Acta Biomed 2020; Vol. 91, Supplement 8: 34-42 DOI: 10.23750/abm.v91i8-S.9971

Review

Extranodal lymphomas: a pictorial review for CT and MRI classification

Alfonso Reginelli[1], Fabrizio Urraro[1], Angelo Sangiovanni[1], Gaetano Maria Russo[1], Carolina Russo[1], Roberta Grassi[1], Andrea Agostini[2], Maria Paola Belfiore[1], Michaela Cellina[3], Chiara Floridi[2], Andrea Giovagnoni[2], Antonello Sica[4], Salvatore Cappabianca[1]

[1] Department of Precision Medicine, University of Campania Luigi Vanvitelli, Naples, Italy; [2] Department of Clinical, Special and Dental Sciences, University Politecnica delle Marche, Ancona, AN, Italy; [3] Department of Radiology, Ospedale Fatebenefratelli, ASST Fatebenefratelli Sacco, Milan, Italy; [4] Oncology and Hematology Unit, Department of Precision Medicine, University of Campania; "Luigi Vanvitelli", Naples, Italy

Summary. Extranodal lymphomas represent an extranodal location of both non-Hodgkin and Hodgkin lymphomas. This study aims to evaluate the role of CT and MRI in the assessment of relationships of extranodal lymphomas with surrounding tissues and in the characterization of the lesion. We selected and reviewed ten recent studies among the most recent ones present in literature exclusively about CT and MRI imaging of extranodal lymphomas. Contrast-enhanced computed tomography (CT) is usually the first-line imaging modality in the evaluation of extranodal lymphomas, according to Lugano classification. However, MRI has a crucial role thanks to the superior soft-tissue contrast resolution, particularly in the anatomical region as head and neck. (www.actabiomedica.it)

Keywords: Extranodal lymphomas, Computed Tomography, Magnetic Resonance Imaging.

Introduction

Lymphoma is a neoplastic proliferation of lymphoid cells in lymph nodes and lymphatic tissues primarily, with bone marrow, spleen, and thymus involvement in many cases (1). In addition to lymphoid organs and tissues, lymphomas can have an extranodal location, with or without contextual nodal involvement (2). This presentation can be primitive or secondary to hematogenous spread from nodal site to extranodal site (3). The extranodal engagement occurred more frequently for non-Hodgkin lymphomas (NHL, 25-40%) than for Hodgkin lymphomas (HL, 1%). Approximately one-third of non-Hodgkin lymphomas (NHL) arise from sites other than lymph nodes, spleen, or the bone marrow (4). The median age at diagnosis for patients with NHL is 67.2 years; however, because of AIDS and organ transplantation increase, lymphoma may become more prevalent in middle-aged patients (5). The most common types of extranodal lymphomas (ENL) are diffuse large B-cell lymphoma (DLBCL) and Malt lymphoma (6).

In 43% of cases, extranodal involvement is localized in the gastrointestinal tract, followed by head and neck with 14% of cases, lung (2%), skin (7%), bone (5%), and brain (6-7%) (7). The head and neck localization represent the second most common malignant neoplasm of these anatomical regions, involving nodal and extranodal sites or both (8, 9), and Waldayer's ring is most frequently involved (10).

Diagnosis and accurate localization and staging are fundamental to choosing the best treatment strategy (11); to this end, PET/CT role has become increasingly important in recent years (12, 13) thanks to the ability to identify metabolically active tumors. At the same time, as regards ENLs and the relationships that lesions contract with surrounding tissues and organs, an accurate morphological characterization is essential, therefore the use of methods such as CT and MRI for the study of these pathologies and many

others remains fundamental. Cross-sectional imaging (MRI, CT and US) techniques gained large application in radiology; in the setting of inflammatory and oncological diseases, they are advised as techniques in the diagnosis, staging and follow-up (14-20).

The purpose of our study was to illustrate, with a pictorial review based on our case studies, typical characteristics of extranodal lymphomas found with CT and MRI, site by site.

Role of Imaging

Contrast-enhanced computed tomography (CT) is usually the first-line imaging modality for newly diagnosed neck masses to determine lesion extent and bony involvement, according to Lugano classification (21). CT diagnostic criteria for characterizing ENL include two diameters measurement (longest and shortest diameter) (22), although an interobserver variation up to 15% was observed, caused by lesions irregularity or an inferior lesion to background contrast (23). Intravenous contrast medium is fundamental, and an optimal bowel opacification is necessary for abdomen evaluation (22). ENL in CT images is reported in **Figures 1 and 2**.

Magnetic resonance imaging (MRI) provides more excellent soft-tissue contrast. It is crucial in accurately determining invasion of sophisticated anatomical planes and skull base, besides evaluating spinal or intracranial extension (**Figures 3 and 4**). Generally, the soft-tissue contrast resolution of MRI is superior to that of CT; however, ENLs MRI in the detailed region as head and neck, have been reported to show variable homogeneity and signal intensity of tumor on both T1WIs and T2WIs (24). After intravenous contrast medium administration, ENL lesions have homogeneous diffuse enhancement, predominantly peripheral thick band-like enhancement and marginal septal enhancement in 68%, 21%, and 11%, respectively, as shown by Chun et al. (25). CT and MRI play a crucial role in clinical staging, assessment of prognosis, and treatment planning for ENLs and other various pathologies (26-33).

ENLs should be in the imaging differential of any soft tissue mass showing (10): imaging homoge-

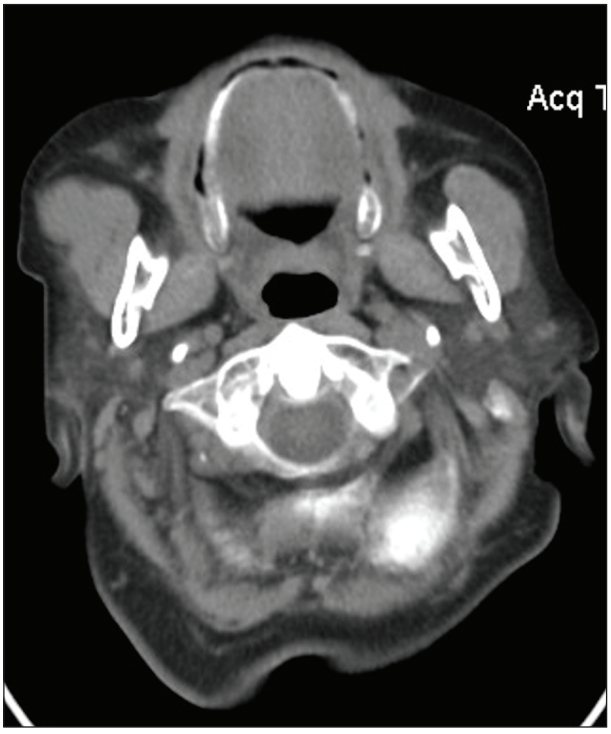

Figure 1. CT shows a rounded lesion at the level of the anterior margin of the right maxillary muscle

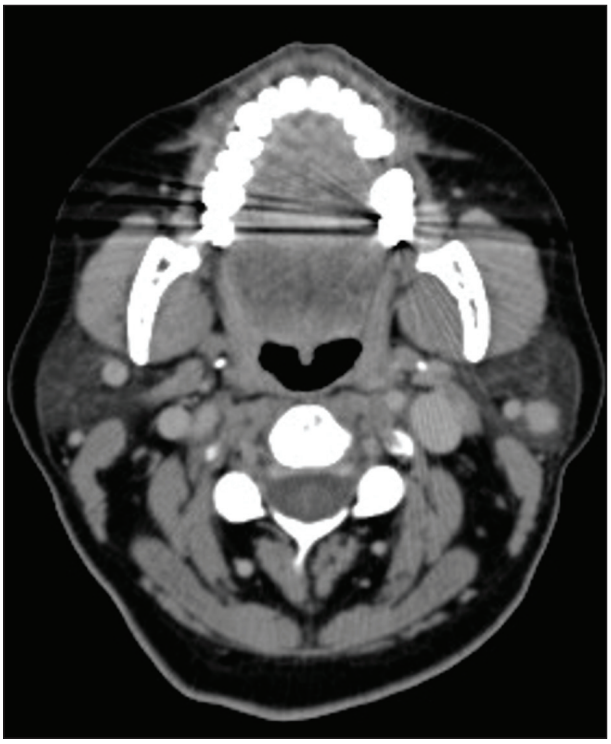

Figure 2. CECT shows a rounded lesion at the level of left parotid gland with inhomogeneus ce and shaded margins

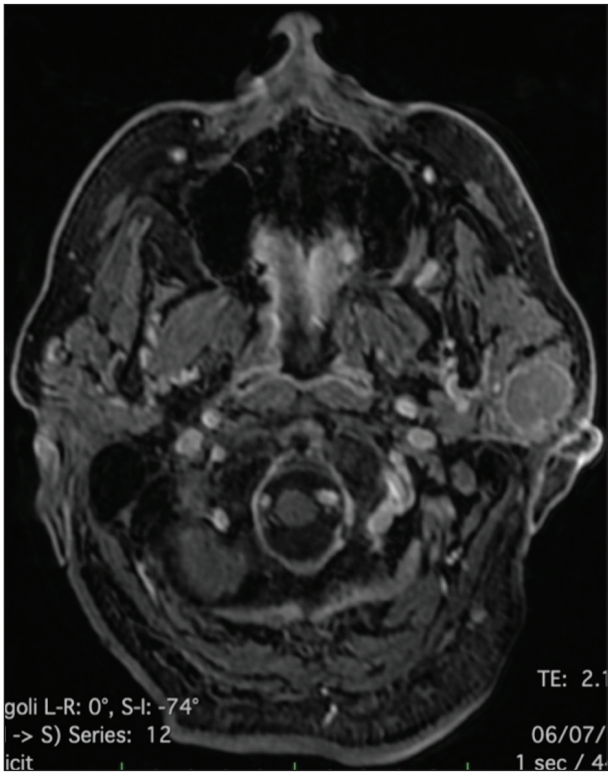

Figure 3. MRI with contrast enhancment show rounded nodular lesion in the context of the left parotid gland with shaded margins and peripheral enhancement.

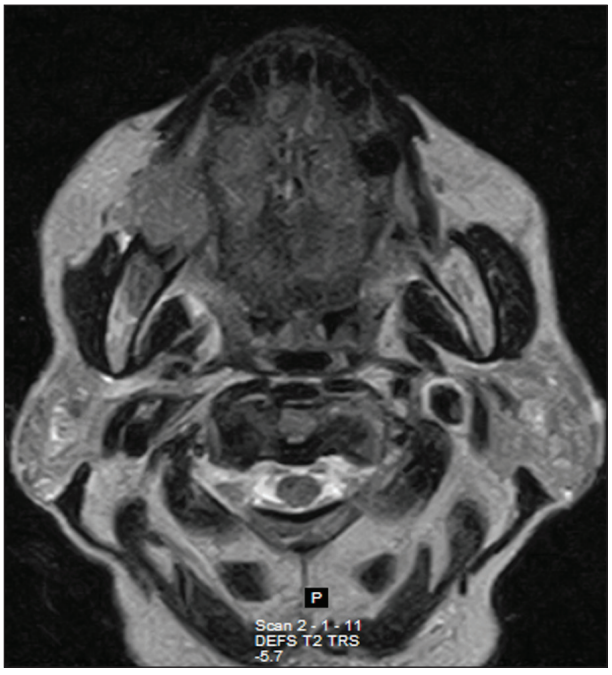

Figure 4. MRI T2w with nodular solid lesion right mandibula inhomogeneously hypointense with lobulated margins.

nous attenuation or signal; absence of calcification; hemorrhage or significant necrosis or cystic changes; the intermediate-to-low signal on fluid-sensitive MRI sequences, and marked diffusion restriction (hypercellular nature of the mass); encasement of vessels without luminal compression and moderate to intense homogenous enhancement. Whatever organs are involved by ENL, these lesions show standard features that suggest diagnosis and indicated that biopsy samples should be taken, avoiding unnecessary surgery, as in many others tumors (34). For this reason, imaging has a vital role in direct diagnosis trough imaging-guided biopsy, with accuracy at around 90% (35).

Head and neck

Lymphomas arising in the head and neck area constitute the second most frequent extranodal site after the gastrointestinal tract (36). Hereafter we will analyze ENLs characteristics in the individual subsites.

Waldeyer's ring

Waldeyer's ring is the most common site where the extranodal disease occurs in head and neck lymphomas. Together with the paranasal sinuses and the nasal cavity, Waldeyer's ring is the most frequently extranodal sites involved. More often, there are more sections of involvement within the ring, and their appearance can identify the extranodal lesions; in fact, Waldeyer's ring looks like squamous carcinoma (37). In MRI, the classical imaging appearance of the EHNLs in the Waldeyer's ring is a well-demarcated mass that shows the T2w intermediate signal conformed to space/surrounding structures with a smooth interface in contrast to epithelial malignancies. T1w shows an isointense signal, and the enhancement is homogenous (10, 38, 39). The margins are sharply demarcated also in the invasion of the adjacent spaces. Multiple subsite involvement is frequently, such as the lack of skull base destruction and unilateral or bilateral non-necrotic lymphadenopathy (40). In order of frequency, the common subsites of Waldayer's ring are (38): palatine tonsils, nasopharyngeal tonsil (or adenoids), lingual tonsils; most Waldeyer's ring lymphomas are of B-Cell

origin, and more than half occur in the palatine tonsil (41, 42). Symptoms are similar to squamous cell carcinoma in these locations. Still, on clinical inspection, the EHNLs is not ulcerated mucosal masses like in the squamous cell carcinoma, and they appear mostly submucosal (43). Clinical symptoms depending on the area involved: f.e., sore throat or tonsillar swelling are present in tonsils involving; nasal obstruction, cervical mass, obstruction of Eustachian tube with decreased hearing in nasopharyngeal tonsil (40); foreign body sensation in lingual tonsils. EHNLs of Waldeyer's ring is associated with gastric disease in 10 percent of patients (43). The appearance of Waldeyer's ring ENLs is shown in **Figure 5**.

Sinonasal region

Sinonasal lymphomas are very rare; they affect less than 1 percent of all malignant tumors of the head and neck and are mainly non-Hodgkin lymphomas (44).

They are divided into two groups that have different symptoms, prognosis, and treatment: B-cell lymphomas, more frequent, less aggressive but with better prognosis; T/NK cell lymphomas: rarer but most found in the nasal cavity (45).

Regarding symptoms, high-grade lymphomas are aggressive with a non-healing ulcer, pain, cranial nerve manifestations, facial swelling, and epistaxis. Low-grade lymphomas present with a sinonasal mass associated with obstructive symptoms, meanwhile high-grade diffuse large B-cell tumors are used to present with bone or soft tissue destruction; T-cell lymphomas are associated with perforation or damage of the nasal septum (44, 46).

In imaging, they are bulky masses with intermediate signal intensity on MRI with moderate contrast improvement. ENL is presented as a destructive soft tissue mass that can mimic squamous cell carcinoma but tends to be more homogeneous in T2 imaging with less intense carcinoma enhancement. Although the areas of development are different, lymphomas are more frequent in the nasal cavity or the maxillary sinus, and the lesions can reshape or erode adjacent bones. Sites like frontal or sphenoid sinuses or the ethmoid are infrequent (47) (**Figure 6)**.

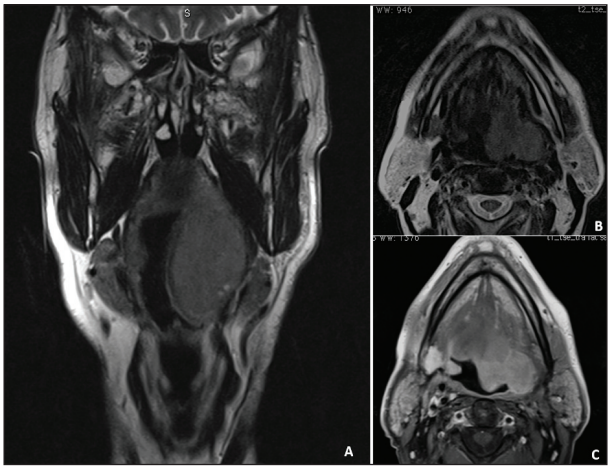

Figure 5. (a-b) Waldeyer's ring lesion. MRI T2w. Nodular capsulated solid lesion in the left parapharyngeal space with reduction of the pharyngeal airspace. (c) After i.v administration the lesion show midly inhomogeneous enhancement.

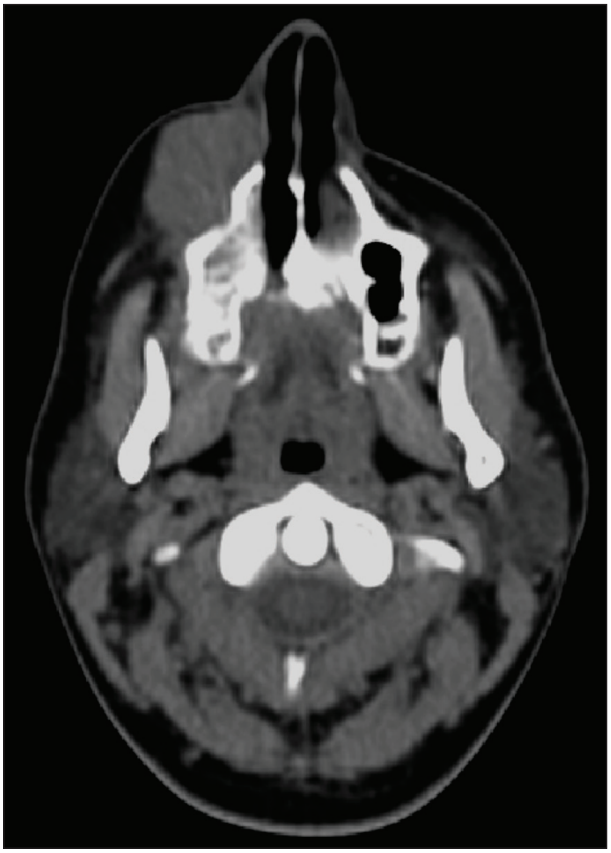

Figure 6. CT of a bulky masses inhomogeneous hypodensity. The CT show a destructive soft tissue mass can mimic squamous cell carcinoma.

Thyroid

Primary thyroid lymphoma is a rare tumor accounting for 1 to 5% of all thyroid malignancies and approximately 2% of all malignant extranodal lymphomas (48). Pure thyroid MALT lymphomas comprise about 6 to 28% of primary thyroid lymphomas and are recognized as extranodal marginal zone B-cell lymphomas (49, 50). Thyroid lymphoma is a rare pathology associated with about 80 % by cases with Hashimoto thyroiditis and more frequent in women, especially between 70 and 80 years (51, 52). The most frequent sign is a palpable mass with neck enlargement, but patients may also present a cold thyroid nodule or symptoms as dysphagia, hoarseness, and suffocation. Primary thyroid lymphoma can be confused radiologically with anaplastic thyroid carcinoma; however, these lesions are characterized by typical features, classified into three types detectable in CT and MRI exams (53):

- type 1 is a solitary nodule surrounded by healthy thyroid tissue, which rapidly enlarges the mass by imitating anaplastic thyroid carcinoma or other aggressive carcinomas;
- type 2 consists of several thyroid nodules that mimic the goiter;
- type 3 shows a homogeneous enlargement of both thyroid lobes with reduced attenuation, with or without peripheral hyper-attenuating thyroid tissue.

A difference between thyroid lymphoma and carcinoma is the presence on transverse imaging of a more homogeneous signal, whereas the lack of calcification, cystic degeneration, or necrosis distinguishes it from goiter (52).

Tongue

Extranodal lymphomas of the tongue are a very rare disease. The alterations are identifiable with the physical examination, while MRI is useful for defining exact disease extension.

Salivary gland

Primary salivary gland lymphoma represents 2-5% of all salivary gland neoplasms, involving parotid gland (70%) and submandibular gland more frequently (54). The diagnosis of primary lymphomatous involvement of the parotid gland requires that three criteria must be fulfilled: involvement of organ is the first disease manifestation; disease must involve gland parenchyma and not adjacent nodes; lymphoid infiltrate is malignant (55). For instrumental diagnosis, CECT should be performed from skull base to clavicles for intraparotid lesions to evaluate the extent of cervical disease fully. In the case of NHL clinical suspicion, special attention must be paid as they may be isodense and, therefore, invisible in CECT. If MRI performed, T2 MR, FS, or STIR make intraparotid lesions more conspicuous; a single unilateral mass of relative soft-tissue homogeneity with a poorly defined margin was thought to be the most common sign of a parotid lymphoma (56). Diffusion-weighted imaging is beneficial in unusual cases with shallow apparent diffusion coefficient values.

Cranial vault and skull base

THE primary NHL of calvarial bones is extremely rare. If present, initial symptoms, and signs usually include painless scalp nodules, headaches, convulsions, or focal neurological deficits, also not to be forgotten as a complication is cerebrospinal fluid diffusion. In the imaging findings of the cranial vault, lymphoma may be present cerebral infiltration and orbital involvement (57, 58). Even though CT is superior to assess cortical bony destruction, MRI allows for better soft tissue characterization, the extent of involvement, and marrow infiltration. Although MRI cannot diagnose lymphoma with certainty, its inclusion in the differential can be critical, since the surgical approach can be very different.

In the skull base, ENLs mainly involve clivus, and principal CT is permeative bony destruction. Other less common imaging features include destructive lytic pattern, sclerosis, or bone expansion beyond cortex, or "traversing" bone lesion with preserved cancellous bone and minimal attenuation of the cortex. Typically, the injury is often isointense to the gray matter on T1WI and intermediate signal on T2WI.

Acknoledgements

Thanks to the Research Program "Valere" supported by the University of Campania "L.Vanvitelli."

Conflict of interest: Authors declare that they have no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

References

1. Guermazi A, Brice P, de Kerviler EE, et al. Extranodal Hodgkin disease: spectrum of disease. Radiographics : a review publication of the Radiological Society of North America, Inc 2001; 21: 161-79.
2. Gurney KA, Cartwright RA. Increasing incidence and descriptive epidemiology of extranodal non-Hodgkin lymphoma in parts of England and Wales. The hematology journal : the official journal of the European Haematology Association 2002; 3: 95-104.
3. Even-Sapir E, Lievshitz G, Perry C, Herishanu Y, Lerman H, Metser U. Fluorine-18 fluorodeoxyglucose PET/CT patterns of extranodal involvement in patients with Non -Hodgkin lymphoma and Hodgkin's disease. Radiologic clinics of North America 2007; 45: 697-709, vii.
4. Groves FD, Linet MS, Travis LB, Devesa SS. Cancer surveillance series: non-Hodgkin's lymphoma incidence by histologic subtype in the United States from 1978 through 1995. Journal of the National Cancer Institute 2000; 92: 1240-51.
5. Zucca E, Conconi A, Cavalli F. Treatment of extranodal lymphomas. Best practice & research. Clinical haematology 2002; 15: 533-47.
6. Vannata B, Zucca E. Primary extranodal B-cell lymphoma: current concepts and treatment strategies. Chinese clinical oncology 2015; 4: 10.
7. Paes FM, Kalkanis DG, Sideras PA, Serafini AN. FDG PET/CT of extranodal involvement in non-Hodgkin lymphoma and Hodgkin disease. Radiographics : a review publication of the Radiological Society of North America, Inc 2010; 30: 269-91.
8. Thomas AG, Vaidhyanath R, Kirke R, Rajesh A. Extranodal lymphoma from head to toe: part 1, the head and spine. AJR. American journal of roentgenology 2011; 197: 350-6.
9. Urquhart A, Berg R. Hodgkin's and non-Hodgkin's lymphoma of the head and neck. The Laryngoscope 2001; 111: 1565-9.
10. Watal P, Bathla G, Thaker S, Sato TS, Moritani T, Smoker WRK. Multimodality Imaging Spectrum of the Extranodal Lymphomas in the Head and Neck-A Pictorial Review. Current problems in diagnostic radiology 2018; 47: 340-352.
11. Glass AG, Karnell LH, Menck HR. The National Cancer Data Base report on non-Hodgkin's lymphoma. Cancer 1997; 80: 2311-20.
12. Kostakoglu L, Goldsmith SJ. Fluorine-18 fluorodeoxyglucose positron emission tomography in the staging and follow- up of lymphoma: is it time to shift gears? European journal of nuclear medicine 2000; 27: 1564-78.
13. Das J, Ray S, Sen S, Chandy M. Extranodal involvement in lymphoma - A Pictorial Essay and Retrospective Analysis of 281 PET/CT studies. Asia Oceania journal of nuclear medicine & biology 2014; 2: 42-56.
14. Agliata G, Schicchi N, Agostini A, et al. Radiation exposure related to cardiovascular CT examination: comparison between conventional 64-MDCT and third-generation dual-source MDCT. La Radiologia medica 2019; 124: 753-761.
15. Floridi C, Radaelli A, Pesapane F, et al. Clinical impact of cone beam computed tomography on iterative treatment planning during ultrasound-guided percutaneous ablation of liver malignancies. Medical oncology (Northwood, London, England) 2017; 34: 113.
16. Agostini A, Kircher MF, Do R, et al. Magnetic Resonance Imaging of the Liver (Including Biliary Contrast Agents) Part 1: Technical Considerations and Contrast Materials. Seminars in roentgenology 2016; 51: 308-316.
17. Panfili E, Nicolini D, Polverini V, Agostini A, Vivarelli M, Giovagnoni A. Importance of radiological detection of early pulmonary acute complications of liver transplantation: analysis of 259 cases. La Radiologia medica 2015; 120: 413-20.
18. Agostini A, Mari A, Lanza C, et al. Trends in radiation dose and image quality for pediatric patients with a multidetector CT and a third-generation dual-source dual-energy CT. La Radiologia medica 2019; 124: 745-752.
19. Agostini A, Kircher MF, Do RK, et al. Magnetic Resonanance Imaging of the Liver (Including Biliary Contrast Agents)-Part 2: Protocols for Liver Magnetic Resonanance Imaging and Characterization of Common Focal Liver Lesions. Seminars in roentgenology 2016; 51: 317-333.
20. Paolicchi F, Bastiani L, Guido D, Dore A, Aringhieri G, Caramella D. Radiation dose exposure in patients affected by lymphoma undergoing repeat CT examinations: how to manage the radiation dose variability. La Radiologia medica 2018; 123: 191-201.
21. Cheson BD, Fisher RI, Barrington SF, et al. Recommendations for initial evaluation, staging, and response assessment of Hodgkin and non-Hodgkin lymphoma: the Lugano classification. Journal of clinical oncology : official journal of the American Society of Clinical Oncology 2014; 32: 3059-68.
22. Regacini R, Puchnick A, Luisi FAV, Lederman HM. Can diffusion-weighted whole-body MRI replace contrast-enhanced CT for initial staging of Hodgkin lymphoma in children and adolescents? Pediatric radiology 2018; 48: 638-647.
23. Hopper KD, Kasales CJ, Van Slyke MA, Schwartz TA, TenHave TR, Jozefiak JA. Analysis of interobserver and intraobserver variability in CT tumor measurements. AJR. American journal of roentgenology 1996; 167: 851-4.
24. Matsuzaki H, Hara M, Yanagi Y, et al. Magnetic resonance imaging (MRI) and dynamic MRI evaluation of extranodal non-Hodgkin lymphoma in oral and maxillofacial regions. Oral surgery, oral medicine, oral pathology and oral radiology 2012; 113: 126-133.
25. Chun CW, Jee WH, Park HJ, et al. MRI features of skeletal

muscle lymphoma. AJR. American journal of roentgenology 2010; 195: 1355-60.
26. Muccio CF, Di Blasi A, Esposito G, Brunese L, D'Arco F, Caranci F. Perfusion and spectroscopy magnetic resonance imaging in a case of lymphocytic vasculitis mimicking brain tumor. Polish journal of radiology 2013; 78: 66-9.
27. Cozzi D, Dini C, Mungai F, Puccini B, Rigacci L, Miele V. Primary pulmonary lymphoma: imaging findings in 30 cases. La Radiologia medica 2019; 124: 1262-1269.
28. Marampon F, Gravina GL, Popov VM, et al. Close correlation between MEK/ERK and Aurora-B signaling pathways in sustaining tumorigenic potential and radioresistance of gynecological cancer cell lines. International journal of oncology 2014; 44: 285-94.
29. d'Amuri FV, Maestroni U, Pagnini F, et al. Magnetic resonance imaging of adrenal gland: state of the art. Gland surgery 2019; 8: S223-s232.
30. Bevilacqua A, D'Amuri FV, Pagnini F, et al. Percutaneous needle biopsy of retroperitoneal lesions: technical developments. Acta bio-medica : Atenei Parmensis 2019; 90: 62-67.
31. D'Amico G, Di Crescenzo V, Muto M, et al. Cytological diagnosis of limph nodes by instrumental guide: Ultrasonography and CT. Recenti progressi in medicina 2013; 104: 367-370.
32. Cipriani P, Di Benedetto P, Ruscitti P, et al. Perivascular Cells in Diffuse Cutaneous Systemic Sclerosis Overexpress Activated ADAM12 and Are Involved in Myofibroblast Transdifferentiation and Development of Fibrosis. J Rheumatol 2016; 43: 1340-9.
33. Giacomelli R, Liakouli V, Berardicurti O, et al. Interstitial lung disease in systemic sclerosis: current and future treatment. Rheumatology international 2017; 37: 853-863.
34. Frampas E. Lymphomas: Basic points that radiologists should know. Diagnostic and interventional imaging 2013; 94: 131-44.
35. Hesselmann V, Zahringer M, Krug B, et al. Computed-tomography- guided percutaneous core needle biopsies of suspected malignant lymphomas: impact of biopsy, lesion, and patient parameters on diagnostic yield. Acta radiologica (Stockholm, Sweden : 1987) 2004; 45: 641-5.
36. Frata P, Buglione M, Grisanti S, et al. Localized Extranodal Lymphoma of the Head and Neck: Retrospective Analysis of a Series of 107 Patients from a Single Institution. Tumori 2005; 91: 456-62.
37. Lee YY, Van Tassel P, Nauert C, North LB, Jing BS. Lymphomas of the head and neck: CT findings at initial presentation. AJR. American journal of roentgenology 1987; 149: 575-81.
38. Aiken AH, Glastonbury C. Imaging Hodgkin and non -Hodgkin lymphoma in the head and neck. Radiologic clinics of North America 2008; 46: 363-78, ix-x.
39. Kato H, Kanematsu M, Kawaguchi S, Watanabe H, Mizuta K, Aoki M. Evaluation of imaging findings differentiating extranodal non-Hodgkin's lymphoma from squamous cell carcinoma in naso- and oropharynx. Clinical imaging 2013; 37: 657-63.
40. King AD, Lei KI, Richards PS, Ahuja AT. Non-Hodgkin's lymphoma of the nasopharynx: CT and MR imaging. Clinical radiology 2003; 58: 621-5.
41. Nayak LM, Deschler DG. Lymphomas. Otolaryngologic clinics of North America 2003; 36: 625-46.
42. Yuen A, Jacobs C. Lymphomas of the head and neck. Seminars in oncology 1999; 26: 338-45.
43. Aviles A, Delgado S, Ruiz H, de la Torre A, Guzman R, Talavera A. Treatment of non-Hodgkin's lymphoma of Waldeyer's ring: radiotherapy versus chemotherapy versus combined therapy. European journal of cancer. Part B, Oral oncology 1996; 32b: 19-23.
44. Abbondanzo SL, Wenig BM. Non-Hodgkin's lymphoma of the sinonasal tract. A clinicopathologic and immunophenotypic study of 120 cases. Cancer 1995; 75: 1281-91.
45. Van Prooyen Keyzer S, Eloy P, Delos M, Doyen C, Bertrand B, Rombaux P. Sinonasal lymphomas. Case report. Acta oto-rhino-laryngologica Belgica 2000; 54: 45-51.
46. Yasumoto M, Taura S, Shibuya H, Honda M. Primary malignant lymphoma of the maxillary sinus: CT and MRI. Neuroradiology 2000; 42: 285-9.
47. Das S, Kirsch CF. Imaging of lumps and bumps in the nose: a review of sinonasal tumours. Cancer imaging : the official publication of the International Cancer Imaging Society 2005; 5: 167-77.
48. Pedersen RK, Pedersen NT. Primary non-Hodgkin's lym phoma of the thyroid gland: a population based study. Histopathology 1996; 28: 25-32.
49. Jaffe ES, Harris NL, Diebold J, Muller-Hermelink HK. World Health Organization classification of neoplastic diseases of the hematopoietic and lymphoid tissues. A progress report. American journal of clinical pathology 1999; 111: S8-12.
50. Thieblemont C, Mayer A, Dumontet C, et al. Primary thyroid lymphoma is a heterogeneous disease. The Journal of clinical endocrinology and metabolism 2002; 87: 105-11.
51. Kim HC, Han MH, Kim KH, et al. Primary thyroid lymphoma: CT findings. European journal of radiology 2003; 46: 233-9.
52. Widder S, Pasieka JL. Primary thyroid lymphomas. Current treatment options in oncology 2004; 5: 307-13.
53. Matsuzuka F, Miyauchi A, Katayama S, et al. Clinical aspects of primary thyroid lymphoma: diagnosis and treatment based on our experience of 119 cases. Thyroid : official journal of the American Thyroid Association 1993; 3: 93-9.
54. Wolvius EB, van der Valk P, van der Wal JE, et al. Primary non-Hodgkin's lymphoma of the salivary glands. An analysis of 22 cases. Journal of oral pathology & medicine : official publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology 1996; 25: 177-81.
55. Hirokawa N, Hareyama M, Akiba H, et al. Diagnosis and Treatment of Malignant Lymphoma of the Parotid Gland. Japanese Journal of Clinical Oncology 1998; 28: 245-249.
56. Zhu L, Wang P, Yang J, Yu Q. Non-Hodgkin lymphoma involving the parotid gland: CT and MR imaging findings. Dentomaxillofac Radiol 2013; 42: 20130046-20130046.

57. Kantarci M, Erdem T, Alper F, Gundogdu C, Okur A, Aktas A. Imaging characteristics of diffuse primary cutaneous B-cell lymphoma of the cranial vault with orbital and brain invasion. AJNR. American journal of neuroradiology 2003; 24: 1324-6.
58. Jamjoom AB, Jamjoom ZA, Naim Ur R, Cheema MA. Primary midline cranial vault lymphoma simulating a parasagittal meningioma: the role of angiography in preoperative diagnosis. Neurosurgical review 1998; 21: 202-5.

Received: 20 May 2020
Accepted: 10 June 2020
Correspondence:
Alfonso Reginelli
Department of Precision Medicine,
University of Campania
"L. Vanvitelli," Naples, Italy
E-mail: alfonso.reginelli@hotmail.com