

Progress of MR spectroscopic imaging in clinical application of prostate

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[Abstract] MRI is now recognized as the best choice for diagnosis of prostatic carcinoma, however is lack of value for evaluation of clinical therapeutic effect. The application of MRS made up these deficiencies. Progress of MRS in diagnosis, assessment and clinical application for prostate cancer were reviewed in this article.

[Key words] Magnetic resonance spectroscopy; Prostatic neoplasms

磁共振波谱成像在前列腺癌中的临床应用进展

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[摘要] MRI 是目前公认诊断前列腺癌的最佳选择, 但对评估临床治疗效果缺乏参考价值, 而 MRS 的出现及应用极大地弥补了其不足。本文就 MRS 对前列腺癌的诊断、评估及临床应用进展进行综述。

[关键词] 磁共振波谱; 前列腺肿瘤

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前列腺癌是全球范围内威胁老年男性健康的常见恶性肿瘤之一^[1], 其定位、定性诊断及临床分期对指导治疗方案的选择有重要意义。准确区分惰性和侵袭性前列腺癌既有助于防止过度治疗产生不必要的并发症, 又可保证侵袭性肿瘤得到及时合理的治疗^[2-4]。¹H-MRS 能提供有关前列腺代谢物, 如枸橼酸盐(citrate, Cit)、胆碱(choline, Cho)和肌酸(creatine, Cr)的空间分布信息, 有助于发现小而隐匿的前列腺癌灶, 充分评价肿瘤的大小及范围^[5]。¹H-MRS 中, 与正常腺体组织相比, 前列腺癌通常以 Cit 减低而 Cho 增加为代谢特征^[6], Cho 含量增高以及 Cho 和 Cr 含量与 Cit 的比值[(Cho+Cr)/Cit]是诊断前列腺癌的主要代谢物指标^[7-8]。在体前列腺的¹H-MRS 研究表明, 采用前列腺区带标准化阈值法区分良恶性病变

具有较高的准确性和观测者间一致性^[9-10]。另外, 离体高分辨魔角旋转¹H-MRS 和在体¹H-MRS 研究均表明, 前列腺癌的(Cho+Cr)/Cit 比值与其 Gleason 评分具有显著相关性^[11-14]。

3.0T MR 的临床应用使¹H-MRS 对前列腺的 SNR 和代谢物的分辨率得到很大提高, 提升了 MRS 对前列腺癌定位、定性诊断以及肿瘤分级的准确性^[15]。直肠内表面线圈的应用使得前列腺三维¹H-MRS 成像成为可能, 目前在 3.0T 场强下, 应用直肠内线圈,¹H-MRS 成像可获得的空间分辨率能达到 0.22 cm。在 1.5T 场强条件下应用脊柱相控阵表面线圈进行前列腺 MRS 虽也可行^[16], 但获得波谱的 SNR 显然不够。基于 Cho 和 Cit 的 T2 弛豫时间相对较短, Scheenen 等^[16]建议在前列腺 MRS 中使用较短的 TE(如 75 ms)。值得注意的是, 较短的 TE 会加重脂质信号对其他代谢物峰的污染; 而采用较短的 TR(如 750 ms)虽可增加 Cit 的 SNR, 但可能造成 Cho 信号部分饱和^[17]。另外, 前列腺¹H-MRS 中包含较大的水和脂质共振峰, 成像时充分抑制水和脂质信号及保证局部磁场的均匀性对保证波谱质量非常重要^[18]。

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1 MRS 应用于前列腺癌定性、定位和体积测量

前列腺内微小癌灶的检测与准确定位对实施肿瘤主动性监测和局部消融治疗具有重大临床价值。大多数前列腺癌为低度恶性肿瘤,对前列腺内“惰性”肿瘤无须过度治疗。联合应用 MRS 有助于提高常规 MRI 对前列腺癌的诊断、肿瘤体积测量以及肿瘤分期的准确性。MRS 检测前列腺癌的总敏感度为 56%,而对 Gleason 评分 $\geq 4+4$ 肿瘤的诊断敏感度可达 89%^[19]。应用图像融合软件, MRS 数据可以叠加到前列腺的 MR 断面解剖图像上,形成彩色的代谢物数据分布图,直观描述肿瘤的位置和大小^[20]。因此,联合应用 MRI 与 MRS 能提高前列腺定位活检诊断前列腺癌的敏感度和特异度。肿瘤体积增大是提示前列腺癌进展的一个特征, MRS 能提高 MR 测量肿瘤体积的精度。随着高场强(如 3T)磁体的应用,前列腺 MRS 成像空间分辨率增加,将进一步提高对小前列腺癌的诊断能力。

2 MRS 应用于前列腺癌分级和临床分期

组织学上前列腺癌可分高分化和低分化腺癌。低分化癌恶性度高,生物侵袭性高,预后差。前列腺癌的枸橼酸含量水平与病理学分级相关联,在高分化癌组织中降低,在低分化肿瘤中缺失。MRS 可对前列腺癌瘤灶进行无创性评估,并不受观察者的主观性因素影响。离体组织高分辨魔角旋转¹H-MRS 研究表明,前列腺癌 Cho 等膜磷脂代谢物含量与肿瘤病理级别显著相关^[21-22]。在体 MR 与 MRS 成像的研究也发现,前列腺癌 (Cho+Cr)/Cit 比值与肿瘤 Gleason 评分的具有统计学相关性^[23]。MRS 辅助 MR 成像能提高前列腺癌分期的准确性。前列腺癌伴有包膜外侵犯时, MRS 测得的各叶内肿瘤体积分数较无包膜外侵犯的肿瘤显著增高^[24]。

3 MRS 应用于前列腺癌的治疗计划

前列腺癌 MR 及 MRS 分期对前瞻性设计中到高分化肿瘤的治疗方案具有重要价值^[25]。一般来讲,放疗前肿瘤包膜外扩散超出 5 mm 是预后不良的指标,往往提示需要实施积极治疗方案。文献^[26]报道,将 MR/MRS 的数据集成用于放疗计划,可对前列腺肿瘤区域实施优化剂量照射。在图像融合软件帮助下,参照 MR/MRS 资料进行放射治疗剂量-容积规划,能降低对膀胱、直肠及股骨头的照射剂量;而以 CT 图像为参考进行放疗规划往往会高估靶照射容积 30%左右。

4 MRS 应用于前列腺癌的治疗后随访

须治疗后早期发现残余肿瘤对早期采取干预治疗

措施非常重要。发现前列腺癌患者治疗后前列腺特异抗原(prostate specific antigen, PSA)再度出现或升高时,通常考虑肿瘤复发的可能,但以 PSA 水平来检测治疗效果往往不是很理想^[25]。常规影像学检查方法包括经直肠内超声、CT 和 MRI 往往不能区分接受治疗后的健康前列腺组织和肿瘤组织^[26-27]。前列腺随机活检是唯一能明确恶性组织是否残留或复发的方法,但易发生取样误差,且难以解释治疗后的病理改变。MRS 诊断前列腺癌残留或复发时,需要对代谢物指标进行合理调整,因为前列腺癌在治疗后代谢物的消减需要时间。例如,前列腺分泌枸橼酸受激素调节,在激素剥夺治疗后,早期 MRS 将会显示多胺的枸橼酸显著下降。随着时间的延长,激素剥夺治疗后 Cho 和 Cr 含量也会逐步减低,可能与相关前列腺组织萎缩有关^[28]。研究证实,前列腺癌 MR/MRS 成像能区分肿瘤残留或复发与良性组织、萎缩及坏死组织。前列腺癌早期治疗后,健康和恶性组织中多胺代谢和柠檬酸均趋于消失,因此通常以 Cho/Cr 比值升高作为前列腺癌残留和肿瘤复发的标志。文献^[29]报道,以前列腺半球内 3 个以上体素 Cho/Cr ≥ 1.5 诊断前列腺癌复发敏感度和特异度分别为 87%和 72%。

综上所述, MR/MRS 成像对检测及诊断前列腺癌具有较高的敏感度和特异度,可经过对前列腺组织代谢物浓度的分析来推断前列腺疾病的病理类型,是一种无创、简单、易操作的分子学检查方法。随着高场强 MR 的广泛应用及成像技术的迅猛发展, MRS 将在前列腺癌诊断以及其治疗前后评价中发挥更为重要的作用。

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