

影像学方法在宫颈癌同步放化疗预后及疗效评估中的研究进展

王腾达, 王锐*

承德医学院附属医院放射科, 河北 承德

收稿日期: 2025年12月29日; 录用日期: 2026年1月23日; 发布日期: 2026年2月2日

摘要

文章旨在介绍计算机断层扫描(Computed Tomography, CT)、磁共振成像(Magnetic Resonance Imaging, MRI)、核医学技术(如PET-CT等)及影像组学对宫颈癌同步放化疗预后及疗效评估中的作用。同步放化疗是局部晚期宫颈癌(LACC)患者的首选治疗方案, 能够显著提高患者的生存率。随着医学影像技术的不断发展, 传统影像学检查方法, 如CT、MRI、US以及PET-CT等, 在宫颈癌同步放化疗预后及疗效评估中发挥了重要作用。新兴的影像组学利用人工智能对MRI影像进行定量分析, 基于从宫颈癌患者影像中提取的高通量特征, 来建立有关患者同步放化疗治疗预后及疗效评估的预测模型。多种影像学方法及影像组学联合应用形成的评估体系为宫颈癌同步放化疗预后及疗效评估提供了重要依据。

关键词

宫颈癌, 同步放化疗, 预后, 计算机断层扫描, 磁共振成像, 正电子发射断层扫描, 影像组学

Research Progress on the Use of Imaging Methods in Prognosis and Efficacy Evaluation of Concurrent Chemoradiotherapy for Cervical Cancer

Tengda Wang, Rui Wang*

Department of Radiology, Affiliated Hospital of Chengde Medical University, Chengde Hebei

*通讯作者。

文章引用: 王腾达, 王锐. 影像学方法在宫颈癌同步放化疗预后及疗效评估中的研究进展[J]. 临床医学进展, 2026, 16(2): 617-624. DOI: 10.12677/acm.2026.162431

Abstract

This article aims to introduce the role of computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine technology (such as PET-CT), and imaging omics in the prognosis and efficacy evaluation of concurrent chemoradiotherapy for cervical cancer. Concurrent chemoradiotherapy is the preferred treatment for patients with locally advanced cervical cancer (LACC), which can significantly improve the survival rate of patients. With the continuous development of medical imaging technology, traditional imaging methods such as CT, MRI, US, and PET-CT have played an important role in the prognosis and efficacy evaluation of concurrent chemoradiotherapy for cervical cancer. The emerging imaging omics uses artificial intelligence to quantitatively analyze MRI images. Based on the high-throughput features extracted from cervical cancer patients' images, it establishes a prediction model for the prognosis and efficacy evaluation of patients treated with concurrent chemoradiotherapy. The evaluation system formed by the combined application of a variety of imaging methods and imaging omics provides an important basis for the prognosis and efficacy evaluation of concurrent chemoradiotherapy for cervical cancer.

Keywords

Cervical Cancer, Concurrent Chemoradiotherapy, Prognosis, Computed Tomography, Magnetic Resonance Imaging, Positron Emission Tomography, Radiomics

Copyright © 2026 by author(s) and Hans Publishers Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

1. 引言

宫颈癌是全球女性中最常见的恶性肿瘤之一, 其发病率和死亡率在发展中国家尤其高; 在女性罹患的癌症中, 宫颈癌的全球发病率和死亡率均居第四位, 在我国发病率居第六位[1]-[3]。宫颈癌的治疗和预后评估是最具挑战的患者管理工作, 根据国际妇产科联合会(International Federation of Gynecology and Obstetrics, FIGO)分期系统, 治疗方法可选择手术、放化疗或联合手术与放化疗的综合治疗, 虽然患者生存率有所提高, 但仍有部分患者出现复发、转移等治疗失败情况, 因此对宫颈癌预后状况进行准确评估有助于优化临床治疗方案选择及随访方案的制定[4]。根据国家综合癌症网络(NCCN)指南[5], 同步放化疗(CCRT)是 LACC 患者的首选治疗方案, 完全缓解率约为 75%~90% [6]-[8]。同步放化疗作为宫颈癌的标准治疗方案之一, 能够显著提高患者的生存率。然而, 如何有效评估治疗效果和预后, 成为临床工作中的重要课题。宫颈癌预后评估主要通过临床分期、病理类型和实验室检查等手段, 其中影像学检查是临床分期评估的主要方法, 在这一过程中发挥了重要作用。常用的影像学检查方法有 CT、MRI、PET-CT、超声等; 近年来兴起的影像组学则借助计算机技术生成高维数据对临床影像图像进行全面客观量化分析[9], 可以为宫颈癌同步放化疗后的治疗效果及预后提供更多的数据支持。本文着重介绍影像学 CT、MRI 及影像组学在宫颈癌同步放化疗预后及疗效评估中的作用。

2. 影像学及影像组学技术在疗效评估中的应用

在同步放化疗后, 影像学检查可以帮助医生评估肿瘤反应情况, 包括完全缓解、部分缓解、疾病稳

定或进展。通过定期进行影像学检查, 医生可以及时调整治疗方案, 提高治疗效果。

影像学技术包括磁共振成像(MRI)、计算机断层扫描(CT)、超声波检查(US)以及正电子发射断层扫描(PET-CT)等。这些技术各有优缺点, 但在宫颈癌的治疗评估中, MRI 和 PET-CT 被广泛应用。MRI 具有优越的软组织对比度, 能够清晰显示肿瘤的大小、位置及其与周围组织的关系; 同时还可以帮助评估淋巴结转移情况。2007 年, Nam 等人[10]研究发现 MRI 评估宫颈癌放疗及同步放化疗中的肿瘤体积退缩具有预后价值, 正式开启了影像学评估宫颈癌同步放化疗预后的先例; 随后, 磁共振成像一直用于宫颈癌治疗疗效的临床评估, 并取得了非常可观的成绩及疗效, 例如 Kim 等人[11]的研究发现了动态增强扫描磁共振成像(DCE-MRI)参数有助于评估宫颈癌对同步放化疗的早期变化, 验证了该技术对疗效监测的意义; 这些研究的发现说明了 MRI 评估宫颈癌治疗成为了可能, 进一步验证了 MRI 具有优越的软组织对比度。随着研究的深入及进展, 弥散加权成像(DWI) [12]-[17]、表观弥散系数(ADC) [18]-[20]以及 DCE-MRI 技术[13] [15] [21]的应用使宫颈癌同步放化疗疗效预测更可靠; 多参数 MRI 可以提高预测性能[21], 并优于单个 MRI 参数, 且多参数 MRI 联合 CPF (临床预后因子)可进一步提高预测性能[15]。尽管多参数 MRI 的应用对宫颈癌的治疗评估简单直观且可视化, 但仅限于观察肿瘤的大小, 相较于肿瘤活性及转移情况的评估, MRI 就显示出了相对的局限性。

正电子发射断层扫描(PET-CT)结合了代谢信息和解剖结构, 能够更好地评估肿瘤的活性及转移情况。PET-CT 在判断肿瘤治疗疗效方面相较于 MRI 具有较高的敏感性, 对淋巴结转移的评估会优于 MRI。Lee 等人[22]的研究证实了同步放化疗期间 PET/CT 图像上肿瘤体积缩小幅度大于 MRI 图像; 2018 年, Su 等人[23]的研究进一步证实了 PET/CT 优于 MRI, 他的结论是对于中晚期宫颈癌根治性同步放化疗后 2~3 个月的疗效评价, 主要表现为对局部和区域残留病灶的检出; 而 PET 在检测淋巴结转移的准确性方面, 也优于 MRI 检查, 例如 Dag 等人[24]的研究发现 FDG PET/CT 检测淋巴结转移的准确性高于 MRI, 同步放化疗后 FDG PET/CT 图像上肿瘤体积缩小幅度大于 MRI 图像, 进一步验证了 PET-CT 在判断肿瘤治疗疗效方面相较于 MRI 具有较高的敏感性。治疗前 F-18 FDG PET/CT 测定的淋巴结 SUVmax 可能是预测局部晚期宫颈癌患者疾病复发的预后生物标志物[25]。肿瘤内 FDG 分布的异质性和 TLG (总糖酵解量)的早期时间变化可能是宫颈癌患者总生存期的重要预测因素[26], HF(瘤内异质性因子)联合淋巴结 SUVmax 和 WBMTV 时, 可提升肿瘤复发预测效能[27], 多参数 PET/MRI 具有更全面评估宫颈癌患者初始治疗方案疗效的潜力[28], 并且 Xu 等人[29]的研究证实了多参数 PET-IVIM MR 在宫颈癌同步放化疗疗效评估中具有最强的预测价值。这些研究使得宫颈癌同步放化疗后疗效预测更加准确, 同时还能让个性化治疗成为可能。相较于以上两种影像学方法, CT 方面对疗效的预测比较少见, Rui 等人[30]的前瞻性研究证实了 vCTP (计算机容积断层扫描灌注)参数对预测其近期疗效有一定价值, 其中低灌注亚区 AF (动脉血流)是预测宫颈癌同步放化疗疗效更有效的指标, 期待未来会有更多人投入到 CT 对宫颈癌同步放化疗疗效预测的研究中。

影像组学对于宫颈癌同步放化疗后的预测效果相较于以上研究比较少。目前已知的研究是 Zhang 等人[31]的发现, 他们的结论验证了 IVIM-DWI、基于 MRI 的影像组学和 CPF 在预测 LACC CCRT 敏感性方面具有较高的临床价值, 且联合预测效能更好, 并且该研究也证实了 DWI 序列中不同 b 值的选择对结果也有一定的影响。虽然以上研究结果比较成功, 但是该研究属于单中心、小样本研究, 并且因为扫描技术以及方法的不同, 很少会涉及多中心研究, 这也是目前缺乏多中心研究的原因之一。未来希望能有更多力量投身该领域的影像组学研究。

3. 局部晚期宫颈癌预后因素研究进展: 从临床指标到影像组学模型

局部晚期宫颈癌(LACC)是预后相对较差的类型, 接受同步放化疗(CCRT)后仍有约 1/3 的患者出现局

部复发和远处转移,无病生存率(DFS)明显下降[1],大约 20%~40%的患者最终发展为复发性疾病[32][33],复发宫颈癌患者的 5 年生存率低于 50% [34]-[36]。原发性治愈治疗后病情持续或复发的患者,由于缺乏有效的挽救性治疗,通常预后较差[37]。

复发性子宫颈癌是指在初始手术和(或)放化疗后,肿瘤再次在子宫颈、阴道等盆腔部位复发,或发生淋巴结转移及远处转移。根据复发部位分为盆腔内复发和盆腔外复发,其中盆腔内复发又分为中心性复发和非中心性复发:中心性复发是指局限于子宫颈或阴道的局部复发,且复发病灶向侧方侵犯未达盆壁;非中心性复发是指盆腔淋巴结转移或盆侧壁的复发,或中心性复发病灶侵达盆壁[38][39]。盆腔外复发是指盆腔以外的淋巴结转移(包括腹股沟淋巴结、腹膜后淋巴结、锁骨上淋巴结、纵隔淋巴结等)或远处转移(肺、肝、骨等)[39]。

子宫颈癌的复发与其预后有着密切关系,目前临床研究中的预后因素包括术前那不勒斯预后评分(NPS)[40]、RPL24[41]、肿瘤直径[8][42]-[45]、组织学类型[42][44][46]-[48]、淋巴结转移[45][47]-[49]、鳞状细胞癌抗原(SCC-Ag)[42][50]以及中性粒细胞与淋巴细胞比值(NLR)[51][52],这些因素都需要在同步放化疗之前进行收集,以此来判断宫颈癌对同步放化疗的敏感程度及其预后等方面的因素;影像学检查可以准确测量肿瘤大小,肿瘤直径越大,预后通常越差,还能够有效评估淋巴结是否存在转移,淋巴结阳性患者的预后往往较差,这与以往的研究一致;同时一些研究表明,影像学特征与肿瘤的临床生物标志物之间可能存在相关性[53],这为个体化治疗提供了新的思路。而这些临床指标的评定有些需要活检或者实验室检查,相较于影像学无创性检查来说比较繁琐或者对患者身体健康有一定的损害。目前影像学对于宫颈癌预后评估方面的研究已经比较完善,MRI 和 PET-CT 在识别宫颈癌预后方面具有重要价值。尤其是 PET-CT,可以在临床症状出现之前,检测到肿瘤代谢活动的变化,从而实现早期干预及预后因素分析。Xin 等人[54]研究了基于机器学习的影像组学预测接受同步放化疗的宫颈癌患者的无病生存期(DFS)和总生存期(OS)的价值,作为一项多中心研究,回顾性分析 700 例接受同步放化疗且仍在随访的 IB2-IVA 期宫颈癌患者。通过收集 T2WI 序列原发灶及其周围 5 mm 区域的三维影像组学特征,并采用 6 种机器学习方法构建最优影像组学模型,准确预测了 LACC 患者 CCRT 后的 DFS 和 OS。结果显示,在 DFS 预测中,联合肿瘤和瘤周组学的 RSF 模型预测效能最佳,在训练集、验证集和测试集预测 1、3、5 年 DFS 的 AUC 分别为 0.986、0.989、0.990,0.884、0.838、0.823 和 0.829、0.809、0.841。在 OS 预测方面,GBM 模型表现最佳,AUC 分别为 0.999、0.995、0.978,0.981、0.975、0.837 和 0.904、0.860、0.905。得出的结论为基于机器学习的影像组学模型有助于预测 LACC 患者同步放化疗后的 DFS 和 OS,且肿瘤和瘤周信息联合具有更高的预测效能,可为宫颈癌患者的治疗决策提供可靠依据。以往的影像组学研究都会纳入肿瘤范围来构建影像组学模型,但该研究同时纳入了瘤周 5 mm 范围并构建了瘤周组学,这是我们以后研究可以借鉴和学习的方面。2023 年,Zhang 等人[55]的研究分析了基于临床预后因素(CPF)、体素内不相干运动扩散加权成像(IVIM-DWI)和 MRI 衍生的影像组学列线图预测局部晚期宫颈癌(LACC)同步放化疗(CCRT)后复发和无病生存(DFS)的价值,并且回顾性分析了 115 例接受同步放化疗的 IB-IVA 宫颈癌患者的资料,他们的结论证实了基于临床、IVIM-DWI 和影像组学参数构建的列线图在预测 LACC 患者同步放化疗后复发和 DFS 方面具有较高的临床价值,可为宫颈癌患者的预后评估和个体化治疗提供参考;同年,Xu 等人[56]的研究结论证实了基于放疗前 CT 建立的高性能混合影像组学模型在危险度分层中具有优势。上述组学成果虽丰,却多为回顾性小样本,缺乏前瞻性验证,这是目前该领域研究最大的瓶颈。同时 PET 方面的研究一直在更新,Cho 等人[57]的研究证实了治疗前 F-18 FDG PET/CT 图像上的 GLRLM 高 GLNU 是 LACC 患者同步放化疗后复发和死亡的独立预后因素;Ma 等人[58]的研究证实了应用超声造影及弹性成像技术预测同步放化疗疗效及疾病进展是可行的。这些影像学对预后的研究,进一步证实了其相较于其他临床检查的优势,不仅可以预测疾病治疗的疗效以及进展,还可以预测肿瘤的复发、PFS

以及 OS, 为患者的预后提供重要信息。

4. 结论

影像学在宫颈癌同步放化疗后的预后及疗效评估中发挥着不可或缺的作用。通过合理选择影像学检查方式, 医生可以更好地监测患者的病情变化, 及时调整治疗方案, 提高患者的生存率和生活质量。未来, 随着影像学技术的发展及其与其他生物标志物结合的深入研究, 影像学在宫颈癌治疗及预后评估中的应用前景将更加广阔。

参考文献

- [1] Cohen, P.A., Jhingran, A., Oaknin, A. and Denny, L. (2019) Cervical Cancer. *The Lancet*, **393**, 169-182. [https://doi.org/10.1016/s0140-6736\(18\)32470-x](https://doi.org/10.1016/s0140-6736(18)32470-x)
- [2] 刘宗超, 李哲轩, 张阳, 周彤, 张婧莹, 游伟程, 潘凯枫, 李文庆. 2020 全球癌症统计报告解读[J]. 肿瘤综合治疗电子杂志, 2021, 7(2): 1-14.
- [3] Sung, H., Ferlay, J., Siegel, R.L., Laversanne, M., Soerjomataram, I., Jemal, A., *et al.* (2021) Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: A Cancer Journal for Clinicians*, **71**, 209-249. <https://doi.org/10.3322/caac.21660>
- [4] Luo, W. (2021) Predicting Cervical Cancer Outcomes: Statistics, Images, and Machine Learning. *Frontiers in Artificial Intelligence*, **4**, Article ID: 627369. <https://doi.org/10.3389/frai.2021.627369>
- [5] Koh, W., Abu-Rustum, N.R., Bean, S., Bradley, K., Campos, S.M., Cho, K.R., *et al.* (2019) Cervical Cancer, Version 3.2019, NCCN Clinical Practice Guidelines in Oncology. *Journal of the National Comprehensive Cancer Network*, **17**, 64-84. <https://doi.org/10.6004/jnccn.2019.0001>
- [6] Kalaghchi, B., Abdi, R., Amouzegar-Hashemi, F., Esmati, E. and Alikhasi, A. (2016) Concurrent Chemoradiation with Weekly Paclitaxel and Cisplatin for Locally Advanced Cervical Cancer. *Asian Pacific Journal of Cancer Prevention*, **17**, 287-291. <https://doi.org/10.7314/apjcp.2016.17.s3.287>
- [7] Hirakawa, M., Nagai, Y., Inamine, M., Kamiyama, K., Ogawa, K., Toita, T., *et al.* (2008) Predictive Factor of Distant Recurrence in Locally Advanced Squamous Cell Carcinoma of the Cervix Treated with Concurrent Chemoradiotherapy. *Gynecologic Oncology*, **108**, 126-129. <https://doi.org/10.1016/j.ygyno.2007.08.091>
- [8] Kuno, I., Takayanagi, D., Asami, Y., Murakami, N., Matsuda, M., Shimada, Y., Hirose, S., *et al.* (2021) TP53 Mutants and Non-HPV16/18 Genotypes Are Poor Prognostic Factors for Concurrent Chemoradiotherapy in Locally Advanced Cervical Cancer. *Scientific Reports*, **11**, Article No. 19261. <https://doi.org/10.1038/s41598-021-98527-2>
- [9] Lambin, P., Rios-Velazquez, E., Leijenaar, R., Carvalho, S., van Stiphout, R.G.P.M., Granton, P., *et al.* (2012) Radiomics: Extracting More Information from Medical Images Using Advanced Feature Analysis. *European Journal of Cancer*, **48**, 441-446. <https://doi.org/10.1016/j.ejca.2011.11.036>
- [10] Nam, H., Park, W., Huh, S., Bae, D., Kim, B., Lee, J., *et al.* (2007) The Prognostic Significance of Tumor Volume Regression during Radiotherapy and Concurrent Chemoradiotherapy for Cervical Cancer Using MRI. *Gynecologic Oncology*, **107**, 320-325. <https://doi.org/10.1016/j.ygyno.2007.06.022>
- [11] Kim, J., Kim, C.K., Park, B.K., Park, S.Y., Huh, S.J. and Kim, B. (2012) Dynamic Contrast-Enhanced 3-T MR Imaging in Cervical Cancer before and after Concurrent Chemoradiotherapy. *European Radiology*, **22**, 2533-2539. <https://doi.org/10.1007/s00330-012-2504-4>
- [12] Kim, H.S., Kim, C.K., Park, B.K., Huh, S.J. and Kim, B. (2012) Evaluation of Therapeutic Response to Concurrent Chemoradiotherapy in Patients with Cervical Cancer Using Diffusion-Weighted MR Imaging. *Journal of Magnetic Resonance Imaging*, **37**, 187-193. <https://doi.org/10.1002/jmri.23804>
- [13] Park, J.J., Kim, C.K., Park, S.Y., Simonetti, A.W., Kim, E., Park, B.K., *et al.* (2014) Assessment of Early Response to Concurrent Chemoradiotherapy in Cervical Cancer: Value of Diffusion-Weighted and Dynamic Contrast-Enhanced MR Imaging. *Magnetic Resonance Imaging*, **32**, 993-1000. <https://doi.org/10.1016/j.mri.2014.05.009>
- [14] Park, J.J., Kim, C.K. and Park, B.K. (2015) Prediction of Disease Progression Following Concurrent Chemoradiotherapy for Uterine Cervical Cancer: Value of Post-Treatment Diffusion-Weighted Imaging. *European Radiology*, **26**, 3272-3279. <https://doi.org/10.1007/s00330-015-4156-7>
- [15] Zheng, X., Guo, W., Dong, J. and Qian, L. (2020) Prediction of Early Response to Concurrent Chemoradiotherapy in Cervical Cancer: Value of Multi-Parameter MRI Combined with Clinical Prognostic Factors. *Magnetic Resonance Imaging*, **72**, 159-166. <https://doi.org/10.1016/j.mri.2020.06.014>

- [16] Liu, B., Ma, W., Zhang, G., Sun, Z., Wei, M., Hou, W., *et al.* (2020) Potentialities of Multi-B-Values Diffusion-Weighted Imaging for Predicting Efficacy of Concurrent Chemoradiotherapy in Cervical Cancer Patients. *BMC Medical Imaging*, **20**, Article No. 97. <https://doi.org/10.1186/s12880-020-00496-x>
- [17] Vojtíšek, R., Baxa, J., Kovářová, P., Almortaza, A., Hošek, P., Sukovská, E., *et al.* (2021) Prediction of Treatment Response in Patients with Locally Advanced Cervical Cancer Using Midtreatment PET/MRI during Concurrent Chemoradiotherapy. *Strahlentherapie und Onkologie*, **197**, 494-504. <https://doi.org/10.1007/s00066-020-01740-7>
- [18] Gu, K., Kim, C.K., Choi, C.H., Yoon, Y.C. and Park, W. (2019) Prognostic Value of ADC Quantification for Clinical Outcome in Uterine Cervical Cancer Treated with Concurrent Chemoradiotherapy. *European Radiology*, **29**, 6236-6244. <https://doi.org/10.1007/s00330-019-06204-w>
- [19] Bian, H., Liu, F., Chen, S., Li, G., Song, Y., Sun, M., *et al.* (2019) Intravoxel Incoherent Motion Diffusion-Weighted Imaging Evaluated the Response to Concurrent Chemoradiotherapy in Patients with Cervical Cancer. *Medicine*, **98**, e17943. <https://doi.org/10.1097/md.00000000000017943>
- [20] Yang, W., Qiang, J.W., Tian, H.P., Chen, B., Wang, A.J. and Zhao, J.G. (2017) Multi-Parametric MRI in Cervical Cancer: Early Prediction of Response to Concurrent Chemoradiotherapy in Combination with Clinical Prognostic Factors. *European Radiology*, **28**, 437-445. <https://doi.org/10.1007/s00330-017-4989-3>
- [21] Lu, H., Wu, Y., Liu, X., Huang, H., Jiang, H., Zhu, C., *et al.* (2021) The Role of Dynamic Contrast-Enhanced Magnetic Resonance Imaging in Predicting Treatment Response for Cervical Cancer Treated with Concurrent Chemoradiotherapy. *Cancer Management and Research*, **13**, 6065-6078. <https://doi.org/10.2147/cmar.s314289>
- [22] Lee, J.E., Huh, S.J., Nam, H. and Ju, S.G. (2012) Early Response of Patients Undergoing Concurrent Chemoradiotherapy for Cervical Cancer: A Comparison of PET/CT and MRI. *Annals of Nuclear Medicine*, **27**, 37-45. <https://doi.org/10.1007/s12149-012-0659-3>
- [23] Su, T., Lin, G., Huang, Y., Liu, F., Wang, C., Chao, A., *et al.* (2017) Comparison of Positron Emission Tomography/Computed Tomography and Magnetic Resonance Imaging for Posttherapy Evaluation in Patients with Advanced Cervical Cancer Receiving Definitive Concurrent Chemoradiotherapy. *European Journal of Nuclear Medicine and Molecular Imaging*, **45**, 727-734. <https://doi.org/10.1007/s00259-017-3884-0>
- [24] Dag, Z., Yilmaz, B., Dogan, A.K., Aksan, D.U., Ozkurt, H., Kızılkaya, H.O., *et al.* (2019) Comparison of the Prognostic Value of F-18 FDG PET/CT Metabolic Parameters of Primary Tumors and MRI Findings in Patients with Locally Advanced Cervical Cancer Treated with Concurrent Chemoradiotherapy. *Brachytherapy*, **18**, 154-162. <https://doi.org/10.1016/j.brachy.2018.11.005>
- [25] Chong, G.O., Jeong, S.Y., Park, S., Lee, Y.H., Lee, S., Hong, D.G., *et al.* (2015) Comparison of the Prognostic Value of F-18 Pet Metabolic Parameters of Primary Tumors and Regional Lymph Nodes in Patients with Locally Advanced Cervical Cancer Who Are Treated with Concurrent Chemoradiotherapy. *PLOS ONE*, **10**, e0137743. <https://doi.org/10.1371/journal.pone.0137743>
- [26] Ho, K.C., Fang, Y.H., Chung, H.W., Yen, T.C., Ho, T.Y., Chou, H.H., Hong, J.H., *et al.* (2016) A Preliminary Investigation into Textural Features of Intratumoral Metabolic Heterogeneity in (18)F-FDG PET for Overall Survival Prognosis in Patients with Bulky Cervical Cancer Treated with Definitive Concurrent Chemoradiotherapy. *American Journal of Nuclear Medicine and Molecular Imaging*, **6**, 166-175.
- [27] Chong, G.O., Lee, W.K., Jeong, S.Y., Park, S., Lee, Y.H., Lee, S., *et al.* (2017) Prognostic Value of Intratumoral Metabolic Heterogeneity on F-18 Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography in Locally Advanced Cervical Cancer Patients Treated with Concurrent Chemoradiotherapy. *Oncotarget*, **8**, 90402-90412. <https://doi.org/10.18632/oncotarget.18769>
- [28] Sarabhai, T., Tschischka, A., Stebner, V., Nensa, F., Wetter, A., Kimmig, R., Forsting, M., *et al.* (2018) Simultaneous Multiparametric PET/MRI for the Assessment of Therapeutic Response to Chemotherapy or Concurrent Chemoradiotherapy of Cervical Cancer Patients: Preliminary Results. *Clinical Imaging*, **49**, 163-168. <https://doi.org/10.1016/j.clinimag.2018.03.009>
- [29] Xu, C., Sun, H., Du, S. and Xin, J. (2019) Early Treatment Response of Patients Undergoing Concurrent Chemoradiotherapy for Cervical Cancer: An Evaluation of Integrated Multi-Parameter PET-IVIM MR. *European Journal of Radiology*, **117**, 1-8. <https://doi.org/10.1016/j.ejrad.2019.05.012>
- [30] Rui, T.D., Dong, Y., Qing, L.S., Tong, R., *et al.* (2020) Volume Computed Tomography Perfusion as a Predictive Marker for Treatment Response to Concurrent Chemoradiotherapy in Cervical Cancer: A Prospective Study. *Acta Radiologica*, **62**, 281-288. <https://doi.org/10.1177/0284185120919261>
- [31] Zhang, Y., Zhang, K., Jia, H., Xia, B., Zang, C., Liu, Y., *et al.* (2022) IVIM-DWI and MRI-Based Radiomics in Cervical Cancer: Prediction of Concurrent Chemoradiotherapy Sensitivity in Combination with Clinical Prognostic Factors. *Magnetic Resonance Imaging*, **91**, 37-44. <https://doi.org/10.1016/j.mri.2022.05.005>
- [32] Peiretti, M., Zapardiel, I., Zanagnolo, V., Landoni, F., Morrow, C.P. and Maggioni, A. (2012) Management of Recurrent Cervical Cancer: A Review of the Literature. *Surgical Oncology*, **21**, e59-e66.

- <https://doi.org/10.1016/j.suronc.2011.12.008>
- [33] Fagundes, H., Perez, C.A., Grigsby, P.W. and Lockett, M.A. (1992) Distant Metastases after Irradiation Alone in Carcinoma of the Uterine Cervix. *International Journal of Radiation Oncology·Biology·Physics*, **24**, 197-204. [https://doi.org/10.1016/0360-3016\(92\)90671-4](https://doi.org/10.1016/0360-3016(92)90671-4)
 - [34] Gao, S., Du, S., Lu, Z., Xin, J., Gao, S. and Sun, H. (2019) Multiparametric PET/MR (PET and MR-IVIM) for the Evaluation of Early Treatment Response and Prediction of Tumor Recurrence in Patients with Locally Advanced Cervical Cancer. *European Radiology*, **30**, 1191-1201. <https://doi.org/10.1007/s00330-019-06428-w>
 - [35] Tseng, J., Yen, M., Twu, N., Lai, C., Horng, H., Tseng, C., *et al.* (2010) Prognostic Nomogram for Overall Survival in Stage IIB-IVA Cervical Cancer Patients Treated with Concurrent Chemoradiotherapy. *American Journal of Obstetrics and Gynecology*, **202**, 174.e1-174.e7. <https://doi.org/10.1016/j.ajog.2009.09.028>
 - [36] Paskeh, M.D.A., Mirzaei, S., Gholami, M.H., Zarrabi, A., Zabolian, A., Hashemi, M., *et al.* (2021) Cervical Cancer Progression Is Regulated by SOX Transcription Factors: Revealing Signaling Networks and Therapeutic Strategies. *Bio-medicine & Pharmacotherapy*, **144**, Article ID: 112335. <https://doi.org/10.1016/j.biopha.2021.112335>
 - [37] Tewari, K.S., Sill, M.W., Long, H.J., Penson, R.T., Huang, H., Ramondetta, L.M., *et al.* (2014) Improved Survival with Bevacizumab in Advanced Cervical Cancer. *New England Journal of Medicine*, **370**, 734-743. <https://doi.org/10.1056/nejmoa1309748>
 - [38] Kim, T.H., Kim, M., Kim, B., Park, S., Ryu, S. and Cho, C. (2017) Prognostic Importance of the Site of Recurrence in Patients with Metastatic Recurrent Cervical Cancer. *International Journal of Radiation Oncology Biology Physics*, **98**, 1124-1131. <https://doi.org/10.1016/j.ijrobp.2017.03.029>
 - [39] 谢鹏, 郭秋芬, 张师前. 复发性子宫颈癌的综合治疗[J]. 中国实用妇科与产科杂志, 2022, 38(5): 499-503.
 - [40] Zhang, X., Gu, M., Zhu, J., Gu, R., Yang, B., Ji, S., *et al.* (2024) Prognostic Value of Naples Prognostic Score in Locally Advanced Cervical Cancer Patients Undergoing Concurrent Chemoradiotherapy. *Biomolecules and Biomedicine*, **25**, 986-999. <https://doi.org/10.17305/bb.2024.10989>
 - [41] Ming, C., Bai, X., Zhao, L., Yu, D., Wang, X. and Wu, Y. (2023) RPL24 as a Potential Prognostic Biomarker for Cervical Cancer Treated by Cisplatin and Concurrent Chemoradiotherapy. *Frontiers in Oncology*, **13**, Article ID: 1131803. <https://doi.org/10.3389/fonc.2023.1131803>
 - [42] Liu, T., Kong, W., Liu, Y. and Song, D. (2020) Efficacy and Prognostic Factors of Concurrent Chemoradiotherapy in Patients with Stage Ib3 and IIa2 Cervical Cancer. *Ginekologia Polska*, **91**, 57-61. <https://doi.org/10.5603/gp.2020.0017>
 - [43] Liu, Y.M., Ni, L.Q., Wang, S.S., Lv, Q.L., Chen, W.J. and Ying, S.P. (2018) Outcome and Prognostic Factors in Cervical Cancer Patients Treated with Surgery and Concurrent Chemoradiotherapy: A Retrospective Study. *World Journal of Surgical Oncology*, **16**, Article No. 18. <https://doi.org/10.1186/s12957-017-1307-0>
 - [44] Fujiwara, M., Isohashi, F., Mabuchi, S., Yoshioka, Y., Seo, Y., Suzuki, O., *et al.* (2014) Efficacy and Safety of Nedaplatin-Based Concurrent Chemoradiotherapy for FIGO Stage IB2-IVA Cervical Cancer and Its Clinical Prognostic Factors. *Journal of Radiation Research*, **56**, 305-314. <https://doi.org/10.1093/jrr/rru101>
 - [45] Endo, D., Todo, Y., Okamoto, K., Minobe, S., Kato, H. and Nishiyama, N. (2015) Prognostic Factors for Patients with Cervical Cancer Treated with Concurrent Chemoradiotherapy: A Retrospective Analysis in a Japanese Cohort. *Journal of Gynecologic Oncology*, **26**, 12-18. <https://doi.org/10.3802/jgo.2015.26.1.12>
 - [46] Tangkananan, A., Thongkhao, P., Janmunee, N. and Hanprasertpong, J. (2022) Impact of Chemotherapy Cycles on Oncological Outcomes in Elders with Locally Advanced Cervical Cancer Treated with Concurrent Chemoradiotherapy. *Journal of Medical Imaging and Radiation Oncology*, **66**, 1014-1021. <https://doi.org/10.1111/1754-9485.13443>
 - [47] Liu, J., Tang, G., Zhou, Q. and Kuang, W. (2022) Outcomes and Prognostic Factors in Patients with Locally Advanced Cervical Cancer Treated with Concurrent Chemoradiotherapy. *Radiation Oncology*, **17**, Article No. 142. <https://doi.org/10.1186/s13014-022-02115-1>
 - [48] Kim, H., Cho, W.K., Kim, Y.J., Kim, Y.S. and Park, W. (2020) Significance of the Number of High-Risk Factors in Patients with Cervical Cancer Treated with Radical Hysterectomy and Concurrent Chemoradiotherapy. *Gynecologic Oncology*, **157**, 423-428. <https://doi.org/10.1016/j.ygyno.2020.02.031>
 - [49] Peng, Q., Chen, K., Li, J., Chen, L. and Ye, W. (2022) Analysis of Treatment Outcomes and Prognosis after Concurrent Chemoradiotherapy for Locally Advanced Cervical Cancer. *Frontiers in Oncology*, **12**, Article ID: 926840. <https://doi.org/10.3389/fonc.2022.926840>
 - [50] Zhang, G., Miao, L., Wu, H., Zhang, Y. and Fu, C. (2021) Pretreatment Squamous Cell Carcinoma Antigen (SCC-Ag) as a Predictive Factor for the Use of Consolidation Chemotherapy in Cervical Cancer Patients after Postoperative Extended-Field Concurrent Chemoradiotherapy. *Technology in Cancer Research & Treatment*, **20**. <https://doi.org/10.1177/15330338211044626>
 - [51] Lee, J.W. and Seol, K.H. (2021) Pretreatment Neutrophil-to-Lymphocyte Ratio Combined with Platelet-to-Lymphocyte Ratio as a Predictor of Survival Outcomes after Definitive Concurrent Chemoradiotherapy for Cervical Cancer. *Journal*

-
- of Clinical Medicine, **10**, Article No. 2199. <https://doi.org/10.3390/jcm10102199>
- [52] Lee, H.J., Kim, J.M., Chin, Y.J., Chong, G.O., Park, S., Lee, Y.H., *et al.* (2019) Prognostic Value of Hematological Parameters in Locally Advanced Cervical Cancer Patients Treated with Concurrent Chemoradiotherapy. *Anticancer Research*, **40**, 451-458. <https://doi.org/10.21873/anticancer.13973>
 - [53] Zhang, X., Zhang, Q., Guo, J., Zhao, J., Xie, L., Zhang, J., *et al.* (2022) Added-Value of Texture Analysis of ADC in Predicting the Survival of Patients with 2018 FIGO Stage IIICr Cervical Cancer Treated by Concurrent Chemoradiotherapy. *European Journal of Radiology*, **150**, Article ID: 110272. <https://doi.org/10.1016/j.ejrad.2022.110272>
 - [54] Xin, W., Rixin, S., Linrui, L., Zhihui, Q., Long, L. and Yu, Z. (2024) Machine Learning-Based Radiomics for Predicting Outcomes in Cervical Cancer Patients Undergoing Concurrent Chemoradiotherapy. *Computers in Biology and Medicine*, **177**, Article ID: 108593. <https://doi.org/10.1016/j.combiomed.2024.108593>
 - [55] Zhang, Y., Liu, L., Zhang, K., Su, R., Jia, H., Qian, L., *et al.* (2023) Nomograms Combining Clinical and Imaging Parameters to Predict Recurrence and Disease-Free Survival after Concurrent Chemoradiotherapy in Patients with Locally Advanced Cervical Cancer. *Academic Radiology*, **30**, 499-508. <https://doi.org/10.1016/j.acra.2022.08.002>
 - [56] Xu, C., Liu, W., Zhao, Q., Zhang, L., Yin, M., Zhou, J., *et al.* (2023) CT-Based Radiomics Nomogram for Overall Survival Prediction in Patients with Cervical Cancer Treated with Concurrent Chemoradiotherapy. *Frontiers in Oncology*, **13**, Article ID: 1287121. <https://doi.org/10.3389/fonc.2023.1287121>
 - [57] Cho, H., Lee, E.S., Lee, J.K., Eo, J.S., Kim, S. and Hong, J.H. (2022) Prognostic Value of Textural Features Obtained from F-Fluorodeoxyglucose (F-18 FDG) Positron Emission Tomography/Computed Tomography (PET/CT) in Patients with Locally Advanced Cervical Cancer Undergoing Concurrent Chemoradiotherapy. *Annals of Nuclear Medicine*, **37**, 44-51. <https://doi.org/10.1007/s12149-022-01802-z>
 - [58] Ma, Y., Zhao, X. and Chen, X. (2024) Contrast-Enhanced Ultrasound Combined with Elastic Imaging for Predicting the Efficacy of Concurrent Chemoradiotherapy in Cervical Cancer: A Feasibility Study. *Frontiers in Oncology*, **14**, Article ID: 1301900. <https://doi.org/10.3389/fonc.2024.1301900>