

**A STATISTICAL COMPARISON OF  
IMRT AND CONVENTIONAL  
EXTERNAL BEAM THERAPY FOR  
SOFT TISSUE SARCOMA OF THE  
THIGH**

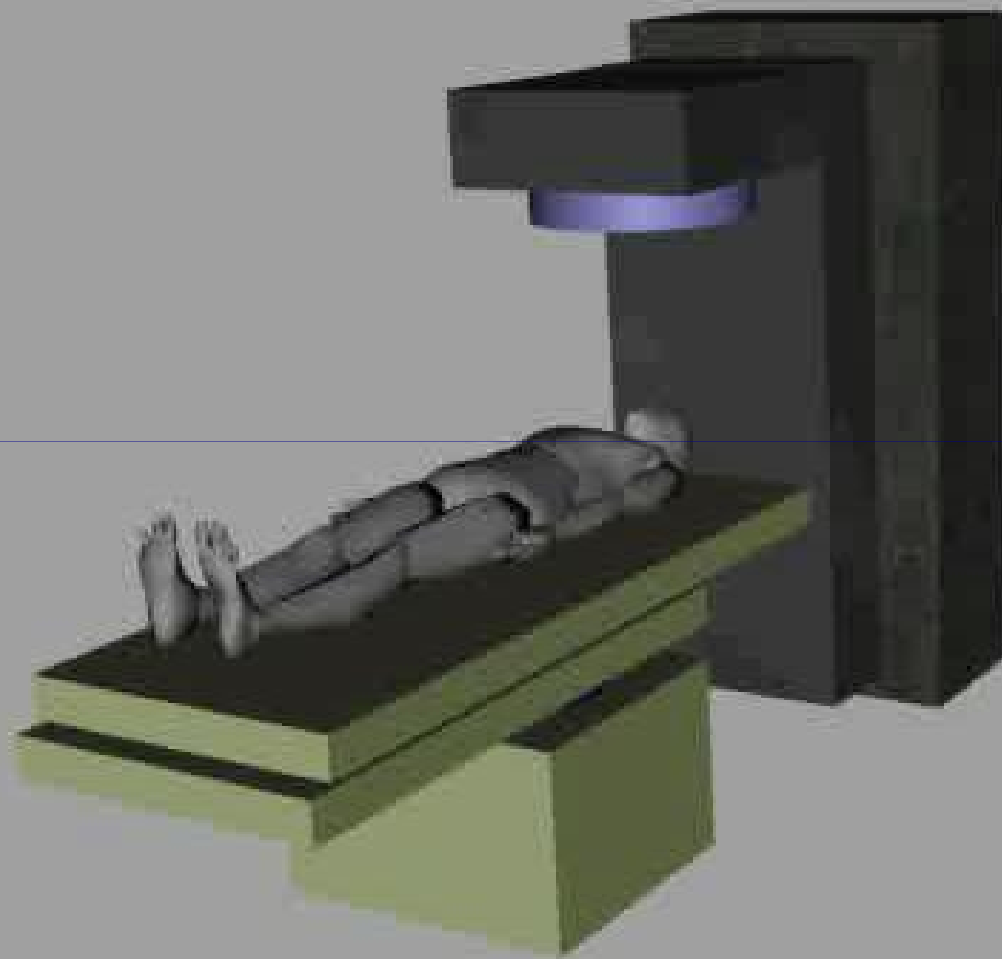
Robinson MH, Young SC, Siddall DJ  
*WPH Sheffield and Premion Healthcare,  
Tugun, Australia*

# RATIONALE

- Pathological femur fracture rate after thigh sarcoma radiotherapy is 6-8%
- Increased by periosteum stripping (29% at 5 years) and dose escalation.
- Radiation induced fractures are problematic due to high rates of delayed union and nonunion.

# IMRT

- IMRT allows prescribed radiation to be shaped to target volumes whilst increasing normal tissue sparing
- Can be used to avoid treating the whole femur circumference.
- The objective of this study is to evaluate the potential benefits of IMRT versus 3D conformal planning with respect to treated femur volume and PTV coverage.



# Soft Tissue Sarcoma Thigh

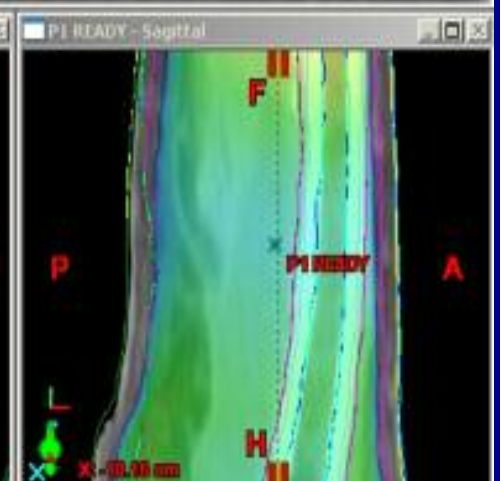
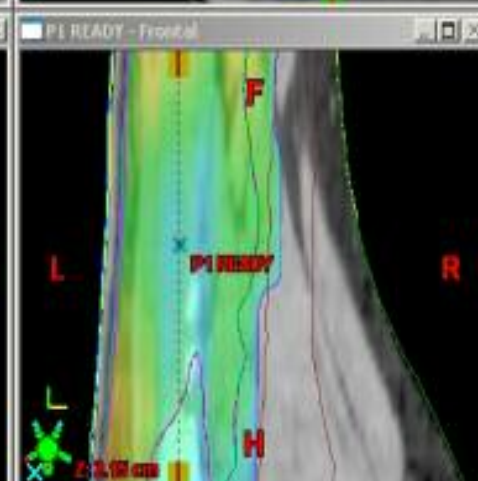
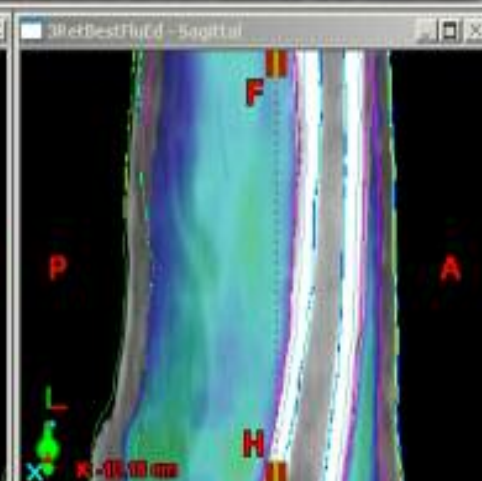
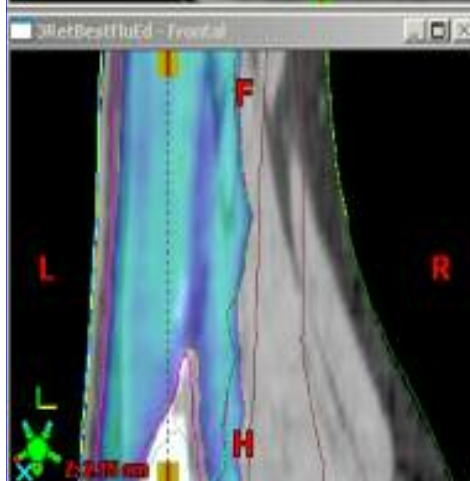
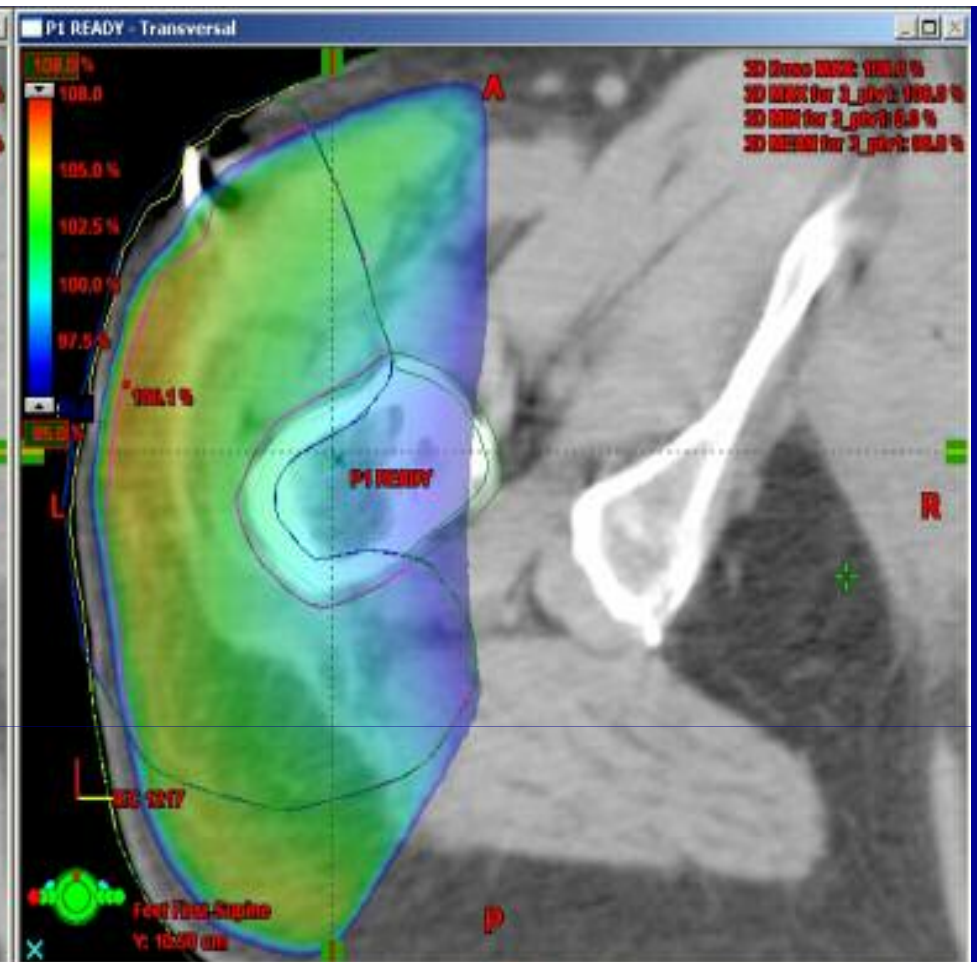
- GTV re-contoured in 12 patients.
- CTV1 had a cranio-caudal margin of 5cm on GTV or 1cm on scar (whichever was longer) and a 2cm axial margin.
- Phase II CTV simply reduced the cranio-caudal margin to 2cm on the GTV.
- Conventional plans created according to the standard two phase prescription of 50Gy in 25# and 10Gy in 5#.

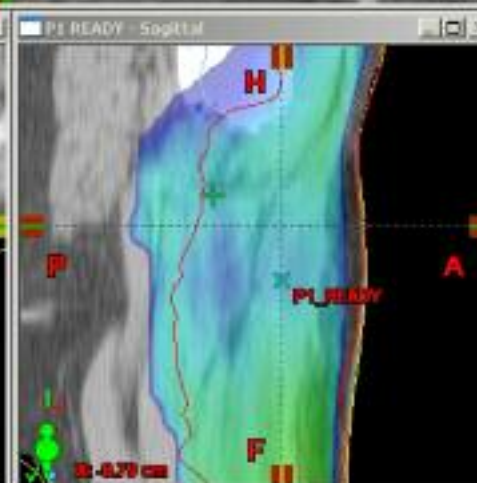
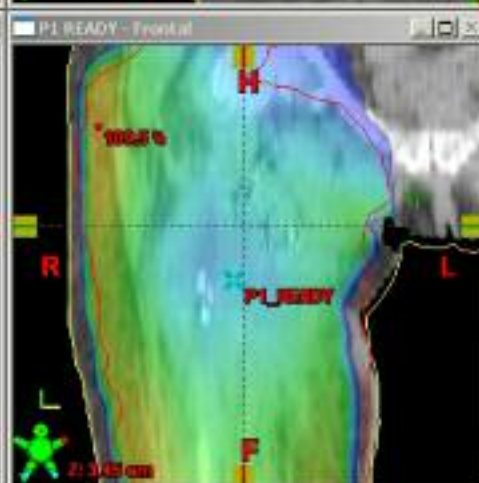
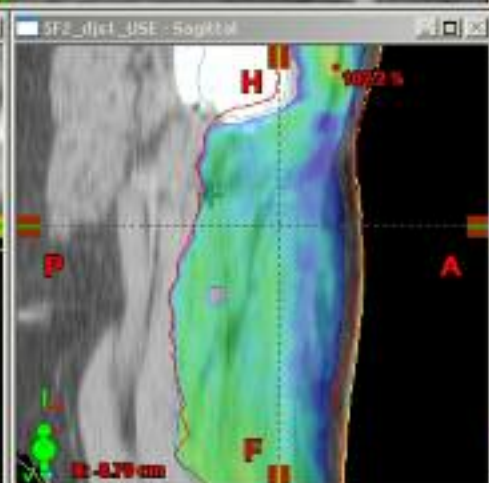
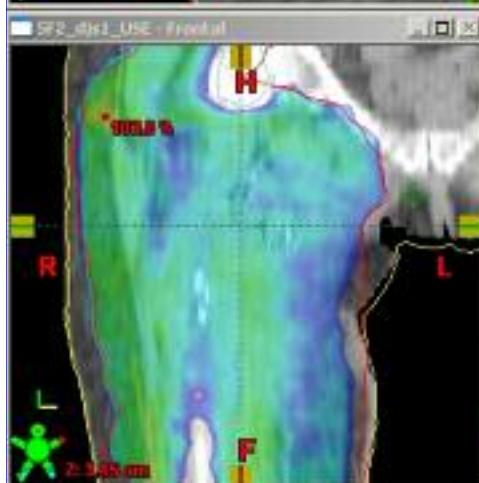
# METHODS

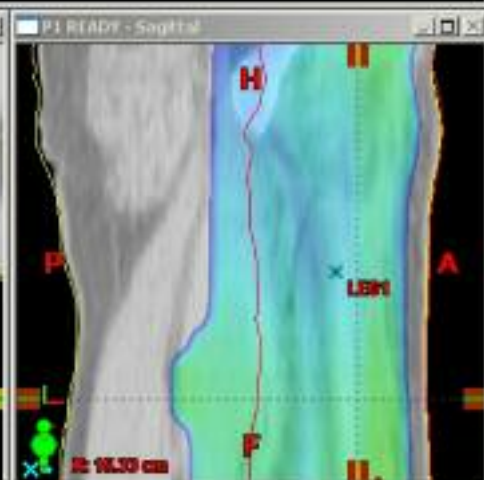
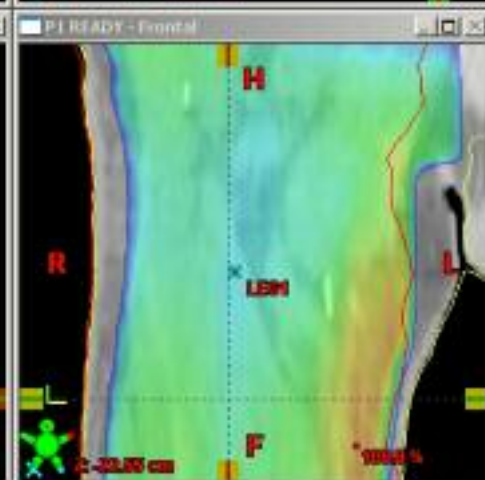
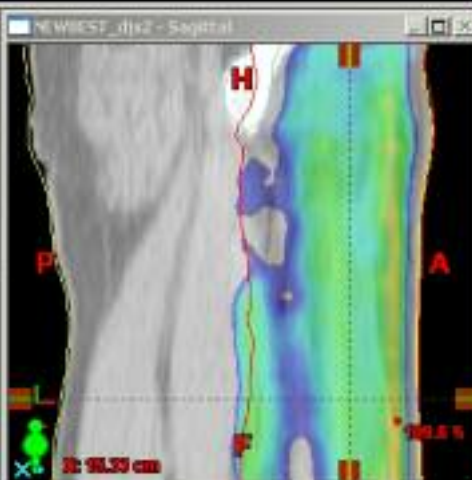
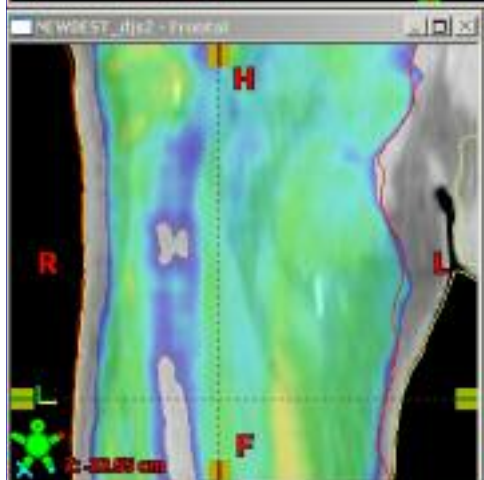
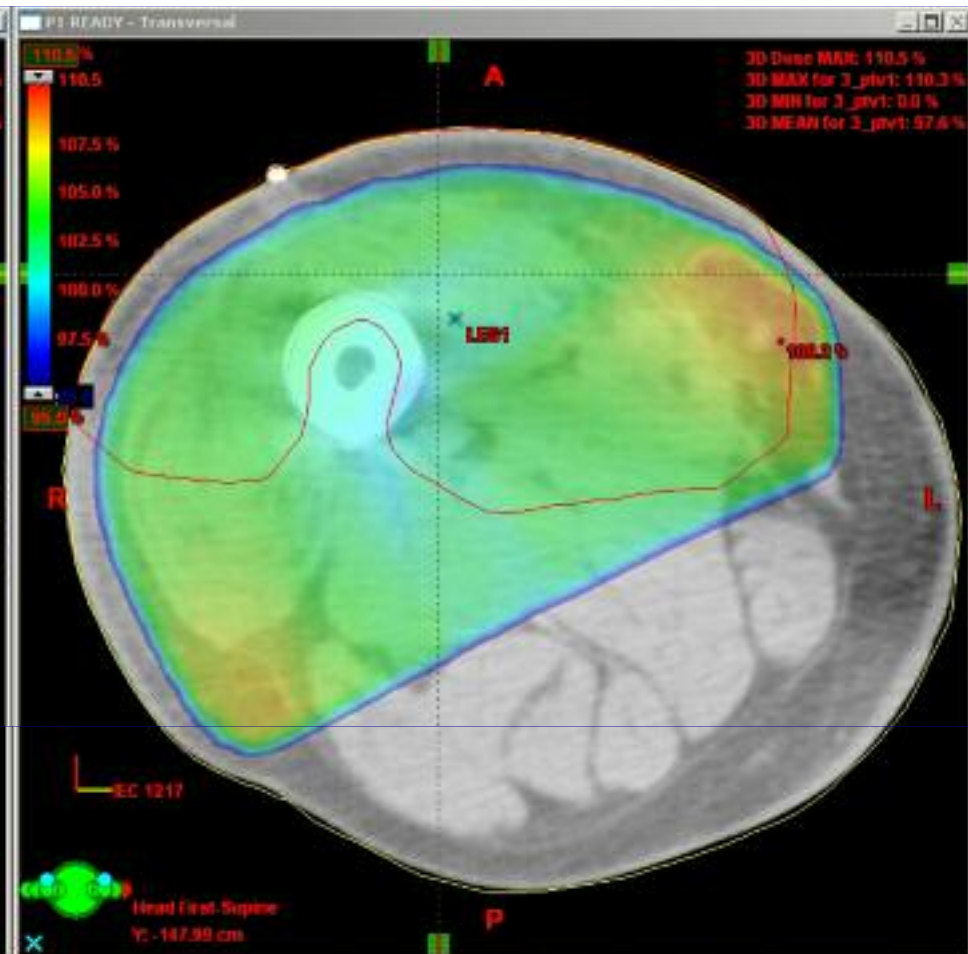
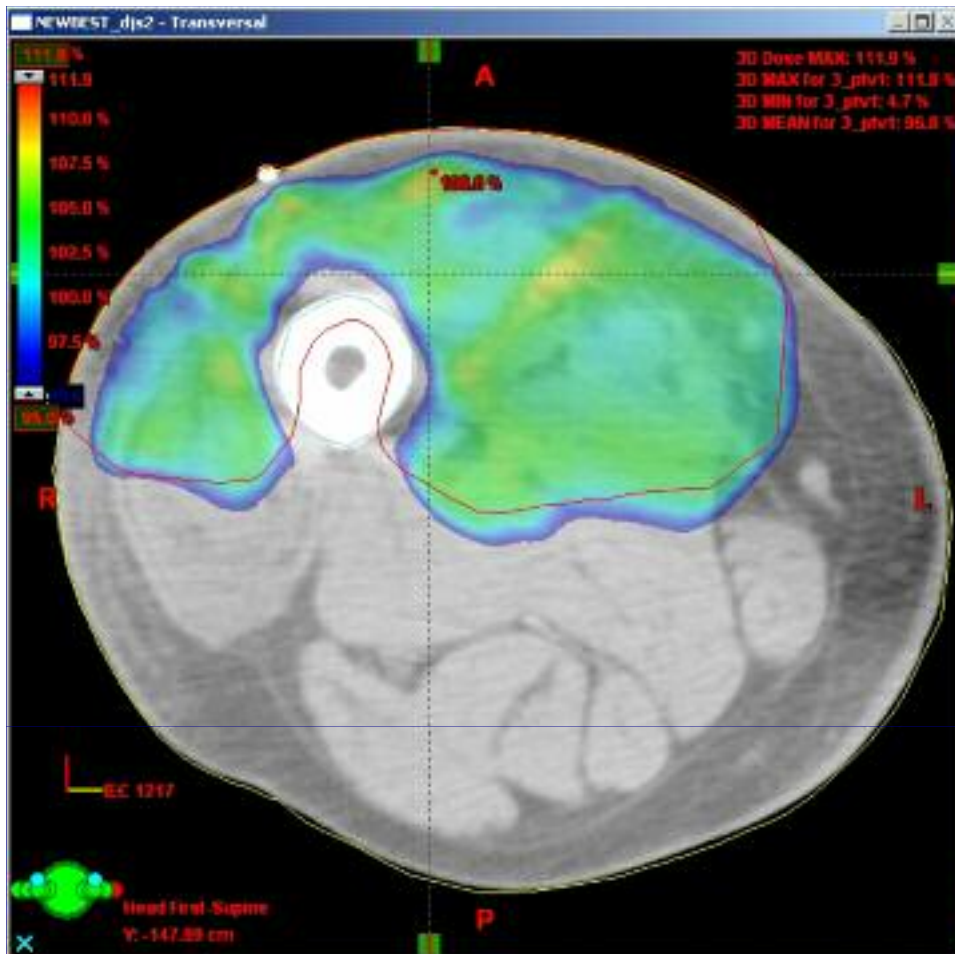
- IMRT inverse planned as separate phases.
- The majority of IMRT plans comprised 5 fields.
- Larger tumours meant some fields were split into two carriage groups.

# RESULTS

- Side-by-side evaluation of dose distribution and DVH of each subjects' plans indicated that the femur could definitely be spared using IMRT
- Volume of normal tissue receiving higher doses could be decreased.
- In many cases PTV and femur overlap inevitably meant that PTV coverage was compromised by IMRT plans.







# RESULTS

- All IMRT plans decreased both mean and high femur doses and all but one subject showed a reduced femur maximum.
- As expected this result was balanced by a general reduction in PTV2  $V_{95\%}$  coverage.
- Basic statistics suggested soft tissue and testes doses were largely unaffected by IMRT planning.

# RESULTS

- Rigorous hypothesis testing confirmed a statistically significant reduction in femur doses with IMRT and in fact suggested that decreases in PTV2 coverage were not significant.
- High doses to normal tissue were significantly reduced and IMRT had no significant effect on mean normal tissue dose, global dose maximum and mean testes dose.

# DESCRIPTIVE STATISTICS

Criteria	Median	Mean	Std. dev.	Range
PTV2 $V_{95\%}$	-5.5%	-5.0%	-6.7	-14.5% to +12.0%
PTV1 – PTV2 $V_{95\%}$	+1.9%	+3.1%	-9.6	-10.4 to +18.9
Femur $V_{100\%}$	<b>-9.8%</b>	<b>-19.1</b>	-20.4	-0.7% to -55.5%
Femur $D_{mean}$	<b>-12.2</b>	<b>-11.6</b>	-5.1	-1.5 to -18.2
Femur $D_{max}$	<b>-8.5</b>	<b>-10.3</b>	-10.0	-37.8 to +0.3
Soft tissue $V_{100\%}$	-2.6%	-3.0%	-2.5	-0.2% to -9.5%
Soft tissue $D_{mean}$	-0.3	-0.3	-3.3	-4.7 to +3.6
Global plan $D_{max}$	+0.8	0.0	-2.9	-5.3 to +3.8
Testes $D_{mean}$	+0.7	-0.1	+0.7	-9.5 to +7.3

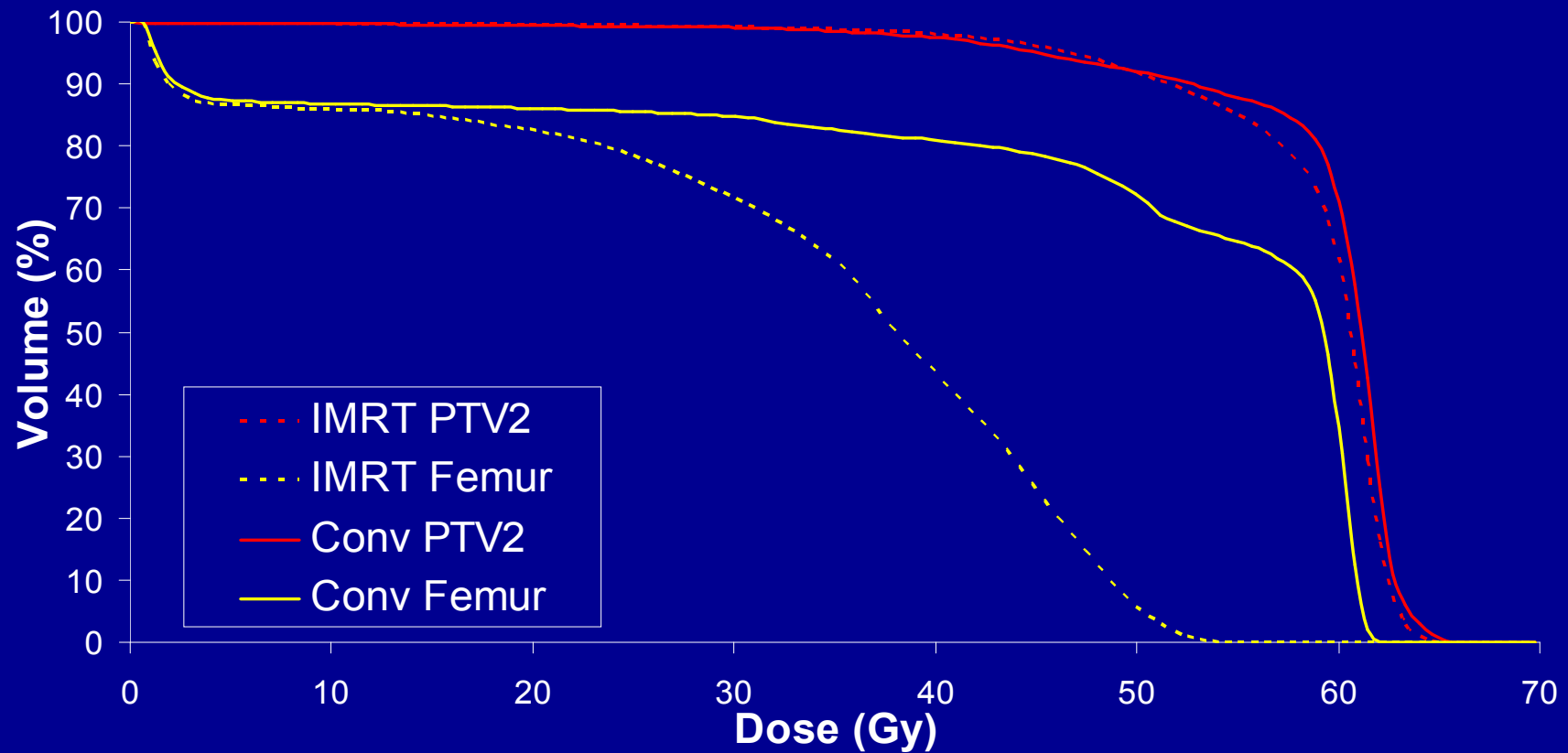
# PRIMARY OUTCOMES

Primary outcomes	Significance at 2.5%?		Null hypothesis?
	Student's t test	Wilcoxon signed rank	
V <sub>FEMUR</sub> 100%	0.4%	0.2%	Disproved
V <sub>PTV2</sub> 95%	2.7%	4.2%	Accepted
V <sub>PTV1-PTV2</sub> 95%	29.1%	37.0%	Accepted

# SECONDARY OUTCOMES

Secondary outcomes			
$D_{\text{FEMUR } 5\%}$	<0.1%	0.2%	Disproved
$D_{\text{FEMUR mean}}$	<0.1%	0.2%	Disproved
$D_{\text{FEMUR max}}$	0.2%	0.2%	Disproved
$V_{\text{SOFT TISSUE } 100\%}$	0.2%	0.4%	Disproved
$D_{\text{SOFT TISSUE } 5\%}$	<0.1%	0.4%	Disproved
$D_{\text{SOFT TISSUE mean}}$	>50.0%	40.0%	Accepted
$D_{\text{GLOBAL max}}$	>50.0%	>50%	Accepted
$D_{\text{TESTES mean}}$	>50.0%	48%	Accepted

# Comparison Conventional and IMRT Dose Volume Histogram



# CONCLUSIONS

Compared with standard 3D conformal methods:

- IMRT offers significantly improved femur sparing.
- PTV and femur overlap can result in slightly poorer PTV coverage for IMRT treatments.
- High end normal tissue doses can be reduced by IMRT treatment.
- IMRT treatment does not increase testes dose nor significantly increase overall normal tissue dose.