

Compass验证系统与Oncentra治疗计划系统剂量体积直方图参数差异分析

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【摘要】目的:比较Compass验证系统与Oncentra治疗计划系统之间剂量体积直方图(DVH)参数差异。**方法:**随机选取11例胸部肿瘤和10例头颈肿瘤的计划,计划数据由Oncentra传出,导入到Compass系统中,比较两个系统间的靶区和危及器官DVH参数的差异,胸部肿瘤DVH评估参数:肺的5、10、20 Gy受量体积(Lung_V₅、Lung_V₁₀、Lung_V₂₀),肺平均剂量(Lung_mean),脊髓最大量(Cord_D_{max})和2%体积受量(Cord_D₂),靶区95%体积受量(PTV_D₉₅);头颈部肿瘤DVH参数:脊髓最大量(Cord_D_{max})和2%体积受量(Cord_D₂),左右晶体最大量(Lens_L_D_{max}、Lens_R_D_{max})和2%体积受量(Lens_L_D₂、Lens_R_D₂),左右腮腺平均量(Parotid_L_Mean、Parotid_R_Mean)和50%体积受量(Parotid_L_D₅₀、Parotid_R_D₅₀),脑干最大量(Stem_D_{max})和2%体积受量(Stem_D₂),靶区95%体积受量(PTV_D₉₅)。**结果:**对两系统DVH参数比较,导入到Compass系统中后,胸部肿瘤计划Lung_V₁₀、Lung_V₂₀、Cord_D_{max}和Cord_D₂均显著变大,差异在1%左右;头颈部肿瘤计划:Cord_D_{max}、Cord_D₂、Lens_L_D_{max}、Lens_R_D_{max}、Parotid_L_Mean、Parotid_R_Mean、Stem_D_{max}、Stem_D₂变大,有统计学意义,其中Cord_D_{max}、Lens_L_D_{max}、Lens_R_D_{max}、Stem_D_{max}离散程度要高于Cord_D₂、Stem_D₂,所有计划靶区剂量在两系统间差异非常小。**结论:**两个不同系统按照DICOM协议可以传输剂量数据,但导入新系统中,因为勾画轮廓内剂量格点定义等原因,DVH都有一定的差异,而这个差异不论是否有统计学意义,其差值都非常小,在临床可接受范围内,但在评估计划时仍然需要注意其改变。对于串联器官建议使用体积剂量来比较两系统间的差异。

【关键词】剂量体积直方图;放射治疗;Compass验证系统;Oncentra治疗计划系统

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Difference analysis of dose volume histogram parameters between Compass verification system and Oncentra treatment planning system

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Abstract: Objective To compare the difference of the dose volume histogram (DVH) parameters between Compass verification system and Oncentra treatment planning system. **Methods** Totally, 11 thoracic cancer plans and 10 plans of head and neck cancers were randomly selected. The plan data were transferred from Oncentra to Compass system, and the differences in DVH parameters of target volumes and organs at risk were compared between the two systems. The DVH comparison parameters for thoracic cancer included the lung volumes receiving the doses of 5 Gy, 10 Gy and 20 Gy (Lung_V₅, Lung_V₁₀, Lung_V₂₀), the mean dose for lungs, the maximum dose for cord (Cord_D_{max}), 2% volume dose for cord (Cord_D₂) and 95% volume dose for target volume (PTV_D₉₅). The DVH comparison parameters for head and neck cancers included Cord_D_{max} and Cord_D₂, the maximum dose for left and right lens (Lens_L_D_{max}, Lens_R_D_{max}), 2% volume dose for left and right lens (Lens_L_D₂, Lens_R_D₂), the mean dose for left and right parotid (Parotid_L_Mean, Parotid_R_Mean), 50% volume dose for left and right parotid (Parotid_L_D₅₀, Parotid_R_D₅₀), the maximum dose of brain stem (Stem_D_{max}), 2% volume dose for brain stem (Stem_D₂) and PTV_D₉₅. **Results** After the data were imported to Compass system, Lung_V₁₀, Lung_V₂₀, Cord_D_{max} and Cord_D₂ in thoracic tumor plans were significantly increased, with about 1% differences. For the plans of head and neck cancers, Cord_D_{max}, Cord_D₂, Lens_L_D_{max}, Lens_R_D_{max}, Parotid_L_Mean, Parotid_R_Mean, Stem_D_{max} and Stem_D₂ became larger in the Compass system, with statistical significance; Cord_D_{max}, Lens_L_D_{max}, Lens_R_D_{max}, Stem_D_{max} were more discrete than Cord_D₂, Stem_D₂; the differences of target volumes between the two systems were very small. **Conclusion** Even though the two different systems can transfer dose data based on DICOM protocol, the different definition of dose grids in delineated regions of interest leads to some differences in DVH values between the two systems. The differences with or without statistical significance are very small

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and acceptable. The small changes are needed be given attention for plan evaluation. For the serial organs at risk, volume dose is recommended to compare the difference between the two systems.

Key words: dose volume histogram; radiotherapy; Compass verification system; Oncentra treatment planning system

前言

在放射治疗中,通常通过剂量体积直方图(Dose Volume Histogram, DVH)和等剂量曲线来评估计划^[1],因为DVH可以定量地给出肿瘤靶区和危及器官体积剂量和受量体积^[2-4],对于靶区以及危及器官的评估更方便。许多研究也给出了DVH参数与放射损伤间的关系^[5-7]。Compass验证系统是三维剂量验证系统,可以通过对比计划DVH和测量并计算后的验证DVH,分析两系统间的DVH在靶区和危及器官的差异来验证治疗计划^[8-10]。但不同系统按照各自对勾画区内剂量网格的内部定义和算法,剂量文件通过DICOM协议传输和导入后,Compass验证系统得到不同于原计划系统计算的DVH结果,本文主要研究两系统间的DVH参数在导入后的差异,并分析其原因。

1 材料和方法

1.1 临床资料

2015年5月在本院治疗的胸部肿瘤11例,头颈部肿瘤10例。其中胸部肿瘤包括肺癌6例,食管癌5例,头颈部全部为鼻咽癌。

1.2 计划系统与DVH参数

Compass (IBA, 7.2.a, 瑞典)剂量验证系统, Oncentra (Elekta, V4.3.0, 荷兰)治疗计划系统。其中, Oncentra系统可以按照DICOM协议导出计划、剂量、靶区和CT序列, Compass系统可以导入所有数据。比较Oncentra计划系统DVH参数与传输至Compass系统后DVH参数值的变化。胸部肿瘤(肺癌, 食管癌)DVH参数评估: 肺的5、10、20 Gy受量的相对体积(Lung_V₅、Lung_V₁₀、Lung_V₂₀)和平均剂量(Lung_mean), 脊髓最大量(Cord_D_{max})和2%体积受量(Cord_D₂), 靶区95%体积受量(PTV_D₉₅); 鼻咽癌DVH参数评估: 脊髓最大量(Cord_D_{max})和2%体积受量(Cord_D₂), 左右晶体最大量(Lens_L_D_{max}、Lens_R_D_{max})和2%体积受量(Lens_L_D₂、Lens_R_D₂), 左右腮腺平均量(Parotid_L_Mean、Parotid_R_Mean)和50%体积受量(Parotid_L_D₅₀、Parotid_R_D₅₀), 脑干最大量(Stem_D_{max})和2%体积受量(Stem_D₂), 靶区95%体积受量(PTV_D₉₅)。所有数据导入到Compass系统后不做任何设置, 如Compass系统中读取的PTV_D₉₅为绝对剂量值, 单位cGy, 未做任何归一。

1.3 数据结果统计

我们以原计划初始计算的DVH参数为基准, 计算两系统DVH参数的差值结果, 即 $DVH_{差} = DVH_{Oncentra} - DVH_{Compass}$, 应用统计软件SPSS16进行结果的统计分析, 使用配对t检验两者差异, 显著性水平 $\alpha=0.05$ 。P<0.05为差异有统计学意义。

2 结果

2.1 两系统胸部DVH参数差异

Oncentra计划系统与Compass系统相比, 导入到Compass系统后, Lung_V₅、Lung_Mean和PTV_D₉₅变大, 但没有统计学意义, Lung_V₁₀、Lung_V₂₀、Cord_D_{max}和Cord_D₂均显著变大, 详见表1。

表1 胸部肿瘤两系统间DVH值比较

Tab.1 DVH comparison between Oncentra and Compass systems for thoracic cancer

Project	Difference (Mean±SD)	P value
Lung_V ₅ (%)	-0.18±0.09	0.520
Lung_V ₁₀ (%)	-0.85±0.66	0.002
Lung_V ₂₀ (%)	-1.09±0.07	0.000
Lung_mean (cGy)	-2.45±4.52	0.102
Cord_D _{max} (cGy)	-189±118	0.002
Cord_D ₂ (cGy)	-9.69±6.34	0.001
PTV_D ₉₅ (cGy)	-0.84±25.62	0.916

DVH: Dose volume histogram; PTV: Planning target volume

2.2 两系统头颈DVH参数差异

Oncentra计划系统与Compass计划系统相比, 导入到Compass系统后, Cord_D_{max}、Cord_D₂、Lens_L_D_{max}、Lens_R_D_{max}、Parotid_L_Mean、Parotid_R_Mean、Stem_D_{max}、Stem_D₂变大, 有统计学意义。其余参数有变化, 但没有统计学意义, 详见表2。

3 讨论

不同系统对于DVH的计算采用相同的算法, 均是收集各器官的剂量数据^[11]。从结果中可以发现, 对于脊髓、脑干的最大量, 两系统之间比较结果都具有统计学差异, 其原因是Oncentra系统中最大量、最小量的结果均是使用统计学中的抽样法, 即随机采集各器官中若干剂量格点的剂量值, 以此来代表该器官的整体受量^[12]。

表2 头颈部肿瘤两系统间DVH值比较
Tab.2 DVH comparison between Oncentra and Compass
systems for head and neck cancer

Project	Difference (Mean±SD, cGy)	P value
Cord_D _{Max}	-402.60±180.80	0.000
Cord_D ₂	-14.46±42.44	0.001
Lens_L_D _{max}	-100.00±98.20	0.010
Lens_L_D ₂	-12.87±23.43	0.116
Lens_R_D _{max}	-117.70±128.99	0.018
Lens_R_D ₂	-22.68±42.10	0.123
Parotid_L_Mean	-51.60±34.57	0.001
Parotid_L_D ₅₀	-18.22±48.50	0.074
Parotid_R_Mean	-40.90±45.77	0.020
Parotid_R_D ₅₀	-8.65±14.78	0.097
Stem_D _{max}	-481.40±346.30	0.002
Stem_D ₂	-17.60±12.27	0.001
PTV_D ₉₅	5.05±27.30	0.572

而在Compass中并没有直接给出某器官最大量和最小量的数值。本文中采用D₀来表示最大量,即0体积的受量。随机采样的方法最大特点是具有较高的准确性,运算速度快。对于勾画的器官较多、器官内剂量格点较多时效率较高,但在体积比较小、器官内剂量格点不多时,其抽样误差会有些影响,例如左右晶体等。因此,在结果中Oncentra与Compass左右晶体最大剂量值的差异有统计学意义,且两者差异的离散程度都较大,正是随机采样的随机性特点的原因。

ICRU83号报告中对于串联器官推荐使用器官D₂来表示近似最大量^[13]。从结果中可以看到,两系统在胸部和头颈部的危及器官脊髓、脑干、左右晶体,最大剂量值的差异都比相对应的2%体积剂量值(D₂)大,而且标准差也很大,即离散程度大。因此,我们在验证时需要更关注危及器官的D₂值。

在并行器官中,胸部肿瘤计划中的肺Lung_V₁₀、Lung_V₂₀,头颈部肿瘤中的Parotid_L_Mean、Parotid_R_Mean在两个系统中的差具有统计学意义,笔者认为原因如下:(1)不同系统为了计算的精确性和效率^[14],在器官内的剂量格点有不同的处理方法,在Oncentra中格点大小可以手工设定也可系统自动设定,Compass系统中为自动设定,但是格点大小以0.125 cm为起始,当某一个方向超过256个格点后,系统自动增加该方向格点大小,保证在该方向不超过256个格点。因此数据导入到Compass系统后,其剂量格点有可能发生改变;(2)在Compass系统中,CT层间轮廓都要使用内插或者外

扩方法来修正^[15]。在此过程中会有体积的变化。两者差别均为导入后的值要大一些,但离散程度不是很大,我们可以理解为系统误差。

综上所述,从结果中我们可以发现,不同系统间传输剂量,在导入新系统中后其DVH结果都有一定的差异,而这个差异不论是否有统计学意义,其差值都非常小。例如肺体积量都1%左右,但在评估计划时还需要注意其变化。而对于串联器官建议使用体积剂量来评估。靶区在两者间没有明显差异,可以认为两者相同。

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