

宫颈癌术后不同射野数调强放射治疗与四野三维适形放射治疗的剂量学比较

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【摘要】目的:利用三维治疗计划系统对宫颈癌术后不同射野数调强放射治疗(IMRT)与三维适形放射治疗(3DCRT)的计划作剂量学比较,评价其剂量分布特点,试图根据不同情况选择最佳的治疗方案。**方法:**选择20例宫颈癌术后患者,利用三维治疗计划系统对每个病例分别模拟三野、五野、七野IMRT计划与四野3DCRT计划。在剂量体积直方图上,比较靶区和正常组织器官照射剂量、靶区内剂量分布均匀性和适形指数。**结果:**无论三野、五野、七野IMRT的靶区剂量覆盖和适形指数皆优于四野3DCRT,均匀性比较无显著差异。较四野3DCRT,IMRT能减少膀胱、直肠、小肠等正常器官的照射剂量。**结论:**IMRT技术在保证肿瘤放射剂量的同时可减少并发症的发生,应该更广泛地应用于临床,同时对于经济条件受限的患者采用三野IMRT较四野3DCRT受益。

【关键词】宫颈癌;不同射野数;调强放射治疗;三维适形放射治疗;剂量学

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Different-field intensity-modulated radiotherapy vs four-field three-dimensional conformal radiotherapy following radical surgery for cervical carcinoma: a dosimetry comparison

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Abstract: Objective To compare the dosimetry of different-field intensity-modulated radiotherapy (IMRT) with four-field three-dimensional conformal radiotherapy (3DCRT) after radical surgery for cervical carcinoma for evaluating the dose distributions, and select the optimal treatment plan according to different situations. **Methods** Twenty patients receiving radical surgery for cervical carcinoma were selected, and different plans, namely three-, five- and seven-field IMRT plan and four-field 3DCRT, were designed for each patients. Based on the dose-volume histogram (DVH), the irradiation dose of target areas, normal tissues and organs, the conformal index and homogeneity index of dose distributions in target areas were compared. **Results** The conformal index and dose coverage of target areas in three-, five- and seven-field IMRT was superior to those in four-field 3DCRT, while the differences in homogeneity index were trivial. The irradiation doses of bladder, rectum, small intestine in IMRT were statistically lower as comparison with four-field 3DCRT. **Conclusion** IMRT should be more widely used in clinic for it can ensure the irradiation dose of tumor and reduce the incidence of complication. Moreover, compared with four-field 3DCRT, three-field IMRT is more beneficial for patients with poor economic conditions

Keywords: cervical carcinoma; different fields; intensity-modulated radiotherapy; three-dimensional conformal radiotherapy; dosimetry

前言

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宫颈癌是全球妇女常见的恶性肿瘤^[1],是严重威胁妇女健康的一种疾病,发病率居我国女性生殖道恶性肿瘤的首位。目前宫颈癌的治疗方案以手术和放化疗为主。放疗适用于宫颈癌的所有期别。常规ⅡA期以下宫颈癌宜行手术治疗,具有不良预后因素者术后需辅助放射治疗、化学治疗;ⅡB期以上中晚期宫颈癌原则上采用放射治疗。约70%以上的宫颈

癌患者治疗措施包括放射治疗^[2]。国内外专家建议早期宫颈癌不良预后因素应包括具有盆腔淋巴结转移、切缘不净和宫旁病理阳性的残留病灶等^[3]。对于宫颈癌,放射治疗效果已得到世界范围内公认。现随机抽取郴州市第一人民医院宫颈癌术后患者20例,利用三维治疗计划系统模拟四野三维适形放疗(3DCRT),并与三野、五野、七野调强放射治疗(IMRT)进行对比,分析不同放疗技术对肿瘤靶区及各危及器官的剂量学贡献,试图从剂量学角度观察和比较不同放疗技术治疗宫颈癌的优劣,从而根据不同情况选择最佳治疗方案。

1 材料与方法

1.1 临床资料

在2015年5月~2016年5月郴州市第一人民医院收治并经病理确诊的宫颈癌术后患者中,随机抽取20例,根据国际妇产科联盟2009临床分期标准,IB期8例、IC期7例、IIA期5例。所有患者都有高危因素(包括盆腔淋巴结转移、切缘不净和宫旁病理阳性的残留病灶等),需接受术后盆腔放疗。患者年龄33~68岁,中位年龄55岁。

1.2 体位固定和CT扫描方法

所有患者均取仰卧体位,膀胱排空,选择合适橡胶模型枕,采用热塑记忆网格体膜固定患者的下腹部和盆腔,在二维模拟定位机下,选择坐标中心点于盆腔中部,并在室内激光灯引导下,于体膜正面及两侧面用魔十字作坐标标记,转移患者至飞利浦大孔径CT-SIM上,双臂上举交叉抱头,扫描范围上至第3腰椎上缘,下至坐骨支下缘下3 cm,层厚3 mm。图像数据以Dicom格式传入治疗计划系统。利用美国瓦里安Eclipse三维治疗计划系统设计三野、五野、七野IMRT计划与四野3DCRT计划。

1.3 靶区及危及器官的勾画

放射治疗科临床医师与放射诊断科医生共同依据增强CT图像勾画靶区和危及器官。根据ICRU 62和83号报告,宫颈癌术后临床靶区(CTV)包括阴道上段1/2及残端、阴道旁软组织和盆腔淋巴引流区域(包括髂总、髂外、髂内、闭孔及骶前淋巴结区,范围为上界达第4~5腰椎间、下界达闭孔下缘水平)^[4-6]。考虑摆位误差及膀胱、直肠充盈程度,确定计划靶区(PTV),一般是在CTV的基础上外扩0.6 cm。勾画的危及器官包括直肠、膀胱、小肠、股骨头、股骨颈等。

1.4 计划设计

采用美国瓦里安Eclipse三维治疗计划系统对每个病例分别模拟设计四野3DCRT计划与三野、五野、

七野IMRT计划。3DCRT计划依据医生勾画的PTV,采用四野适形照射技术,入射野角度分别为0°、90°、180°、270°,所有射野形状在适形PTV的基础上各方向外放0.6 cm。三野IMRT计划为共面照射,入射野角度分别为50°、180°、310°;五野IMRT计划为共面照射,入射野角度分别为36°、108°、180°、252°、324°;七野IMRT计划为共面照射,入射野角度分别为30°、80°、130°、180°、230°、280°、330°。无论三野、五野、七野IMRT计划,优化权重因子及条件一致,处方剂量均为45 Gy(1.8 Gy/25 f)。

1.5 评价指标

根据ICRU 83号报告,对靶区引入 $D_{98\%}$ (近似于最小剂量)、 $D_{2\%}$ (近似于最大剂量)、 $D_{50\%}$ (近似于平均剂量)、适形度指数(CI)和均匀性指数(HI)等指标;对危及器官引入接受 x 剂量的体积百分比(V_x)来评估计划质量^[7]。靶区剂量分布的评价指标包括98%体积所接受的剂量($D_{98\%}$)、2%体积所接受的剂量($D_{2\%}$)和50%体积所接受的剂量($D_{50\%}$)。靶区剂量 $HI=D_{2\%}/D_{98\%}$,HI值越大(越远离1),说明靶区内剂量分布均匀性越差^[8-9]。 $CI=V_{PTV,REF}/V_{PTV} \times V_{PTV,REF}/V_{REF}$,其中, V_{PTV} 为靶体积, $V_{PTV,REF}$ 为参考等剂量线面所包绕的靶区体积, V_{REF} 为参考等剂量线面所包绕的所有区域体积,CI值为0~1,越接近1,表示适形度越高^[10]。本研究采用处方剂量的95%等剂量线面作为参考等剂量线面。危及器官受照剂量主要评价指标包括直肠 V_{45} 、膀胱 V_{45} 、小肠 V_{45} 及 V_{40} 。

1.6 统计学方法

采用SPSS 13.0软件进行统计分析,剂量资料用均数±标准差表示,均数比较采用方差分析。 $P<0.05$ 为差异有统计学意义。

2 结果

通过对4种不同照射方法的DVH图比较得知,4种计划的处方剂量PTV覆盖率均达到95%,对靶区进行有效覆盖。4种不同照射技术PTV剂量的比较见表1,三野、五野、七野IMRT的 $D_{98\%}$ 较四野3DCRT稍大;调强五野、七野IMRT的 $D_{2\%}$ 、 $D_{50\%}$ 较四野3DCRT稍小;三野的 $D_{2\%}$ 、 $D_{50\%}$ 较四野3DCRT稍大,差异没有统计学意义($P>0.05$)。由表2可知,三野、五野、七野IMRT的CI值优于四野3DCRT,差异具有统计学意义($P<0.05$);三野、五野、七野IMRT的HI值稍优于四野3DCRT,差异没有统计学意义($P>0.05$)。由表3可知,三野、五野、七野IMRT的直肠 V_{45} 、膀胱 V_{45} 、小肠 V_{45} 及 V_{40} 明显低于四野3DCRT,差异具有统计学意义($P<0.05$)。

表1 4种不同照射方法PTV剂量的比较(Gy, $\bar{x} \pm s$)Tab.1 Dose comparison of PTV in four different radiotherapy plans (Gy, $Mean \pm SD$)

| Radiotherapy plan | PTV | | |
|-------------------|------------------|-----------------|------------------|
| | D _{98%} | D _{2%} | D _{50%} |
| Four-field 3DCRT | 44.16±0.23 | 48.85±0.58 | 47.66±0.32 |
| Three-field IMRT | 44.55±0.65 | 48.93±0.49 | 47.78±0.35 |
| Five-field IMRT | 44.73±0.48 | 47.42±0.26 | 46.08±0.28 |
| Seven-field IMRT | 44.68±0.36 | 47.38±0.33 | 46.12±0.38 |

PTV: Planning target volume; 3DCRT: Three-dimensional conformal radiotherapy; IMRT: Intensity-modulated radiotherapy

表2 4种不同照射方法CI和HI值的比较($\bar{x} \pm s$)Tab.2 Comparison of CI and HI in four different radiotherapy plan ($Mean \pm SD$)

| Radiotherapy plan | CI | HI |
|-------------------|------------|-----------|
| Four-field 3DCRT | 0.54±0.06 | 1.09±0.03 |
| Three-field IMRT | 0.73±0.05* | 1.07±0.04 |
| Five-field IMRT | 0.83±0.04* | 1.06±0.02 |
| Seven-field IMRT | 0.84±0.03* | 1.05±0.03 |

CI: Conformal index; HI: Homogeneity index; *: Compared with 3DCRT, $P < 0.05$.

3 讨论

宫颈癌治疗以放射治疗和手术治疗或二者综合治疗为主,化疗为辅^[11]。有研究表明早期高危宫颈癌术后辅助放疗能够降低盆腔复发率,是宫颈癌术后治疗的有效手段^[12]。常规布野外照射往往由于正常器官所受剂量较大,从而增加放疗后副反应。3DCRT通过靶区三维重建,使高剂量区的分布和靶区的立体形状基本一致,相比常规布野外照射已经有较大的剂量学优势^[13]。近年来,随着IMRT技术的发展,该技术可以使靶区得到更加精准的照射,同时

表3 4种不同照射方法正常组织受量的比较(%, $\bar{x} \pm s$)Tab.3 Dose comparison of organs-at-risk in four different radiotherapy plans (%, $Mean \pm SD$)

| Radiotherapy plan | Rectum-V ₄₅ | Bladder-V ₄₅ | Bowels-V ₄₅ | Bowels-V ₄₀ |
|-------------------|------------------------|-------------------------|------------------------|------------------------|
| Four-field 3DCRT | 70.35±13.16 | 72.26±11.28 | 20.18±6.97 | 28.38±5.96 |
| Three-field IMRT | 58.36±10.16* | 56.56±12.11* | 12.56±5.85* | 16.77±8.05* |
| Five-field IMRT | 42.23±9.28* | 43.36±10.13* | 8.76±4.18* | 12.43±6.06* |
| Seven-field IMRT | 40.41±8.26* | 40.85±7.67* | 8.35±3.86* | 12.29±5.03* |

*: Compared with 3DCRT, $P < 0.05$.

大大降低周围正常器官的剂量,使正常组织得到更好的保护^[14-16]。

宫颈癌放疗中直肠并发症的主要影响因素有受照射的总剂量、体积和剂量率,其中最重要的因素是受照剂量^[17-18]。放射性膀胱炎的发生不仅跟盆腔放疗剂量、放疗技术、膀胱受照射的体积有关,还与患者自身特性有关,如分娩使膀胱有慢性轻度炎症,盆腔手术使膀胱轻度损伤等^[19]。如果小肠受照体积及剂量过大,便会引起放射性肠炎的发生^[20]。因直肠、膀胱、小肠并发症的发生均与盆腔放疗剂量密切相

关,所以减少危及器官的照射剂量可降低放疗并发症的发生。

郴州市第一人民医院在未开展IMRT之前基本采用四野3DCRT,在靶区覆盖、CI、HI以及危及器官的保护上基本能满足临床要求。而本研究表明无论三野、五野、七野IMRT在靶区剂量覆盖、适形指数上皆优于四野3DCRT,差异具有统计学意义。均匀性比较无太大差异。较3DCRT,IMRT能较大地减少膀胱、直肠、小肠等正常器官的照射剂量。因此IMRT较四野3DCRT有望减少小肠、直肠和膀胱等正常器

官的放疗并发症,应该更广泛地应用于临床,同时对于经济条件受限的患者采用三野IMRT较四野3DCRT可受益。

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