establishment of (inter)national networks to obtain substantial datasets in the future. KEY POINTS: • Machine learning does not yet significantly impact imaging-driven diagnosis for musculoskeletal malignancies compared to other disciplines such as lung, breast or CNS cancer. • Research in the area of musculoskeletal tumour imaging and machine learning is still very limited. • Machine learning in musculoskeletal tumour imaging is impeded by insufficient availability of data and rarity of the disease.

8

Transarterial Embolization for the Treatment of Chronic Musculoskeletal Pain: a Systematic Review of Indications, Safety, and Efficacy

Kishore S, Sheira D, Malin ML, Trost DW, Mandl LA. *ACR Open Rheumatol* (2022); 4(3):209-217. doi: 10.1002/acr2.11383. Epub 2021 Nov 29. PMID: 34842365.

Abstract

Objective: The study objective was to evaluate the safety and efficacy of transcatheter arterial "embolization" (TAE) in the treatment of chronic "musculoskeletal pain" refractory to standard therapy.

Conclusion: TAE appears to be a safe and effective treatment for some types of chronic refractory "musculoskeletal pain". Randomized placebo-controlled studies are necessary to confirm these findings.



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9 The Current Use of Ultrasound to Measure Skeletal Muscle And Its Ability to Predict Clinical Outcomes: a Systematic Review

Casey P, Alasmar M, McLaughlin J, Ang Y, McPhee J, Heire P, Sultan J. *J Cachexia Sarcopenia Muscle* (2022); 13(5):2298-2309. doi: 10.1002/jcsm.13041. Epub 2022 Jul 19. PMID: 35851996. Review .

Abstract

Quantification and monitoring of lean body mass is an important component of nutrition assessment to determine nutrition status and muscle loss. The negative impact of reduced muscle mass and muscle function is increasingly evident across acute and chronic disease states but is particularly pronounced in patients with cancer. Ultrasound is emerging as a promising tool to directly measure skeletal muscle mass and quality. Unlike other ionizing imaging techniques, ultrasound can be used repeatedly at the bedside and may compliment nutritional risk assessment. This review aims to describe the current use of skeletal muscle ultrasound (SMUS) to measure muscle mass and quality in patients with acute and chronic clinical conditions and its ability to predict functional capacity, severity of malnutrition, hospital admission, and survival. Databases were searched from their inception to August 2021 for full-text articles in English. Relevant articles were included if SMUS was investigated in acute or chronic clinical contexts and correlated with a defined clinical outcome measure. Data were synthesized for narrative review due to heterogeneity between studies. This review analysed 37 studies (3100 patients), which met the inclusion criteria. Most studies (n = 22) were conducted in critical care. The clinical outcomes investigated included functional status at discharge (intensive care unit-acquired weakness), nutritional status, and length of stay. SMUS was also utilized in chronic conditions such as chronic obstructive pulmonary disease, chronic heart failure, and chronic renal failure to predict hospital readmission and disease severity. Only two studies investigated the use of SMUS in patients with cancer. Of the 37 studies, 28 (76%) found that SMUS (cross-sectional area, muscle thickness, and echointensity) showed significant associations with functional capacity, length of stay, readmission, and survival. There was significant heterogeneity in terms of ultrasound technique and outcome measurement across the included studies. This review highlights that SMUS continues to gain momentum as a potential tool for skeletal muscle assessment and predicting clinically important outcomes. Further work is required to standardize the technique in nutritionally vulnerable patients, such as those with cancer, before SMUS can be widely adopted as a bedside prognostic tool.

10 Diagnostic Performance of Diffusion MRI for differentiating Benign and Malignant Nonfatty Musculoskeletal Soft Tissue Tumors: A Systematic Review and Meta-analysis

Wang Q, Xiao X, Liang Y, Wen H, Wen X, Gu M, Ren C, Li K, Yu L, Lu L. *J Cancer* (2021); 12(24):7399-7412. doi: 10.7150/jca.62131. eCollection 2021. PMID: 35003360.

Abstract

Objective: To evaluate the diagnostic performance of standard diffusion-weighted imaging (DWI), intravoxel incoherent motion (IVIM), and diffusion kurtosis imaging (DKI), for differentiating benign and malignant soft tissue tumors (STTs). Conclusion: The DWI-derived ADC value and the IVIM DWI-derived D value might be accurate tools for discriminating musculoskeletal STTs, especially for non-myxoid SSTs, using more than two b values, with maximal b value ranging from 600 to 800 s/mm², additionally, a high-field strength (3.0 T) optimizes the diagnostic performance.



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Radiomics in Oncological PET Imaging: A Systematic Review-Part 2, Infradiaphragmatic Cancers, Blood Malignancies, Melanoma and Musculoskeletal Cancers

Morland D, Triumbari EKA, Boldrini L, Gatta R, Pizzuto D, Annunziata S. *Diagnostics (Basel)*. (2022); 12(6):1330. doi: 10.3390/diagnostics12061330. PMID: 35741139. Review.

Abstract

The objective of this review was to summarize published radiomics studies dealing with infradiaphragmatic cancers, blood malignancies, melanoma, and musculoskeletal cancers, and assess their quality. PubMed database was searched from January 1990 to February 2022 for articles performing radiomics on PET imaging of at least 1 specified tumor type. Exclusion criteria included: non-oncological studies; supradiaphragmatic tumors; reviews, comments, cases reports; phantom or animal studies; technical articles without a clinically oriented question; studies including <30 patients in the training cohort. The review database contained PMID, first author, year of publication, cancer type, number of patients, study design, independent validation cohort and objective. This database was completed twice by the same person; discrepant results were resolved by a third reading of the articles. A total of 162 studies met inclusion criteria; 61 (37.7%) studies included >100 patients, 13 (8.0%) were prospective and 61 (37.7%) used an independent validation set. The most represented cancers were esophagus, lymphoma, and cervical cancer (n = 24, n = 24 and n = 19 articles, respectively). Most studies focused on 18F-FDG, and prognostic and response to treatment objectives. Although radiomics and artificial intelligence are technically challenging, new contributions and guidelines help improving research quality over the years and pave the way toward personalized medicine.

12

Computed Tomography-Defined Low Skeletal Muscle Index and Density in Cancer Patients: Observations From a Systematic Review

McGovern J, Dolan RD, Horgan PG, Laird BJ, McMillan DC. *J Cachexia Sarcopenia Muscle*. (2021); 12(6):1408-1417. doi: 10.1002/jcsm.12831. Epub 2021 Oct 18. PMID: 34664431. Review.

Abstract

Background: Computed tomography (CT) analysis of body composition has garnered interest as a potential prognostic tool in those with cancer. A range of pre-defined thresholds currently exist within the literature to define low skeletal muscle mass and density. The aim of the present systematic review was to assess the prevalence of low skeletal muscle index (SMI) and density (SMD) within the literature, across a range of common solid tumours.

Conclusions: Low SMI and SMD are endemic across a range of cancer types and disease stage, challenging pre-existing dogma of the determinants of prevalence.



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13 Association Between Skeletal Muscle Mass and Quality of Life in Adults with Cancer: a Systematic Review and Meta-Analysis

Hanna L, Nguo K, Furness K, Porter J, Huggins CE. *J Cachexia Sarcopenia Muscle*. (2022); 13(2):839-857. doi: 10.1002/jcsm.12928. Epub 2022 Feb 13. PMID: 35156342. Review.

Abstract

Low skeletal muscle mass is known to be associated with poor morbidity and mortality outcomes in cancer, but evidence of its impact on health-related quality of life (HRQOL) is less established. This systematic review and meta-analysis was performed to investigate the relationship between skeletal muscle mass and HRQOL in adults with cancer. Five databases (Ovid MEDLINE, Embase via Ovid, CINAHL plus, Scopus, and PsycInfo) were systematically searched from 1 January 2007 until 2 September 2020. Studies reporting on the association between measures of skeletal muscle (mass and/or radiodensity) derived from analysis of computed tomography imaging, and a validated measure of HRQOL in adults with cancer, were considered for inclusion. Studies classifying skeletal muscle mass as a categorical variable (low or normal) were combined in a meta-analysis to investigate cross-sectional association with HRQOL. Studies reporting skeletal muscle as a continuous variable were qualitatively synthesized. A total of 14 studies involving 2776 participants were eligible for inclusion. Skeletal muscle mass classified as low or normal was used to dichotomize participants in 10 studies (n = 1375). Five different cut points were used for classification across the 10 studies, with low muscle mass attributed to 58% of participants. Low muscle mass was associated with poorer global HRQOL scores [n = 985 from seven studies, standardized mean difference -0.27, 95% confidence interval (CI) -0.40 to -0.14, P < 0.0001], and poorer physical functioning domain HRQOL scores (n = 507 from five studies, standardized mean difference -0.40, 95% CI -0.74 to -0.05, P = 0.02), but not social, role, emotional, or cognitive functioning domain scores (all P > 0.05). Five studies examined the cross-sectional relationship between HRQOL and skeletal muscle mass as a continuous variable and found little evidence of an association unless non-linear analysis was used. Two studies investigated the relationship between longitudinal changes in both skeletal muscle and HRQOL, reporting that an association exists across several HRQOL domains. Low muscle mass may be associated with lower global and physical functioning HRQOL scores in adults with cancer. The interpretation of this relationship is limited by the varied classification of low muscle mass between studies. There is a need for prospective, longitudinal studies examining the interplay between skeletal muscle mass and HRQOL over time, and data should be made accessible to enable reanalysis according to different cut points. Further research is needed to elucidate the causal pathways between these outcomes.



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Thyroid Cancer and Imaging

The following is a non-exhaustive bibliography of systematic reviews that are free to access, published years 2021-2024 on the field of [Thyroid Cancer and Imaging](#).

14

Ultrasound-Base Radiomics for Discerning Lymph Node Metastasis in Thyroid Cancer: a Systematic Review and Meta-Analysis

Zhang S, Liu R, Wang Y, Zhang Y, Li M, Wang Y, Wang S, Ma N, Ren J. *Acad Radiol.* 2024 Aug;31(8):3118-3130. doi: 10.1016/j.acra.2024.03.012. Epub 2024 Mar 29. PMID: 38555183. Review.

Abstract

Purpose: Ultrasound is the imaging modality of choice for preoperative diagnosis of lymph node metastasis (LNM) in thyroid cancer (TC), yet its efficacy remains suboptimal. As radiomics gains traction in tumor diagnosis, its integration with ultrasound for LNM differentiation in TC has emerged, but its diagnostic merit is debated. This study assesses the accuracy of ultrasound-integrated radiomics in preoperatively diagnosing LNM in TC.

Conclusion: Ultrasound-based radiomics effectively evaluates LNM in TC preoperatively. Adding clinical features does not notably enhance the model's performance. Some radiomics studies showed high bias, possibly due to the absence of standard application guidelines.

15

Ultrasound Features as Predictive Markers of BRAFV600E Mutation in Thyroid Cancer: a Systematic Review and Meta-Analysis

Liu R, Li H, Bai X, Yang H, He Y. *Gland Surg.* 2024 Jul 30;13(7):1243-1253. doi: 10.21037/gs-24-134. Epub 2024 Jul 24. PMID: 39175707

Abstract

Background: Conflicting evidence exists on the predictive value of ultrasound characteristics for BRAFV600E gene expression in thyroid cancer. This study aimed to determine the predictive value of ultrasound features for BRAFV600E gene expression status in thyroid cancer.

Conclusions: The expression status of the BRAFV600E gene in thyroid cancer correlates with nodules exhibiting hypoechogenicity, absence of halo, irregular borders, and taller-than-wide shape. Notably, the absence of a halo and hypoechogenicity were identified as the most predictive ultrasonic features. However, due to the limited sample size, there may be bias in the meta-analysis results, and more extensive research is necessary.



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16 The Role of SPECT/CT and PET/CT Hybrid Imaging in the Management of Ectopic Thyroid Carcinoma - a Systematic Review

Peștean C, Pavel A, Piciu D. Diagnostics (Basel). 2024 Jun 27;14(13):1369. doi: 10.3390/diagnostics14131369.PMID: 39001259. Review.

Abstract

Background and objectives: Thyroid ectopy represents a rare disease with an incidence of 0.3-1/100,000. It occurs due to the defective embryological process of the thyroid gland development. The thyroid ectopic tissue may suffer malignant transformation. This review aims to shed light on the roles that I-131 SPECT/CT (radioiodine 131 single-photon emission tomography fused with computed tomography) and F-18 PET/CT (fluorodeoxyglucose F18 positron emission tomography fused with computer tomography) may play in managing patients with ectopic thyroid carcinoma.

Conclusions: F-18 PET/CT and I-131 SPECT/CT hybrid nuclear imaging is of great value in assessing ectopic thyroid carcinoma. F-18 FDG PET/CT plays an important role in the primary tumour evaluation and distant disease detection. Ga-68 FAPIs are a promising alternative. I-131 SPECT/CT adds important information related to the anatomical characterization of primary and distant iodine-avid lesions.

17 Sensitivities Evaluation of Five Radiopharmaceuticals in Four Common Medullary Thyroid Carcinoma Metastatic Sites on PET/CT: A Network Meta-Analysis and Systematic Review

Li P, Zhang Y, Xu T, Zhu J, Wei T, Zhao W. Nucl Med Commun. 2023 Dec 1;44(12):1114-1125. doi: 10.1097/MNM.0000000000001773. Epub 2023 Sep 29. PMID: 37769014

Abstract

Objectives: Detecting medullary thyroid carcinoma (MTC) metastatic lesions accurately is still a challenge for clinicians. PET/computed tomography (PET/CT) seems to be the most effective method in recent years. However, the sensitivity of each radiopharmaceutical varies greatly in different metastatic sites. We aim to investigate and compare five novel and common PET or PET/CT radiopharmaceutical sensitivities at the four most frequent metastatic sites by network meta-analysis.

Conclusion: TF2/ 68 Ga-SSM288 had the best sensitivity in lymph nodes and liver lesions. 11 C-methionine was most sensitive in lung lesions. While 18 F-DOPA and 68 Ga-SSA had familiar sensitivities to be the best two radiopharmaceuticals.



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18 Efficacy and Safety of Ultrasound-Guided Radiofrequency, Microwave and Laser Ablation for the Treatment of T1N0M0 Papillary Thyroid Carcinoma on a Large Scale: A Systematic Review and Meta-Analysis

Gao X, Yang Y, Wang Y, Huang Y. *Int J Hyperthermia*. 2023 Dec;40(1):2244713. doi: 10.1080/02656736.2023.2244713. PMID: 37604507. Review.

Abstract

Background: To analyze the efficacy and safety of radiofrequency ablation (RFA), microwave ablation (MWA) and laser ablation (LA) in T1N0M0 papillary thyroid carcinoma (PTC) patients by evaluating data on several outcomes on a large scale.

Conclusion: RFA, MWA and LA were reliable in curing PTC, and RFA presented advantages in most outcomes. T1aN0M0 patients may experience fewer side effects than T1bN0M0 patients.

19 Suboptimal Accuracy of Ultrasound and Ultrasound-Based Risk Stratification Systems in Detecting Medullary Thyroid Carcinoma Should Not be Overlooked. Findings From a Systematic Review with Meta-Analysis

Ferrarazzo G, Camponovo C, Deandrea M, Piccardo A, Scappaticcio L, Trimboli P. *Clin Endocrinol (Oxf)*. 2022 Nov;97(5):532-540. doi: 10.1111/cen.14739. Epub 2022 Apr 22. PMID: 35419855. Review.

Abstract

Objective: Ultrasound (US) is the pivotal procedure during the diagnostic work-up of thyroid nodule and several US-based risk stratification systems (RSSs) have been recently developed. Since the performance of RSSs in detecting medullary thyroid carcinoma (MTC) has been rarely investigated, the present systematic review aimed to achieve high evidence about (1) how MTC is classified according to RSSs; (2) if RSSs correctly classify MTC at high risk/suspicion, and (3) if MTC is classified as suspicious at US when RSSs are not used.

Conclusions: As conclusion, MTC presentation according to RSSs is partially known and it is classified in a high-risk/suspicion category of RSSs in just over a half of cases. This advises for further studies, ideally supported by international societies, to better define the US presentation of MTC.



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20 Safety and Efficacy of Ultrasound-Guided Thermal Ablation in Treating T1aN0M0 and T1bN0M0 Papillary Thyroid Carcinoma: a Meta-Analysis

Wang MH, Liu X, Wang Q, Zhang HW. *Front Endocrinol (Lausanne)*. 2022 Jul 27;13:952113. doi: 10.3389/fendo.2022.952113. eCollection 2022. PMID: 35966062.

Abstract

Background: Papillary thyroid cancer (PTC) is the most common thyroid tumor, and early diagnosis and treatment can effectively improve prognosis. Many controversies surround the treatment method of T1N0M0 PTC. Recently, thermal ablation (TA) has shown some benefits in the treatment of PTC patients, but the safety and efficacy of its treatment remain controversial. This article performs a meta-analysis of TA in patients with T1aN0M0 and T1bN0M0 PTC.

Conclusions: TA is an effective and safe method for managing T1aN0M0 and T1bN0M0 papillary thyroid nodules.

21 Diagnostic Accuracy of Ultrasound, CT and Their Combination in Detecting Cervical Lymph Node Metastasis in Patients with Papillary Thyroid Cancer: a Systematic Review and Meta-Analysis

Yang J, Zhang F, Qiao Y. *BMJ Open*. 2022 Jul 4;12(7):e051568. doi: 10.1136/bmjopen-2021-051568. PMID: 35788082.

Abstract

Objectives: To determine the diagnostic accuracy of ultrasound (US), CT and their combination in detecting cervical lymph node metastasis (CLNM) in patients with papillary thyroid cancer (PTC).

Discussion: These findings suggest US, with a DOR almost twice that of CT in the neck-level-based analysis, was superior to CT in detecting CLNM in patients with PTC, especially in the lateral compartment. The combination of US and CT increased the sensitivity from 41%-49% for the individual modalities to 64% for combined modalities in the patient-based analysis.

22 Diagnostic Performance of Ultrasound and Computed Tomography in Parallel for the Diagnosis of Lymph Node Metastasis in Patients with Thyroid Cancer: a Systematic Review and Meta-Analysis

Wang Y, Chen M, Chen P, Tong J, Zhang Y, Yang G. *Gland Surg*. 2022 Jul;11(7):1212-1223. doi: 10.21037/gs-22-347. PMID: 35935558

Abstract

Background: Currently, there is no evidence-based medical evidence for the diagnosis of lymph node metastasis (LNM) of thyroid cancer (TC) by ultrasound combined with computed tomography (US + CT), and the results of various studies on its diagnostic efficacy are inconsistent. Therefore, the diagnosis of cervical LNM by US + CT is controversial at present. The aims of the present systematic review and meta-analysis were to evaluate the diagnostic performance of US + CT in parallel for diagnosing cervical LNM in patients with TC.



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23 Head-to-Head Comparison of FNA Cytology vs. Calcitonin Measurement in FNA Washout Fluids (FNA-CT) to Diagnose Medullary Thyroid Carcinoma. A Systematic Review and Meta-Analysis

Trimboli P, Giannelli J, Marques B, Piccardo A, Crescenzi A, Deandrea M. Endocrine. 2022 Jan;75(1):33-39. doi: 10.1007/s12020-021-02892-x. Epub 2021 Oct 4. PMID: 34606057.

Abstract

Purpose: The sensitivity of cytology after fine needle aspiration (FNA-cytology) in detecting medullary thyroid carcinoma (MTC) is low. To overcome this problem, measuring calcitonin (CT) in washout fluid of FNA (FNA-CT) has been largely diffused and showed good performance. However, no evidence-based study exists comparing systematically the sensitivity of FNA-cytology and FNA-CT. This study aimed to systematically review the literature and collect data allowing a head-to-head comparison meta-analysis between FNA-cytology and FNA-CT in detecting MTC lesions.

Conclusions: FNA-CT is significantly more sensitive than FNA-cytology in detecting MTC. Accordingly, FNA-CT represents the standard method to use in patients with suspicious MTC lesions, combined with cytology.

24 Investigating (18)F-FDG PET/CT Parameters as Prognostic Markers for Differentiated Thyroid Cancer: a Systematic Review

Wang H, Dai H, Li Q, Shen G, Shi L, Tian R. Front Oncol. 2021 May 13;11:648658. doi: 10.3389/fonc.2021.648658. eCollection 2021. PMID: 34055616.

Abstract

Aims: The aim of this study was to determine whether ¹⁸F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) parameters might be prognostic markers for patients with differentiated thyroid carcinoma (DTC). **Conclusion:** 18F-FDG PET/CT parameters alone or combined with other variables can serve as prognostic markers to identify DTC patients with poor outcomes, especially in the setting of an elevated Tg and a negative WBS. Future research is needed to confirm these findings and to examine the prognostic value of PET/CT parameters for DTC patients, considering the heterogeneity in PET/CT parameters, unclear information of patients, and PET/CT-adapted treatment modifications.

25 Diagnostic values of F-18 FDG PET or PET/CT, CT, and US for Preoperative Lymph Node Staging in Thyroid Cancer: A Network Meta-Analysis

Kim K, Shim SR, Lee SW, Kim SJ. Br J Radiol. 2021 Apr 1;94(1120):20201076. doi: 10.1259/bjr.20201076. Epub 2021 Feb 17. PMID: 33595337

Abstract

Objective: This study compared the diagnostic performance of three different imaging modalities for preoperative lymph node (LN) staging in thyroid cancer patients, using a network meta-analysis (NMA). **Conclusion:** The results from this NMA indicate that F-18 FDG PET or PET/CT, CT, and US have complementary diagnostic roles for preoperative staging in thyroid cancer patients.



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Lung Cancer and Imaging

The following is a non-exhaustive bibliography of systematic reviews that are free to access, published years 2021-2024 on the field of [Lung Cancer and Imaging](#).

26 Current Status and Quality of Prognosis Prediction Models of Non-Small Cell Lung Cancer Constructed Using Computed Tomography (CT)-Based Radiomics: a Systematic Review and Radiomics Quality Score 2.0 Assessment

Jia X, Wang Y, Zhang H, Sun D. Quant Imaging Med Surg. 2024 Sep 1;14(9):6978-6989. doi: 10.21037/qims-24-22. Epub 2024 Aug 19. PMID: 39281123. Review.

Abstract

Background: Radiomics extracts specific quantitative data from medical images and explores the characteristics of tumors by analyzing these representations and making predictions. The purpose of this paper is to review computed tomography (CT)-based radiomics articles related to prognostic outcomes in non-small cell lung cancer (NSCLC), assess their scientificity and quality by the latest radiomics quality score (RQS) 2.0 scoring criteria, and provide references for subsequent related studies.

Conclusions: The value of radiomics studies needs to be increased, such that clinical application will be possible, and the field of radiomics still has much room for growth. To make prediction models more reliable and stable in forecasting the prognosis of NSCLC and advancing the individualized treatment of NSCLC patients, more clinicians must participate in their development and clinical testing.

27 Predicting Histopathological Features of Aggressiveness in Lung Cancer Using CT Radiomics: a Systematic review

Cheng DO, Khaw CR, McCabe J, Pennycuick A, Nair A, Moore DA, Janes SM, Jacob J. Clin Radiol. 2024 Sep;79(9):681-689. doi: 10.1016/j.crad.2024.04.022. Epub 2024 May 17. PMID: 38853080. Review.

Abstract

Purpose: To examine the accuracy of CT radiomics to predict histopathological features of aggressiveness in lung cancer using a systematic review of test accuracy studies.

Conclusion: Due to the high risk of bias and concerns regarding applicability, the evidence is inconclusive as to whether radiomic features can accurately predict prognostically important histopathological features of cancer aggressiveness. Many studies were excluded due to lack of external validation. Rigorously conducted prospective studies with sufficient external validity will be required for radiomic models to play a role in improving lung cancer outcomes.



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Additional Benefit Of Endoscopic Ultrasound With Bronchoscope-Guided Fine Needle Aspiration to Endobronchial Ultrasound-Guided Transbronchial Needle Aspiration in the Evaluation of Lung Cancer: a Systematic Review and Meta-Analysis

Lee J, Song JU. J Thorac Dis. 2024 Aug 31;16(8):5063-5072. doi: 10.21037/jtd-24-721. Epub 2024 Aug 12. PMID: 39268141.

Abstract

Background: Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) and endoscopic ultrasound with bronchoscope-guided fine needle aspiration (EUS-B-FNA) are minimally invasive procedures for the diagnosis and staging of lung cancer. This study aimed to investigate the additional diagnostic value of EUS-B-FNA following EBUS-TBNA.

Conclusions: In pooled estimates, the addition of EUS-B-FNA to EBUS-TBNA increased the diagnostic yield for the diagnosis and staging of lung cancer. Nodal station 4L, station 5, and station 8 were lesions frequently diagnosed by the addition of EUS-B-FNA. Because of statistical between-study heterogeneity, our findings should be interpreted with caution.

29

Development of the Korean Association for Lung Cancer Clinical Practice Guidelines: Recommendations on Radial Probe Endobronchial Ultrasound for Diagnosing Lung Cancer – An Updated Meta-Analysis

Kim K, Kim SH, Chung HS, Kim J, Kim MH, Lee MK, Kim I, Eom JS. Cancer Res Treat. 2024 Apr;56(2):464-483. doi: 10.4143/crt.2023.749. Epub 2023 Nov 29. PMID: 38037321.

Abstract

Purpose: Radial probe endobronchial ultrasound (RP-EBUS) accurately locates peripheral lung lesions (PLLs) during transbronchial biopsy (TBB). We performed an updated meta-analysis of the diagnostic yield of TBB for PLLs using RP-EBUS to generate recommendations for the development of the Korean Association of Lung Cancer guidelines.

Conclusion: Our study showed that TBB with RP-EBUS is an accurate diagnostic tool for PLLs with good safety profiles, especially for PLLs with within orientation on RP-EBUS or positive CT bronchus sign.



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30 CT-Based Radiomics for Predicting Ki-67 Expression in Lung Cancer: a Systematic Review and Meta-Analysis

Luo X, Zheng R, Zhang J, He J, Luo W, Jiang Z, Li Q. *Front Oncol.* 2024 Feb 7;14:1329801. doi: 10.3389/fonc.2024.1329801. eCollection 2024. PMID: 38384802.

Abstract

Background: Radiomics, an emerging field, presents a promising avenue for the accurate prediction of biomarkers in different solid cancers. Lung cancer remains a significant global health challenge, contributing substantially to cancer-related mortality. Accurate assessment of Ki-67, a marker reflecting cellular proliferation, is crucial for evaluating tumor aggressiveness and treatment responsiveness, particularly in non-small cell lung cancer (NSCLC).

Conclusion: In summary, CT-based radiomics exhibit promise in predicting Ki-67 expression in lung cancer. While the results suggest potential clinical utility, additional research efforts should concentrate on enhancing diagnostic accuracy. This could pave the way for the integration of radiomics methods as a less invasive alternative to current procedures like biopsy and surgery in the assessment of Ki-67 expression.

31 Predictive Value of (18)F-FDG PET/CT Radiomics for EGFR Mutation Status in Non-Small Cell Lung Cancer: a Systematic Review and Meta-Analysis

Ma N, Yang W, Wang Q, Cui C, Hu Y, Wu Z. *Front Oncol.* 2024 Feb 1;14:1281572. doi: 10.3389/fonc.2024.1281572. eCollection 2024. PMID: 38361781.

Abstract

Objective: This study aimed to evaluate the value of 18F-FDG PET/CT radiomics in predicting EGFR gene mutations in non-small cell lung cancer by meta-analysis. **Conclusion:** 18F-FDG PET/CT radiomics may be useful in predicting mutation status of the EGFR gene in non-small cell lung cancer.

32 PET Radiomics and Response to Immunotherapy in Lung Cancer: A Systematic Review of the Literature

Evangelista L, Fiz F, Laudicella R, Bianconi F, Castello A, Guglielmo P, Liberini V, Manco L, Frantellizzi V, Giordano A, Urso L, Panareo S, Palumbo B, Filippi L. *Cancers (Basel).* 2023 Jun 20;15(12):3258. doi: 10.3390/cancers15123258. PMID: 37370869. Review.

Abstract

The aim of this review is to provide a comprehensive overview of the existing literature concerning the applications of positron emission tomography (PET) radiomics in lung cancer patient candidates or those undergoing immunotherapy.

Conclusions: Radiomics is promising for the evaluation of TME and for the prediction of response to immunotherapy, but some limitations should be overcome.



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33 Systematic Review, Meta-Analysis and Radiomics Quality Score Assessment of CT Radiomics-Based Models Predicting Tumor EGFR Mutation Status in Patients with Non-Small-Cell Lung Cancer

Felfli M, Liu Y, Zerka F, Voyton C, Thinnas A, Jacques S, Iannessi A, Bodard S. *Int J Mol Sci.* 2023 Jul 14;24(14):11433. doi: 10.3390/ijms241411433. PMID: 37511192. Review.

Abstract

Assessment of the quality and current performance of computed tomography (CT) radiomics-based models in predicting epidermal growth factor receptor (EGFR) mutation status in patients with non-small-cell lung carcinoma (NSCLC). Two medical literature databases were systematically searched, and articles presenting original studies on CT radiomics-based models for predicting EGFR mutation status were retrieved. Forest plots and related statistical tests were performed to summarize the model performance and inter-study heterogeneity. The methodological quality of the selected studies was assessed via the Radiomics Quality Score (RQS). The performance of the models was evaluated using the area under the curve (ROC AUC). The range of the Risk RQS across the selected articles varied from 11 to 24, indicating a notable heterogeneity in the quality and methodology of the included studies. The average score was 15.25, which accounted for 42.34% of the maximum possible score. The pooled Area Under the Curve (AUC) value was 0.801, indicating the accuracy of CT radiomics-based models in predicting the EGFR mutation status. CT radiomics-based models show promising results as non-invasive alternatives for predicting EGFR mutation status in NSCLC patients. However, the quality of the studies using CT radiomics-based models varies widely, and further harmonization and prospective validation are needed before the generalization of these models.

34 Additional Value of PET and CT Image-Based Features in the Detection of Occult Lymph Node Metastases in Lung Cancer: A Systematic Review of the Literature

Guglielmo P, Marturano F, Bettinelli A, Sepulcri M, Pasello G, Gregianin M, Paiusco M, Evangelista L. *Diagnostics (Basel).* 2023 Jun 23;13(13):2153. doi: 10.3390/diagnostics13132153. PMID: 37443547. Review.

Abstract

Lung cancer represents the second most common malignancy worldwide and lymph node (LN) involvement serves as a crucial prognostic factor for tailoring treatment approaches. Invasive methods, such as mediastinoscopy and endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA), are employed for preoperative LN staging. Among the preoperative non-invasive diagnostic methods, computed tomography (CT) and, recently, positron emission tomography (PET)/CT with fluorine-18-fluorodeoxyglucose ([18F]FDG) are routinely recommended by several guidelines; however, they can both miss pathologically proven LN metastases, with an incidence up to 26% for patients staged with [18F]FDG PET/CT. These undetected metastases, known as occult LN metastases (OLMs), are usually cases of micro-metastasis or small LN metastasis (shortest radius below 10 mm). Hence, it is crucial to find novel approaches to increase their discovery rate. Radiomics is an emerging field that seeks to uncover and quantify the concealed information present in biomedical images by utilising machine or deep learning approaches. The extracted features can be integrated into predictive models, as numerous reports have emphasised their usefulness in the staging of lung cancer. However, there is a paucity of studies examining the detection of OLMs using quantitative features derived from images. Hence, the objective of this review was to investigate the potential application of PET- and/or CT-derived quantitative radiomic features for the identification of OLMs.



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Can Quantitative Peritumoral CT Radiomics Features Predict the Prognosis of Patients with Non-Small Cell Lung Cancer? A Systematic Review

Wu L, Lou X, Kong N, Xu M, Gao C. *Eur Radiol.* 2023 Mar;33(3):2105-2117. doi: 10.1007/s00330-022-09174-8. Epub 2022 Oct 29. PMID: 36307554.

Abstract

Objectives: To provide an overarching evaluation of the value of peritumoral CT radiomics features for predicting the prognosis of non-small cell lung cancer and to assess the quality of the available studies.

Conclusions: Peritumoral radiomics features based on CT images showed promise in predicting the prognosis of NSCLC, although well-designed studies and further biological validation are still needed.

36

Thoracic Staging in Patients with Non-Small Cell Lung Cancer: A Systematic Review and Meta-Analysis on Diagnostic Accuracy of [18F]FDG PET/MRI and [18F]FDG PET/CT

Shahraki Mojahed B, Saravani K, Parooie F. *Nucl Med Rev Cent East Eur.* 2023;26(0):11-19. doi: 10.5603/NMR.a2022.0037. Epub 2022 Dec 30. PMID: 36584217.

Abstract

Background: This study aimed to evaluate the diagnostic accuracy of [18F]FDG PET/MR versus [18F]FDG PET/CT in the thoracic staging of patients with non-small cell lung cancer (NSCLS). **Conclusions:** The present meta-analysis showed that [18F]FDG PET/CT and [18F]FDG PET/MRI exhibit relatively the same performance in detecting N and T stages in patients with NSCLC. Thus, [18F]FDG PET/MRI can be a worthy alternative for [18F]FDG PET/CT in the diagnosis of advanced of NSCLC in the chest area, more specifically in N-staging, since it provides higher soft-tissue contrast. There is a need for more reliable research for comparing the diagnostic performance of these imaging techniques and various optimized [18F]FDG PET/MRI protocols.

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Prognostic Value of (18)F-FDG PET/CT in Patients with Advanced or Metastatic Non-Small-Cell Lung Cancer Treated with Immune Checkpoint Inhibitors: a Systematic Review and Meta-Analysis

Ling T, Zhang L, Peng R, Yue C, Huang L. *Front Immunol.* 2022 Nov 17;13:1014063. doi: 10.3389/fimmu.2022.1014063. eCollection 2022. PMID: 36466905.

Abstract

Purpose: This study aimed to investigate the value of 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) in predicting early immunotherapy response of immune checkpoint inhibitors (ICIs) in patients with advanced or metastatic non-small-cell lung cancer (NSCLC). **Conclusion:** Baseline MTV and TLG may have predictive value and should be prospectively studied in clinical trials. Baseline SUVmax and SUVmean may not be appropriate prognostic markers in advanced or metastatic NSCLC patients treated with ICIs.



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Clinical and CT Patterns to Predict EGFR Mutation in Patients with Non-Small Cell Lung Cancer: a Systematic Literature Review and Meta-Analysis

Ortiz AFH, Camacho TC, Vásquez AF, Del Castillo Herazo V, Neira JGA, Yepes MM, Camacho EC. *Eur J Radiol Open.* 2022 Feb 7;9:100400. doi: 10.1016/j.ejro.2022.100400. eCollection 2022. PMID: 35198656.

Abstract

Purpose: This study aims to determine if the presence of specific clinical and computed tomography (CT) patterns are associated with epidermal growth factor receptor (EGFR) mutation in patients with non-small cell lung cancer.

Conclusions: GGO, air bronchogram, vascular convergence, pleural retraction, spiculated margins, early disease stage, female gender, and non-smoking status are significant risk factors for EGFR mutation. At the same time, cavitation is a protective factor for EGFR mutation. The mathematical model built acts as a good predictor for EGFR mutation in patients with lung adenocarcinoma.

39

Prognostic Value of MTV and TLG of (18)F-FDG PET in Patients with Stage I and II Non-Small-Cell Lung Cancer: a Meta-Analysis

Wen W, Piao Y, Xu D, Li X. *Contrast Media Mol Imaging.* 2021 Nov 22;2021:7528971. doi: 10.1155/2021/7528971. eCollection 2021. PMID: 34887713. Review.

Abstract

Purpose: The present systematic literature review and meta-analysis focused on examining the significance of total lesion glycolysis (TLG) and metabolic tumor volume (MTV) in predicting the prognosis of stages I/II non-small-cell lung cancer (NSCLC) based on 18F-FDG PET parameters.

Conclusion: The present work suggests the predictive value of PET/CT among stage I and II NSCLC patients. Our results verified that stage I/II NSCLC cases with increased TLG and MTV had a higher risk of side reactions, and TLG is related to increased mortality risk.

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Can (18)F-FDG PET/CT Predict EGFR Status in Patients with Non-Small Cell Lung Cancer? A Systematic Review and Meta-Analysis

Du B, Wang S, Cui Y, Liu G, Li X, Li Y. *BMJ Open.* 2021 Jun 8;11(6):e044313. doi: 10.1136/bmjopen-2020-044313. PMID: 34103313.

Abstract

Objectives: This study aimed to explore the diagnostic significance of 18F-fluorodeoxyglucose (18F-FDG) positron emission tomography (PET)/CT for predicting the presence of epidermal growth factor receptor (EGFR) mutations in patients with non-small cell lung cancer (NSCLC).

Conclusion: Meta-analysis results showed 18F-FDG PET/CT had low pooled sensitivity and specificity. The low DOR and the likelihood ratio scatter plot indicated that 18F-FDG PET/CT should be used with caution when predicting EGFR mutations in patients with NSCLC.



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Lung Cancer Screening with Low-Dose CT in Smokers: A Systematic Review and Meta-Analysis

Hunger T, Wanka-Pail E, Brix G, Griebel J. Diagnostics (Basel). 2021 Jun 5;11(6):1040. doi: 10.3390/diagnostics11061040.PMID: 34198856. Review.

Abstract

Lung cancer continues to be one of the main causes of cancer death in Europe. Low-dose computed tomography (LDCT) has shown high potential for screening of lung cancer in smokers, most recently in two European trials. The aim of this review was to assess lung cancer screening of smokers by LDCT with respect to clinical effectiveness, radiological procedures, quality of life, and changes in smoking behavior. We searched electronic databases in April 2020 for publications of randomized controlled trials (RCT) reporting on lung cancer and overall mortality, lung cancer morbidity, and harms of LDCT screening. A meta-analysis was performed to estimate effects on mortality. Forty-three publications on 10 RCTs were included. The meta-analysis of eight studies showed a statistically significant relative reduction of lung cancer mortality of 12% in the screening group (risk ratio = 0.88; 95% CI: 0.79-0.97). Between 4% and 24% of screening-LDCT scans were classified as positive, and 84-96% of them turned out to be false positive. The risk of overdiagnosis was estimated between 19% and 69% of diagnosed lung cancers. Lung cancer screening can reduce disease-specific mortality in (former) smokers when stringent requirements and quality standards for performance are met.

42

Current Progress and Quality of Radiomic Studies for Predicting EGFR Mutation in Patients With Non-Small Cell Lung Cancer Using PET/CT Images: a Systematic Review

Abdurixiti M, Nijjati M, Shen R, Ya Q, Abuduxiku N, Nijjati M. Br J Radiol. 2021 Jun 1;94(1122):20201272. doi: 10.1259/bjr.20201272. Epub 2021 May 12. PMID: 33882244.

Abstract

Objectives: To assess the methodological quality of radiomic studies based on positron emission tomography/computed tomography (PET/CT) images predicting epidermal growth factor receptor (EGFR) mutation status in patients with non-small cell lung cancer (NSCLC).

Conclusions: The PET/CT-based radiomics signature could serve as a diagnostic indicator of EGFR mutation status in NSCLC patients. However, the current conclusions should be interpreted with care due to the suboptimal quality of the studies. Consensus for standardization of PET/CT-based radiomic workflow for EGFR mutation status in NSCLC patients is warranted to further improve research.

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Screening Smokers for Lung Cancer with Low-Dose CT Decreases Lung Cancer Mortality

Barry HC. Am Fam Physician. 2021 May 15;103(10):630.PMID: 33983004. No abstract available.