

鼻咽癌调强放射治疗计划设计的规范与实践

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浙江省肿瘤医院鼻咽癌调强放疗工作环境概况

- 鼻咽癌调强专用加速器(Elekta Precise)两台
- GE大孔径CT模拟(Hight speed)系统一套
- ADAC计划系统三套(带医生工作站四台)
- Mapcheck 1175验证系统一套、专用测量模体
- 计划设计参考标准: **RTOG Protocal 0522、0615**等
- **monaco**计划系统一套(带蒙特卡洛算法和生物剂量优化, 做剂量对照和研究用)
- 近年鼻咽癌调强病例 ≥ 500 例/年

我院鼻咽癌调强计划设计的规范与实践标准

- 统一的靶区和重危器官命名(临时假器官除外)
- 统一处方剂量(允许特殊情况除外)、统一剂量归一标准, 使同等分期病人的受照剂量有可对比性, 从而有临床统计意义
- 调强计划设计由鼻咽癌计划组物理师负责, 按脚本化(**Protocol**)的计划设计流程进行
- 计划验证由剂量测量组专人负责进行验证, 比对采用DTA方法, 条件为TH10.0、%Diff 3.0、mm3.0、Pass标准 $\geq 94\%$, 等中心点剂量误差 $\leq 3\%$
- EPID摆位验证由剂量测量组专人负责进行, 对病人进行垂直(0度)和水平(90度)二个方向照射前投照, 影像与计划的DRR影像比对, 确定X、Y、Z轴方向误差 σ_x 、 σ_y 、 σ_z , Pass标准 σ_x 、 σ_y 、 σ_z 均小于3mm

鼻咽癌调强放射治疗应用硬件设备

- **GE80cm**大孔径CT模拟系统
- (带ADW后处理工作站)
- **ADAC pinnacle**计划系统, 版本7.6c
- (带DMPO, EUD功能)
- 医科达**Precise**加速器
- (80叶MLC、带EPID)
- **Sun Nuclear Mapcheck 1175**二维验证系统, 专用测量体模

CT扫描与靶区、器官勾画

- CT扫描影像经网络传输至**ADAC**治疗计划系统
- CT模拟定位时设置**MARK**点随影像传送至计划系统, 一般情况下**MARK**点尽量设置恰当, 可作为摆位中心点使用, 减少重新对位环节产生的误差
- 按统一命名的靶区、器官名称脚本, 医生进行靶区和重危器官的勾画

ROI命名规范 (**Protocol**)

- | | | |
|---------------|------------------|-------------------|
| • GTVnx | • Optic_nerve_L | • Pituitary |
| • PTVnx | • Optic_nerve_R | • Cochrea_L |
| • GTVnd | • Optic_chiasm | • Cochrea_R |
| • PTV1 | • Larynx/trachea | • Ring |
| • PTV2 | • Mandible_L | • NT |
| • Brain_stem | • TMJ_L | • PTV1-(PTVnx+nd) |
| • Spinal_cord | • TMJ_R | • PTVnx-GTVnx |
| • Parotid_L | • Temple_lobe_L | • Fan_up |
| • Parotid_R | • Temple_lobe_R | • Fan_down |
| • Lens_L | • Pituitary | |
| • Lens_R | • Cochrea_L | |

物理参数设置 (protocol)

- 优化算法: **DMPO**
- 照射野数: **9野** (等分角度)
- 子野数量限定: **100**
- 最大子野跳数: **5MU**
- 最大子野面积: **5cm²**

计划处方剂量 (protocol)

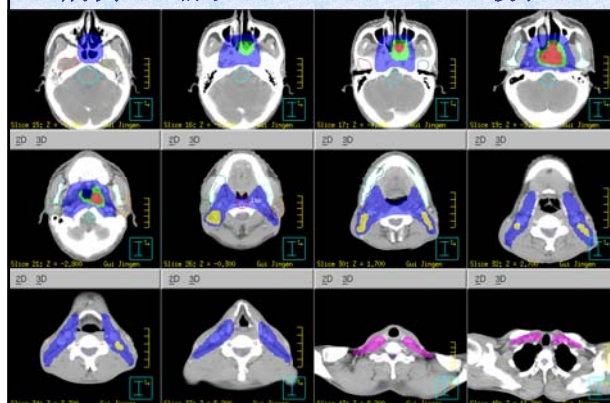
靶区	分次剂量 cGy	照射次数 cGy	总剂量
GTVnx	220	33	7260
PTVnx	213	33	6996
GTVnd	213	33	6996
PTV1	186	33	6006
PTV2	186	<u>28</u>	5096

靶区剂量指的是 $\geq 95\%$ 靶区体积所达到的剂量

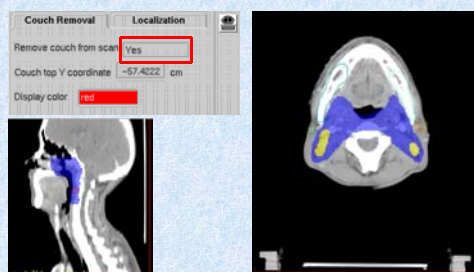
主要危及器官的剂量限量(protocol)

器官	MaxDose(cGy)	Volume
Brain_stem	5400	0
Spinal_cord	4000	0
Parotid	3000	<30%
Lence	800	0
Optic_nerve	5400	0
Optic_chiasm	5400	0
Temple lobe	6000	<1cm ³

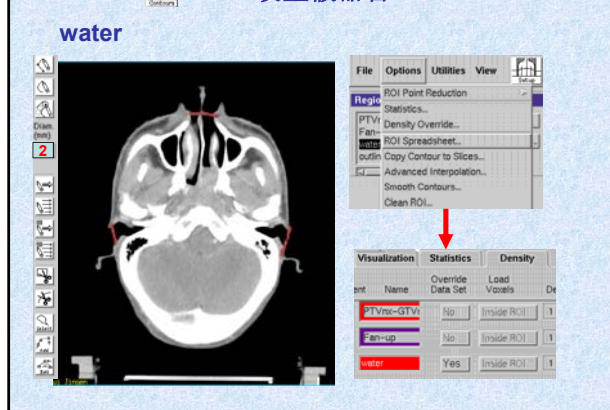
病例一: 编号090445 (GTVnx、GTVnd较小)

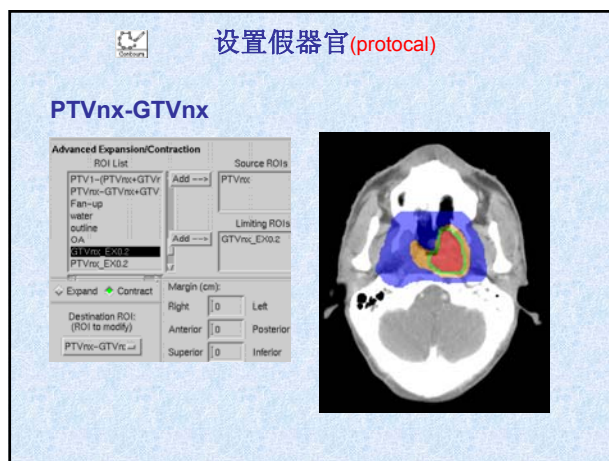
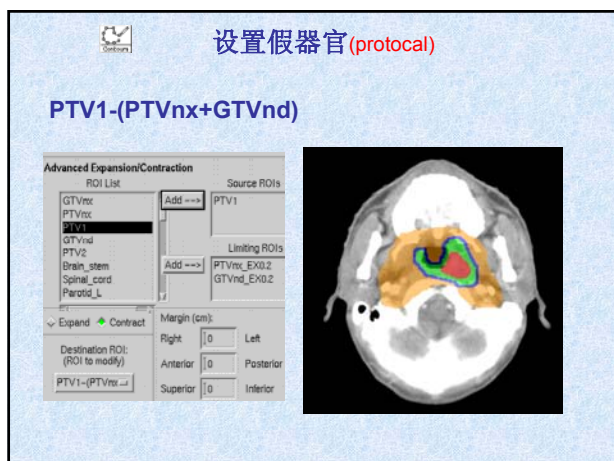
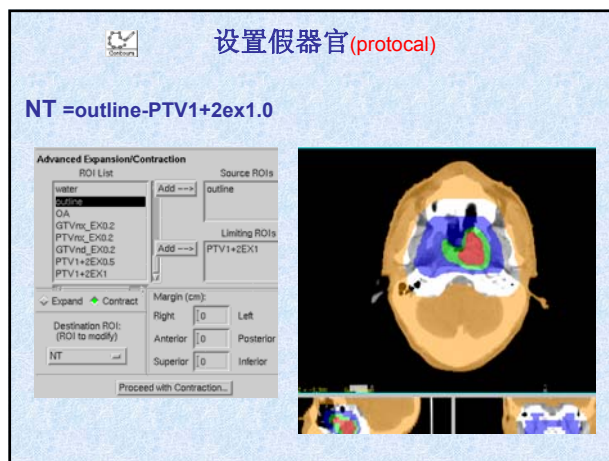
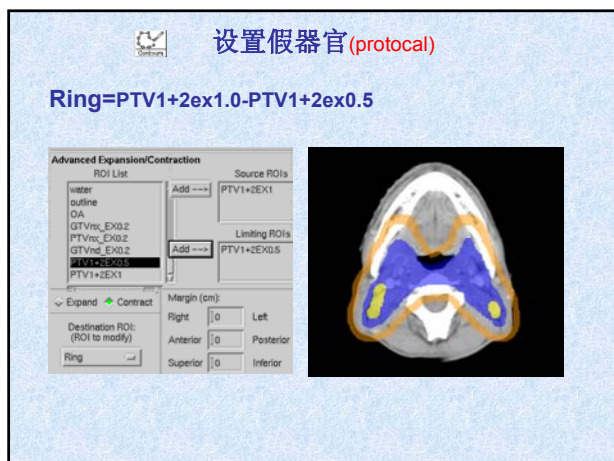
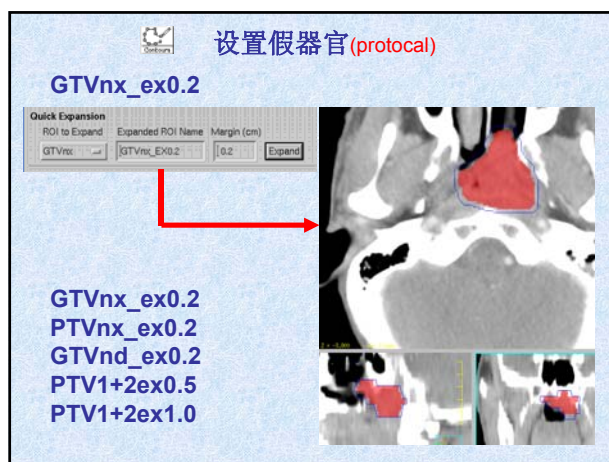
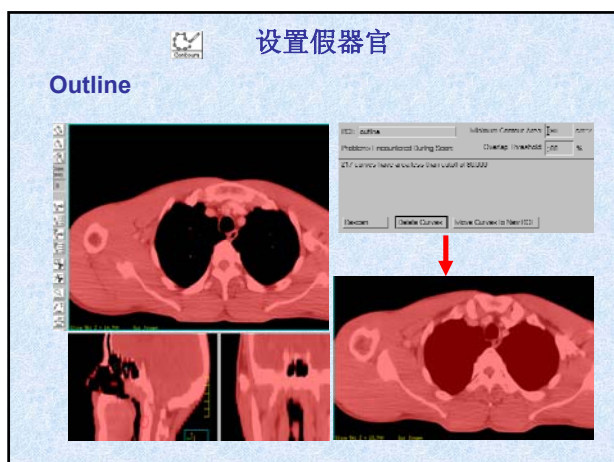


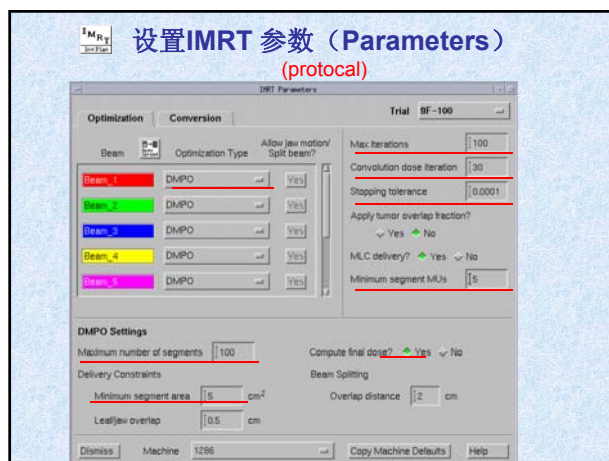
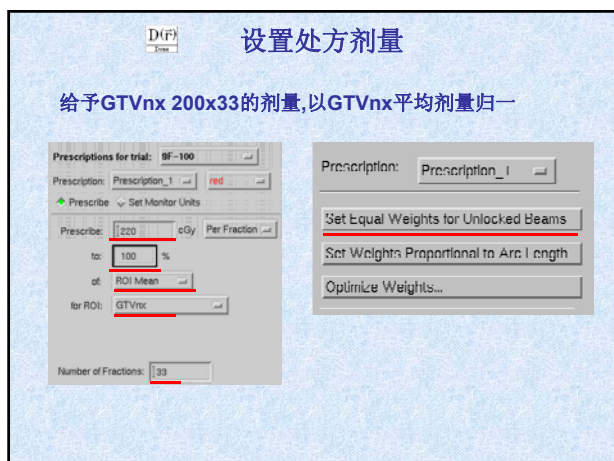
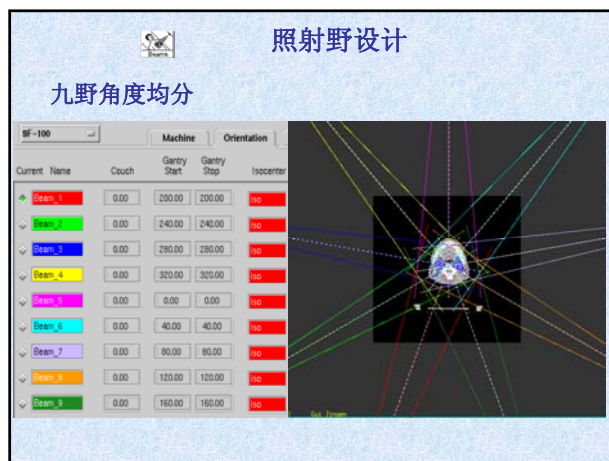
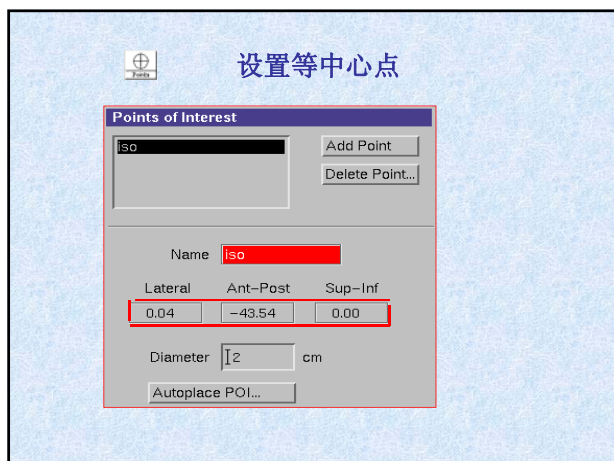
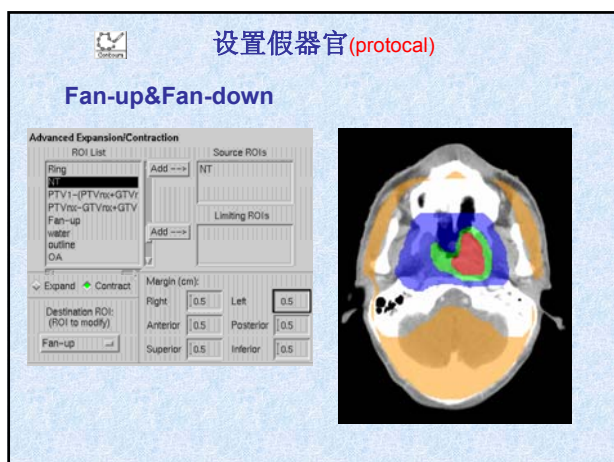
去CT床



设置假器官









设置IMRT Objectives(靶区) (protocol)

ROI	Type	Constrain	Target cGy	% Volume	% Variation	Weight
GTVnx	Min Dose		7260			50
GTVnx	Min DVH		7260	95		50
GTVnx	Max Dose		7500			50
GTVnx	Uniform Dose		7300			1
PTVnx-GTVnx	Min Dose		6996			50
PTVnx-GTVnx	Max Dose		7100			30
PTVnx-GTVnx	Min DVH		6996	95		30
PTVnx-GTVnx	Uniform Dose		7050			1
PTVnx	Min Dose		6996			70
PTVnx	Max Dose		7200			50
PTVnx	Min DVH		6996	95		70
PTVnx	Uniform Dose		7050			1



设置IMRT Objectives(靶区) (protocol)

ROI	Type	Constrain	Target cGy	% Volume	% Variation	Weight
PTV1-(PTVnx+GTVnx)	Min Dose		6000			60
PTV1-(PTVnx+GTVnx)	Max Dose		6700			50
PTV1-(PTVnx+GTVnx)	Min DVH		6000	95		70
PTV1-(PTVnx+GTVnx)	Uniform Dose		6050			1
PTV2	Min Dose		6950			80
PTV2	Max Dose		6300			70
PTV2	Min DVH		6000	95		100
PTV2	Uniform Dose		6050			1



设置IMRT Objectives(危及器官) (protocol)

ROI	Type	Constrain	Target cGy	% Volume	% Variation	Weight	Objective Value	s
Brain_Cont	Max Dose		5200			20	---	
Brain_Cont	Max EUD		2200			0.5	---	1.5
Brain_Cont	Max Dose		3800			20	---	
Brain_Cont	Max EUD		1600			0.5	---	1.5
Parotid_L	Max DVH		3000	45		10	---	
Parotid_L	Max EUD		2200			0.2	---	1
Parotid_R	Max DVH		3000	45		10	---	
Parotid_R	Max EUD		2200			0.2	---	1
Lens_L	Max Dose		700			10	---	
Lens_L	Max EUD		500			0.5	---	1.2
Lens_R	Max Dose		700			10	---	
Lens_R	Max EUD		500			0.5	---	1.2

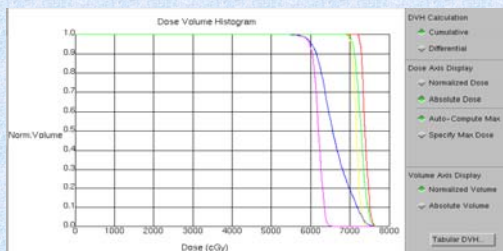


设置IMRT Objectives(危及器官) (protocol)

ROI	Type	Constrain	Target cGy	% Volume	% Variation	Weight	Objective Value	s
Brain_Cont	Max Dose		5200			10	---	
Brain_Cont	Max Dose		5200			10	---	
Brain_Cont	Max Dose		5200			10	---	
Parotid_Cont_L	Max Dose		5400			5	---	
Parotid_Cont_R	Max Dose		5400			5	---	
Spine	Max Dose		5300			5	---	
Spine	Max EUD		3500			0.2	---	1
NT	Max Dose		3700			5	---	
NT	Max EUD		1200			0.2	---	1
Gen-L	Max Dose		3400			5	---	
Gen-R	Max Dose		3800			10	---	



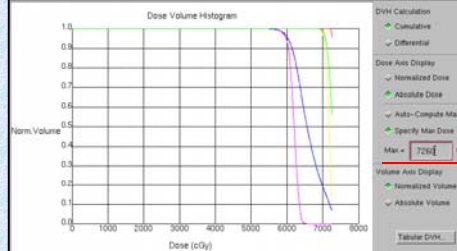
DVH(靶区)



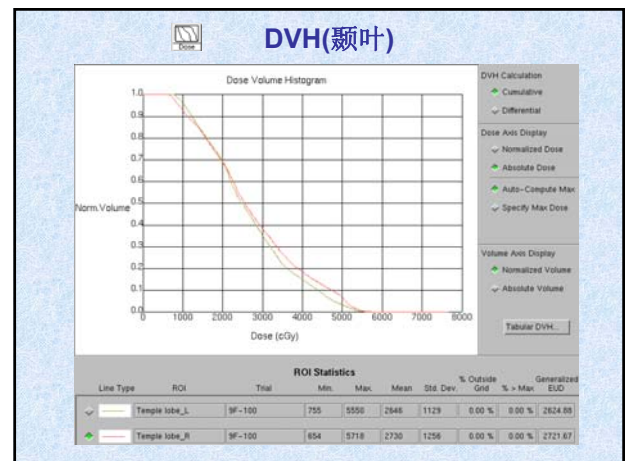
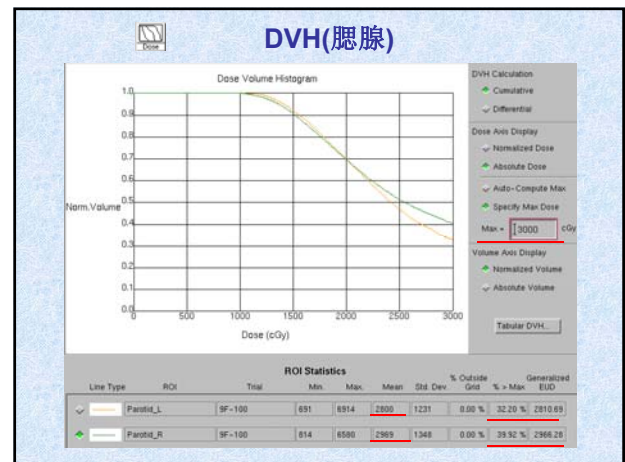
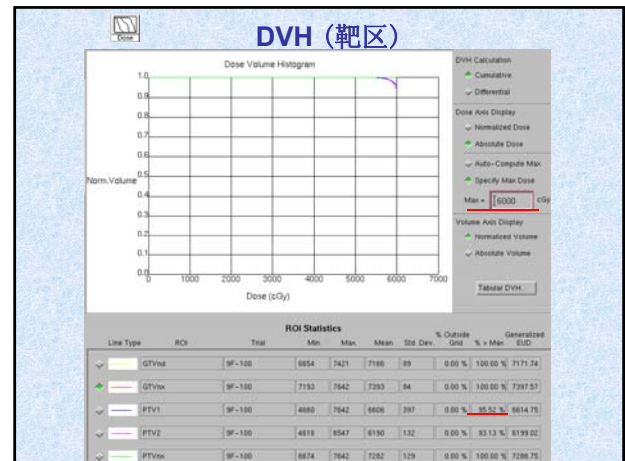
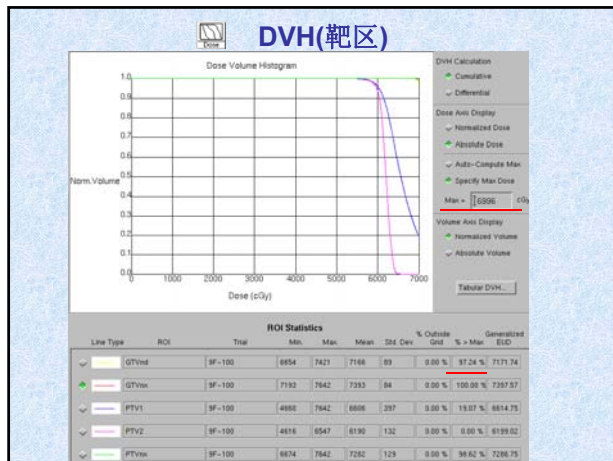
		ROV Statistics								
Line Type	ROI	Total	Min	Max	Mean	Std. Dev.	% Outside Grid	% > Max EUD	Generated EUD	
✓	GTVnd	9F-100	6654	7421	7166	89	0.00 %	0.00 %	7171.74	
	GTVnx	9F-100	7193	7642	7383	84	0.00 %	0.00 %	7297.57	
✓	PTV1	9F-100	4880	7642	6806	397	0.00 %	0.00 %	6614.75	
	PTV2	9F-100	4816	6547	6190	132	0.00 %	0.00 %	6199.02	
✓	PTVnx	9F-100	6674	7642	7282	129	0.00 %	0.00 %	7286.75	

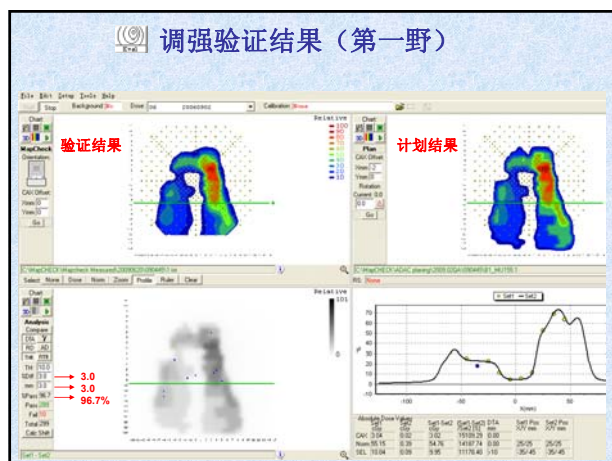
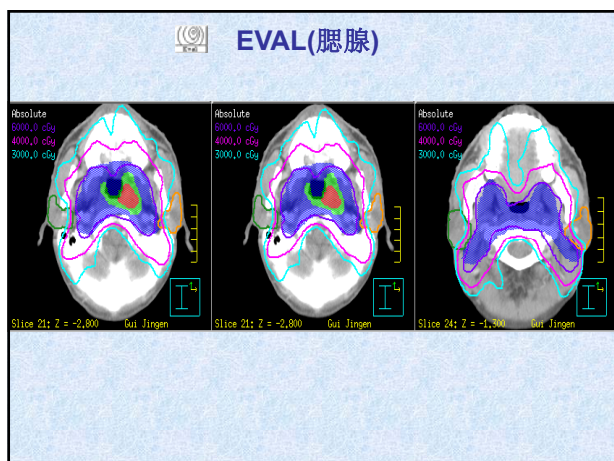
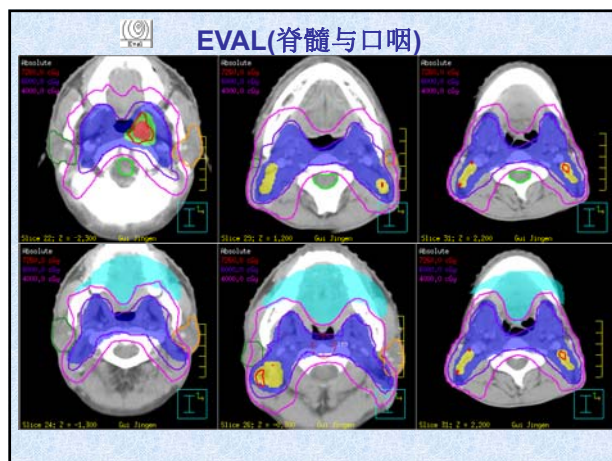
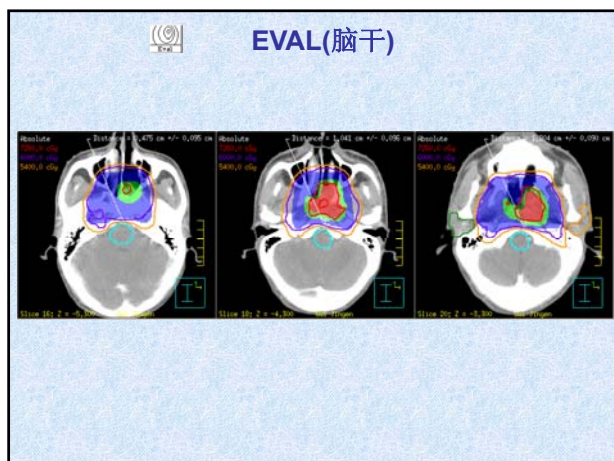
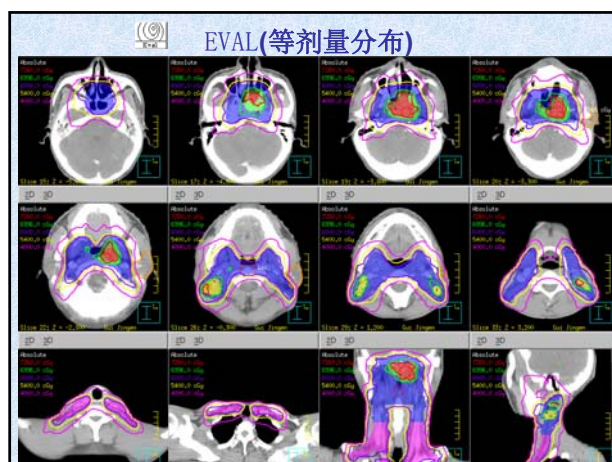
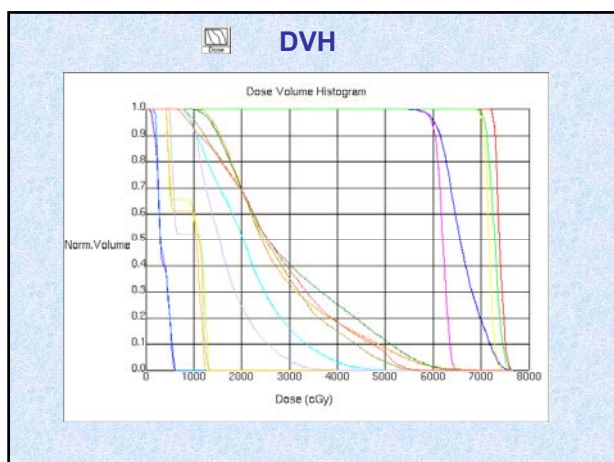


DVH(靶区)

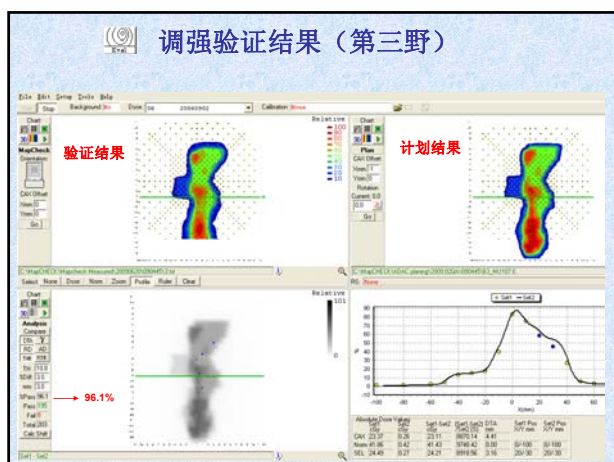


ROI Statistics									
Line Type	ROI	Total	Min	Max	Mean	Std Dev	% Outside Grid	% > Max	Generated
✓	GTVnd	9F-100	6654	7421	7166	89	0.00 %	13.25 %	7171.74
✗	GTVnx	9F-100	7193	7642	7393	84	0.00 %	85.86 %	7297.57
✓	PTV1	9F-100	4880	7642	6806	397	0.00 %	6.48 %	6614.75
✓	PTV2	9F-100	4816	6547	6190	132	0.00 %	0.00 %	6199.02
✓	PTVnx	9F-100	6674	7642	7282	129	0.00 %	55.76 %	7286.75

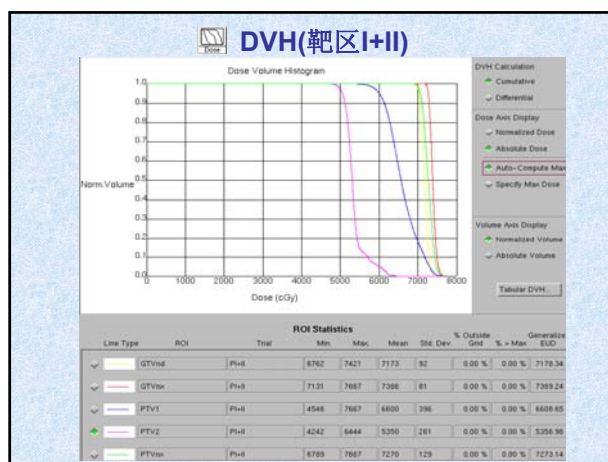




调强验证结果 (第三野)



DVH(靶区I+II)



I+II计划优化结果(靶区)

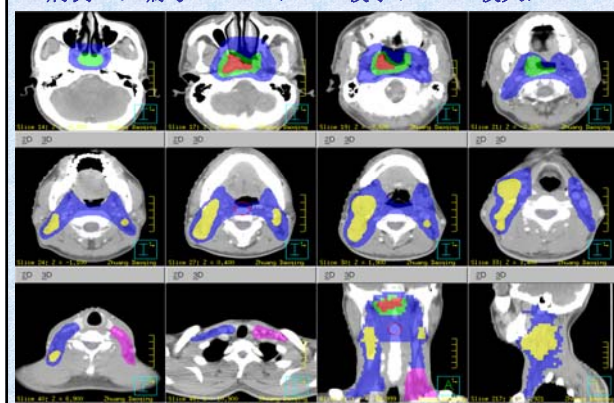
- 计划结果
- 预置处方
- GTVnx (D95) 7260cGy 7260cGy
- PTVnx (D95) 7050cGy 6996cGy
- GTVnd (D95) 7010cGy 6996cGy
- PTV1 (D95) 6010cGy 6006cGy
- PTV2 (D95) 5060cGy 5096cGy

- 子野数量 100
- 总跳数 1155.5MU
- 剂量率 400~500MU/min
- 总出来时间 3min≤

I+II计划主要危及器官的剂量

器官	MaxDose(cGy)	Volume
Brain_stem	5117 5400	0
Spinal_cord	3840 4000	0
Parotid_L	3000 3000	32%
Parotid_R	3000 3000	39.2%
Lence_L	537 800	0
Lence_R	588 800	0
Optic_nerve_L	1447 5400	0
Optic_nerve_R	1354 5400	0
Optic_chiasm	1292 5400	0
Temple_lobe_L	5662 6000	0cm³
Temple_lobe_R	5875 6000	0cm³

病例二: 编号090440 (GTVnx较小、GTVnd较大)

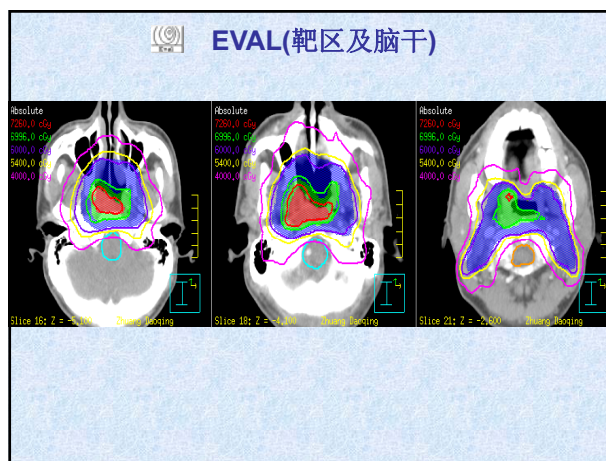
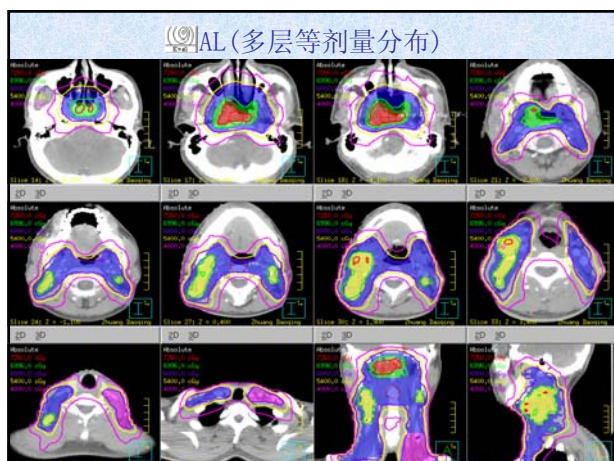
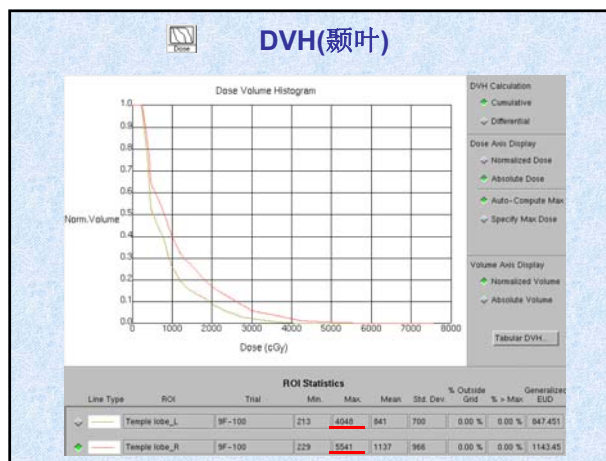
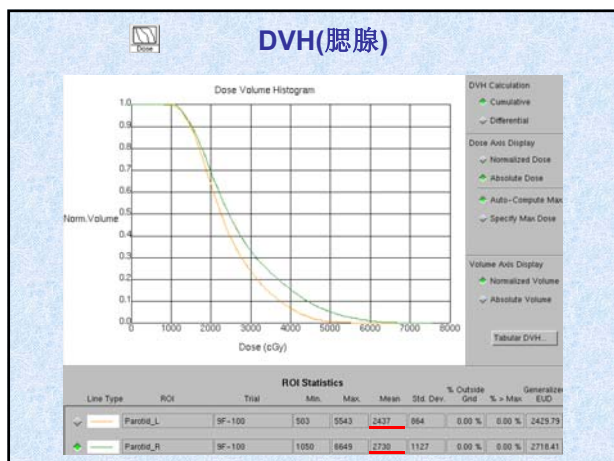
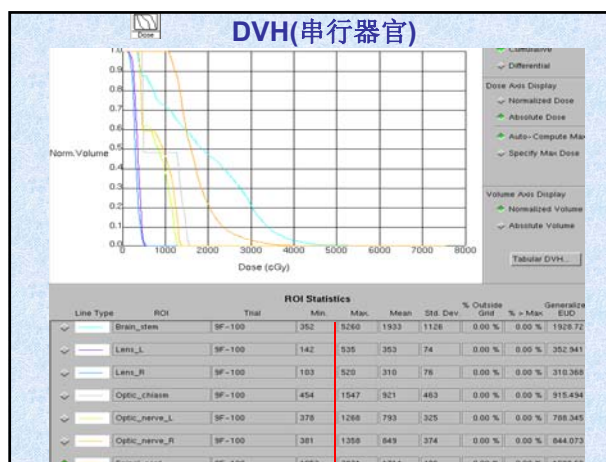
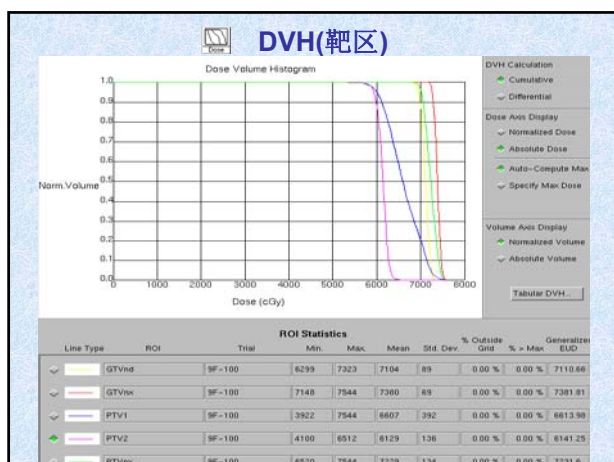


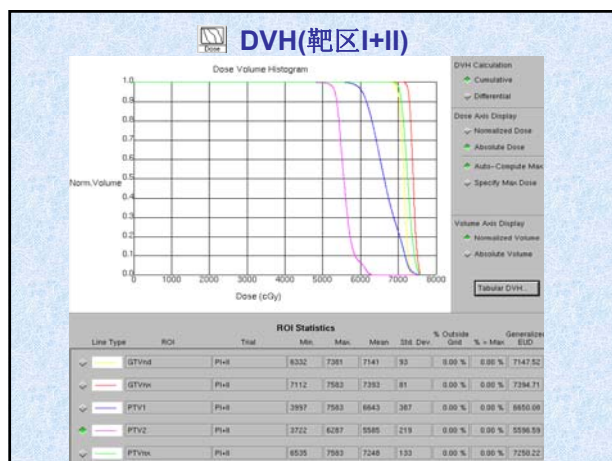
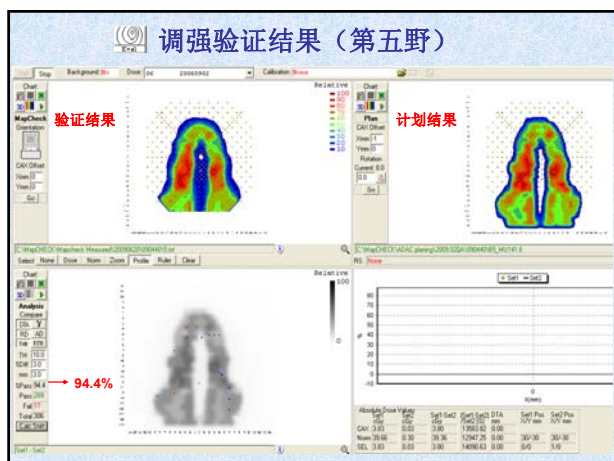
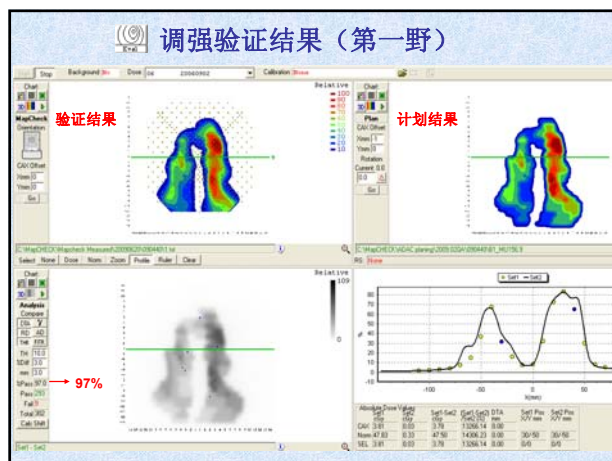
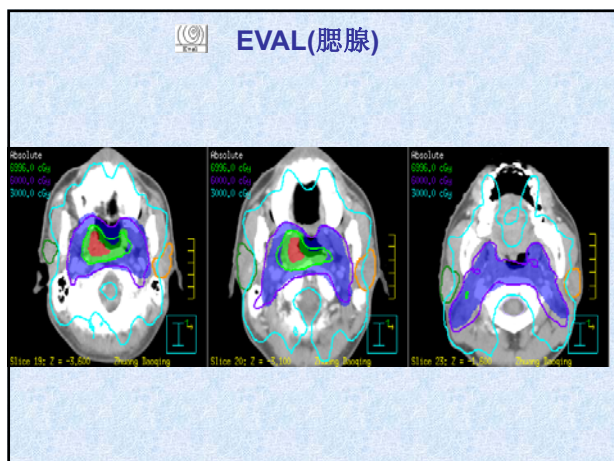
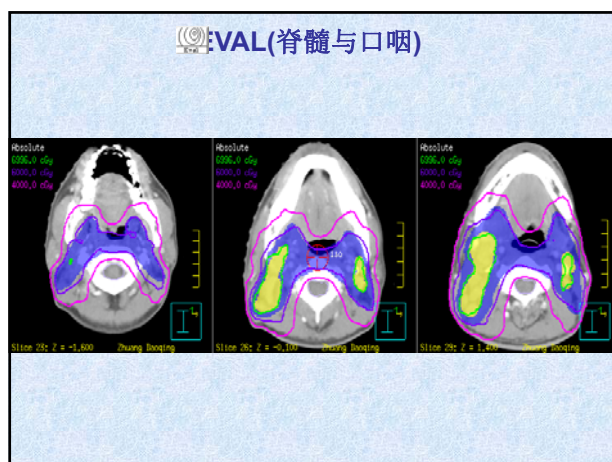
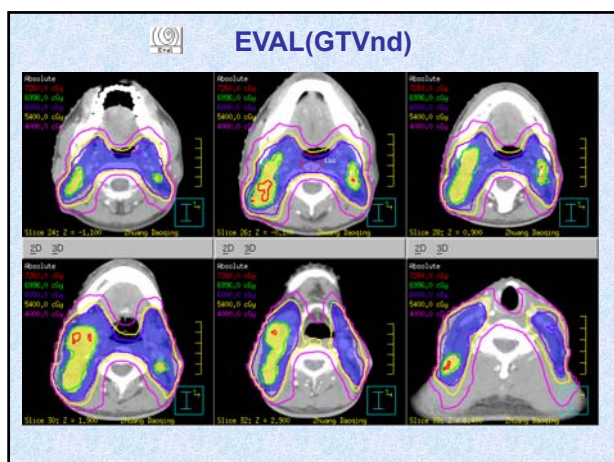
IMRT Objectives

(protocol)

GTVnd的目标函数

ROI	Type	Constrain	Target cGy	% Volume	% Variation	Weight	Objective Value
PTVnx=GTVnx+K	Uniform Dose		7050			1	0.000500321
GTVnx	Min Dose		6996			7d	0.00320887
GTVnx	Max Dose		7200			50	0.000844826
GTVnd	Min DVH		6930	95		100	4.689e-07
GTVnd	Uniform Dose		7000			1	0.000520347





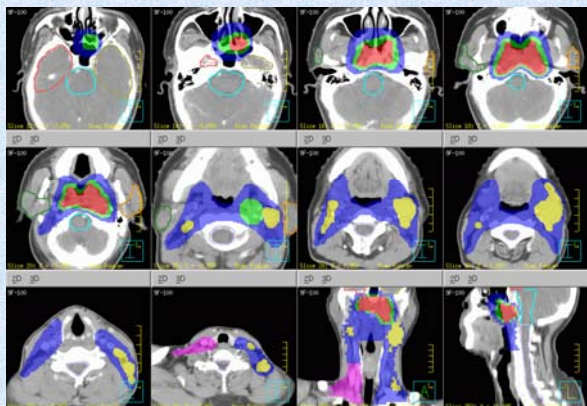
计划优化结果

	计划结果	预置剂量
• GTVnx (D95)	7260cGy	7260cGy
• PTVnx (D95)	7010cGy	6996cGy
• GTVnd (D95)	6960cGy	6996cGy
• PTV1 (D95)	6000cGy	6006cGy
• PTV2 (D95)	5315cGy	5096cGy
• 子野数	98	
• 总跳数	1165.5MU	

I+II计划主要危及器官的剂量

器官	MaxDose(cGy)	Volume
Brain_stem	5331	0
Spinal_cord	3922	0
Parotid_L	3000	24%
Parotid_R	3000	33.9%
Lence_L	537	0
Lence_R	528	0
Optic_nerve_L	1575	0
Optic_nerve_R	1291	0
Optic_chiasm	1372	0
Temple_lobe_L	4049	0cm ³
Temple_lobe_R	5611	0cm ³

病例三：编号090377（GTVnx较大、GTVnd较大）



IMRT Objectives

GTVnx、PTVnx、GTVnd的目标函数

ROI	Type	Constran	Target cGy	% Volume	% Variation	Weight	Objective Value
GTVnx	Min Dose		7260			1.70	0.00103687
GTVnx	Min DVH		7260	95		1.70	1.20575e-05
GTVnx	Max Dose		7500			1.70	0.00137256
GTVnx	Uniform Dose		7300			1.1	0.000457563
PTVnx-GTVnx	Min Dose		6960			1.50	0.0040429
PTVnx-GTVnx	Max Dose		7150			1.30	0.00461792
PTVnx-GTVnx	Min DVH		6996	95		1.30	0.000197055
PTVnx-GTVnx	Uniform Dose		7050			1.1	0.000613318
GTVnd	Min Dose		6996			1.80	0.00399251
GTVnd	Max Dose		7200			1.50	0.00445066
GTVnd	Min DVH		7020	95		1.100	0.000363696
GTVnd	Uniform Dose		7050			1.1	0.00060611

IMRT Objectives

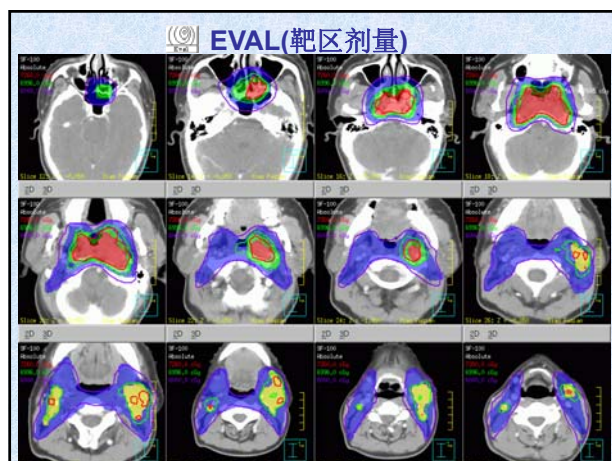
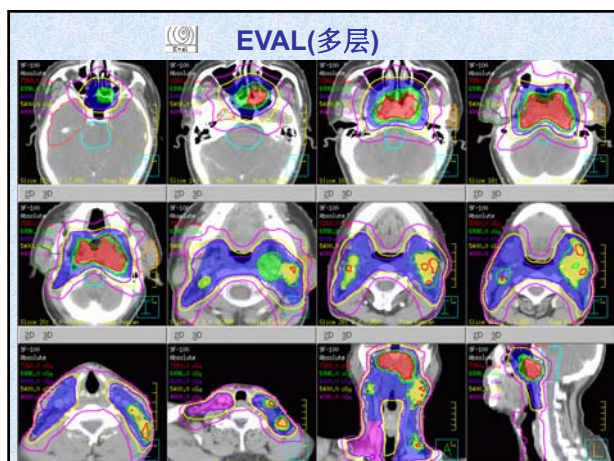
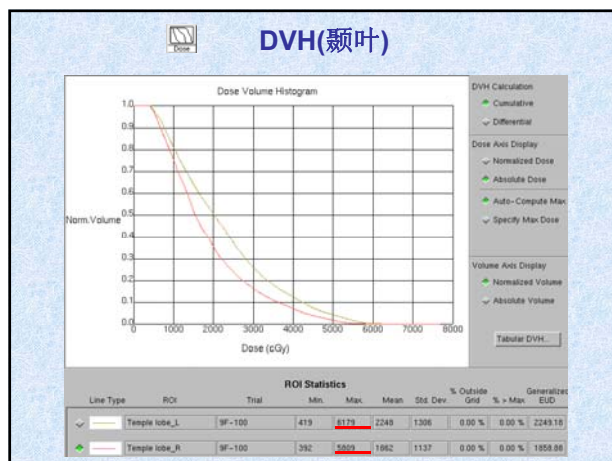
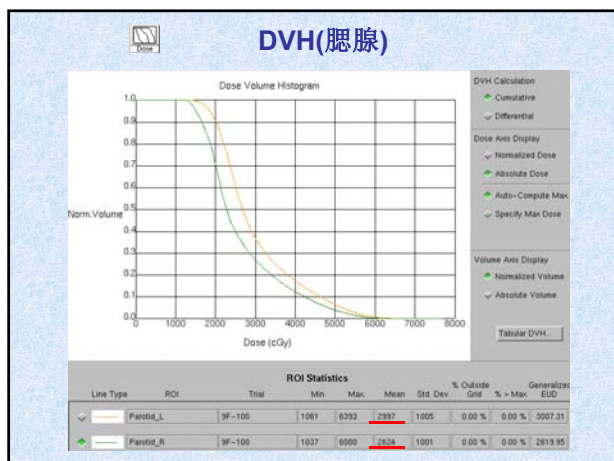
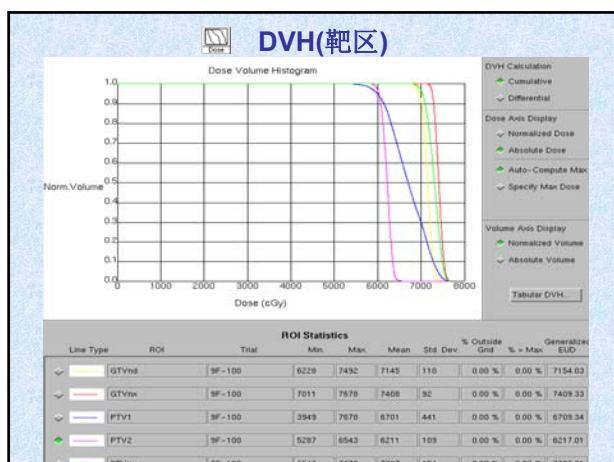
PTV1、PTV2的目标函数

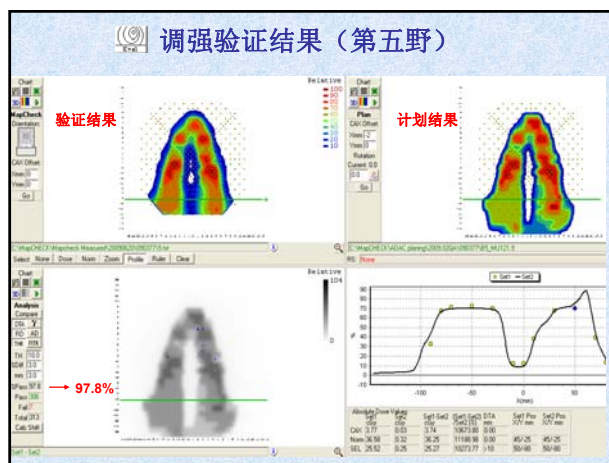
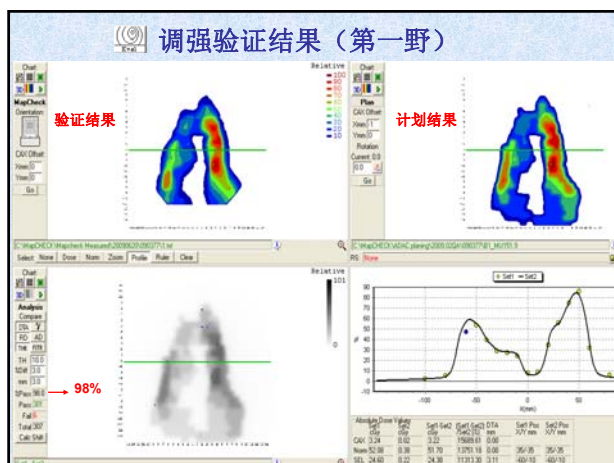
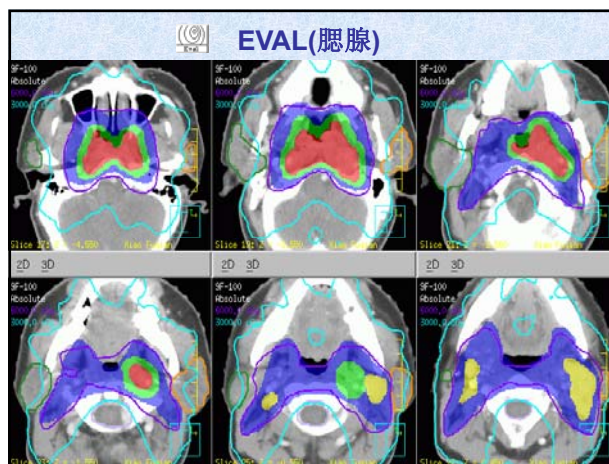
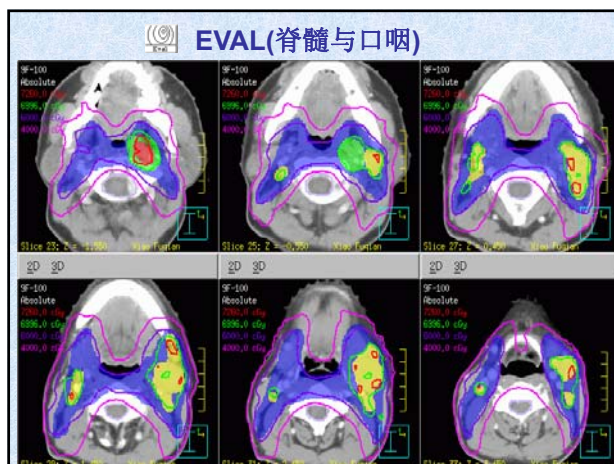
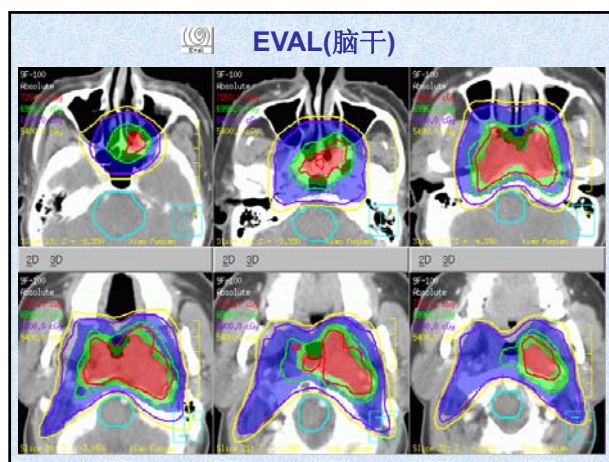
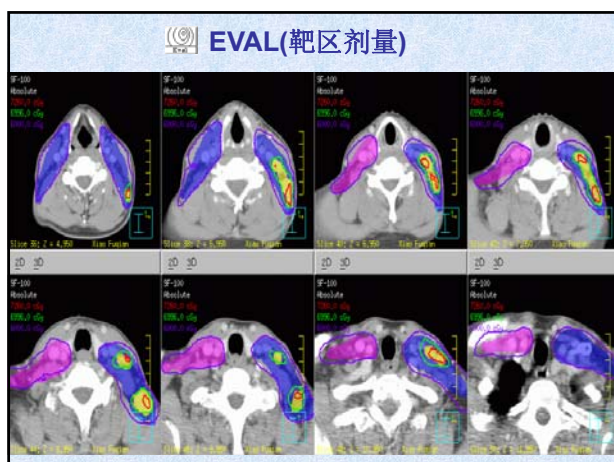
ROI	Type	Constran	Target cGy	% Volume	% Variation	Weight	Objective Value
PTV1-(PTVnx+GTVnx)	Min Dose		6000			1.30	0.00999382
PTV1-(PTVnx+GTVnx)	Max Dose		6700			1.50	0.0134567
PTV1-(PTVnx+GTVnx)	Min DVH		6000	95		1.70	0.000582611
PTV1-(PTVnx+GTVnx)	Uniform Dose		6050			1.1	0.00795987
PTV2	Min Dose		5950			1.50	0.00109544
PTV2	Max Dose		6300			1.70	0.00369904
PTV2	Min DVH		6000	95		1.1	2.19801e-06
PTV2	Uniform Dose		6050			1.1	0.00126794

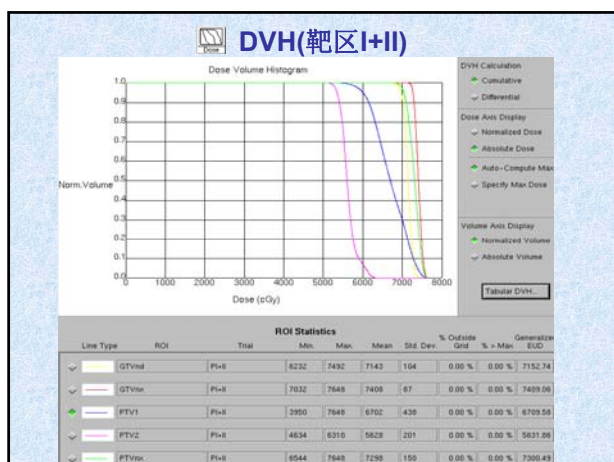
IMRT Objectives

脑干、脊髓、腮腺的目标函数

ROI	Type	Constran	Target cGy	% Volume	% Variation	Weight	Objective Value	a	gEUD
Brain_stem	Max Dose		5200			1.20	0.000342269		
Brain_stem	Max EUD		5000			1.20	8.74569e-05	1.50	5046.76
Spinal_cord	Max Dose		3800			1.20	0.000319002		
Spinal_cord	Max EUD		11600			0.5	0.000582096	1.5	1722.07
Parotid_L	Max DVH		3000	45		1.10	0		
Parotid_L	Max EUD		2600			0.2	0.0010637	1.1	3023.99
Parotid_R	Max DVH		3000	45		1.10	0		
Parotid_R	Max EUD		2200			0.2	0.00145752	1.1	5619.95







计划优化结果

- | | 计划结果 | 预置处方剂量 |
|---------------|---------|---------|
| • GTVnx (D95) | 7260cGy | 7260cGy |
| • PTVnx (D95) | 7030cGy | 6996cGy |
| GTVnd (D95) | 6970cGy | 6996cGy |
| PTV1 (D95) | 6000cGy | 6006cGy |
| • PTV2 (D95) | 5340cGy | 5096cGy |
| • 子野数量 | 100 | |
| • 总跳数 | 1126MU | |

I+II计划主要危及器官的剂量

器官	MaxDose(cGy)	Volume
Brain_stem	5377	0
Spinal_cord	3818	0
Parotid_L	3000	36.6%
Parotid_R	3000	26.5%
Lence_L	680	0
Lence_R	525	0
Optic_nerve_L	3317	0
Optic_nerve_R	2826	0
Optic_chiasm	2470	0
Temple_lobe_L	6137	6000=0.03cm ³
Temple_lobe_R	5810	0cm ³

• 2009年鼻咽癌调强治疗EPID监测摆位误差统计

- $\sigma \leq 3\text{mm}$
- | | |
|-----------------|-------|
| • 2009.1~2009.3 | 88.2% |
| • 2009.4~2009.6 | 91.0% |

2009/06/25

小结

- 加强与放疗医师的沟通与探讨，提高专业知识，充分发挥物理师在放疗计划设计中的主动性
- 鼻咽癌的调强放疗是目前最值得研究与探讨的放疗技术之一，需要一份认真、严肃和科学的态度对待放疗计划设计中的每一个细节
- 鼻咽癌靶区与危及器官众多，需要更多的耐心与细致，一个相对完美的计划脚本需要花费大量的时间和精力去摸索和优化
- 规范化的计划设计可以获得相当的收获，计划设计效率显著提高

谢谢!