

# Developing SBRT for primary renal cancer: a planning study

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# Definition

- Cancer arising from kidney tissue
- No evidence of distant spread
- Potentially curable



# Current management

- Standard-of-care: surgery
- Unsuitable for surgery:
  - RFA
  - Cryotherapy
- *Invasive*
- *May require general anaesthesia*
- *Poor local control  $\geq 3$  cm*
- *Not suitable close to vessels*
- Unmet need for non-surgical therapy



# SBRT for primary renal cancer

Author	Type	N	PRC volume (cc) (range)	Dose	F/U (months) (range)	LC	Toxicity (CTCAE grade given where available)
Kaplan 2015*	Case series	21	29 (4-232)	48 Gy in 3# (prescription isodose not supplied)	21 (3-84)	84% at 2 years	One patient renal dysfunction One patient hypertension
Ponsky 2015	Phase I trial	19	58 (14-175)	24-48 Gy in 4# (to 65-75% isodose)	14 (6-35)	100% at 3 years	G1-2: 2 patients G3: 1 patient (kidney dysfunction) G4: 1 patient (duodenal ulcer)
Pham 2014	Phase I – II trial	20	23-223	GTV < 5 cm 26 Gy in 1# GTV ≥ 5 cm 42 Gy in 3# (to 75-85% isodose)	At least 6	-	G1-2: 60%; G3-4: Nil
Stahler 2014	Case series	40	34 (8-120) RCC 42 (25-78) TCC	25 Gy in 1# (to 70% isodose)	28 (6-78)	98% at 2 years	G1-2: 13% (5 patients) G3-4: Nil
Svedman 2008†	Case series	7	6-164	GTV ≤ 6 cm 30 Gy in 3# GTV > 6 cm 40 Gy in 4# (to approx. 65% isodose)	39 (10-70)	86%	2 patients elevated creatinine No dialysis

- Relatively small numbers in studies
  - ?competing modalities
  - ?not possible to deliver meaningful dose



# Aim

- To estimate the proportion of patients treatable with SBRT –
- with respect to published dose constraints

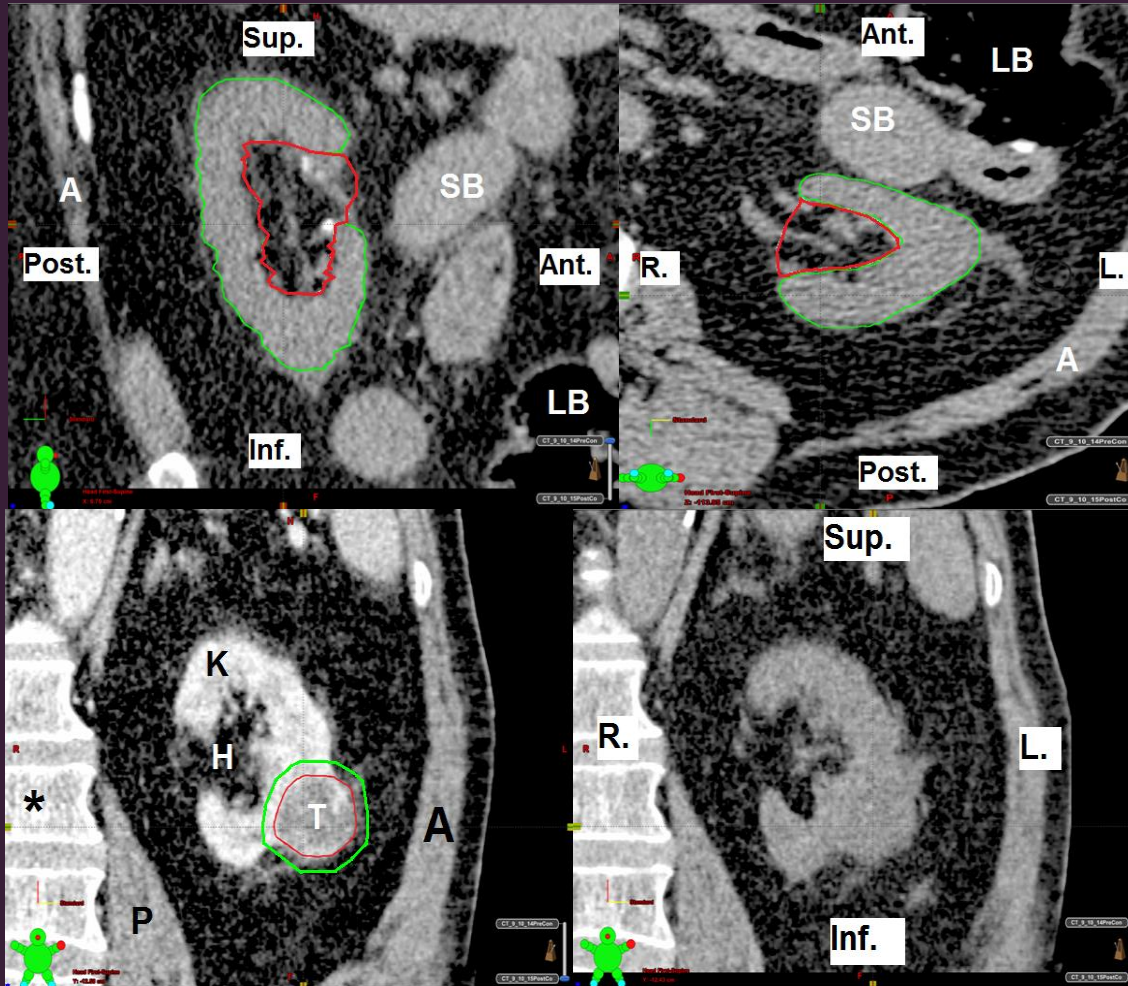


# Method: selection

- Planning study (Multiplan<sup>®</sup> for Cyberknife<sup>®</sup>)
- Selection criteria:
  - MDM – suitable for radical treatment
  - $\leq 6$  cm in max. diameter
  - Adequate imaging for import to Multiplan<sup>®</sup>
  - Representative positions within kidney



# Method: contouring



*5 mm GTV – PTV  
Based on  
respiratory  
tracking and  
compensation*



# Method: dose

- 45 Gy in 3 fractions to 80% isodose
- Reduced in 3 Gy increments if constraints not met – minimum 36 Gy
- $\alpha / \beta$  may be as high as 7–10 Gy for renal cancer (Ning 1997; Wersall 2005)
- Some studies have shown viable tumour with lower doses (Ponsky 2015)

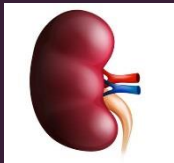




# Method: constraints

- Dose-limiting: small bowel and kidney
- Used CTE (UK consensus) and Pham et al. (2014)

## CTE 3# constraints



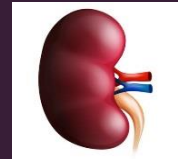
*At least 200 cc  
(combined)  
< 16 Gy*



*Point max. < 25.2 Gy*

*D5cc < 17.7 Gy*

## Pham et al. 3# constraints



*No constraint*

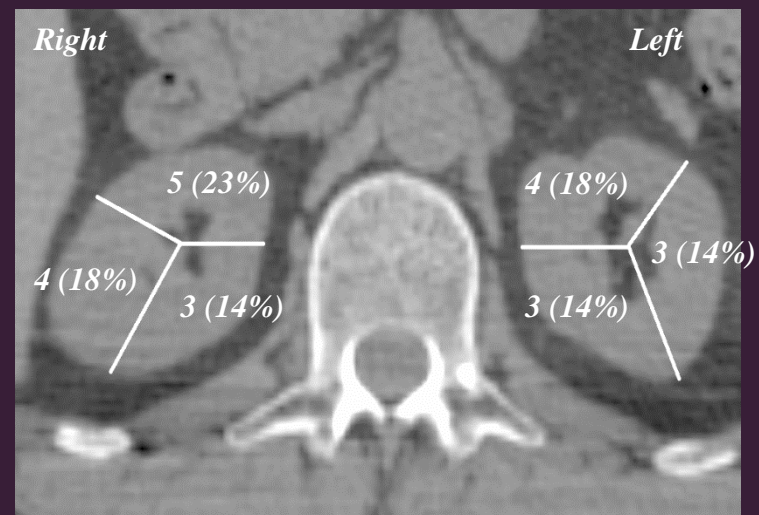
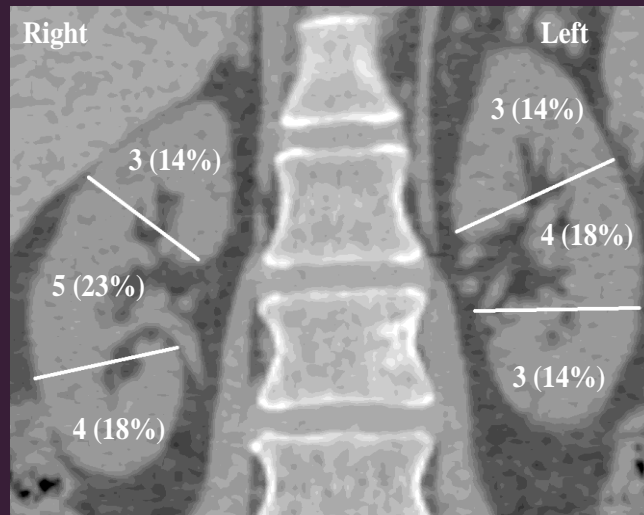


*Point max. < 30 Gy*

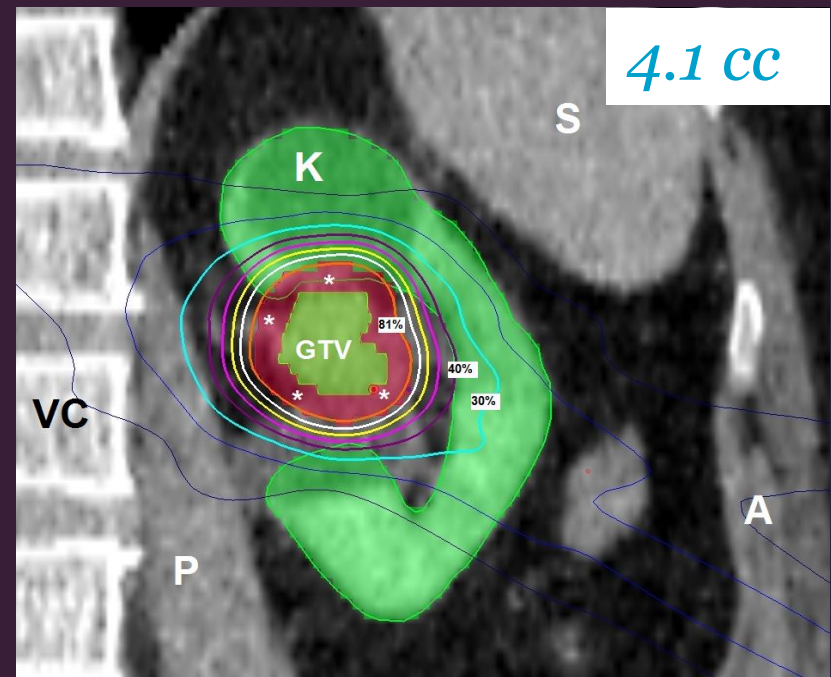
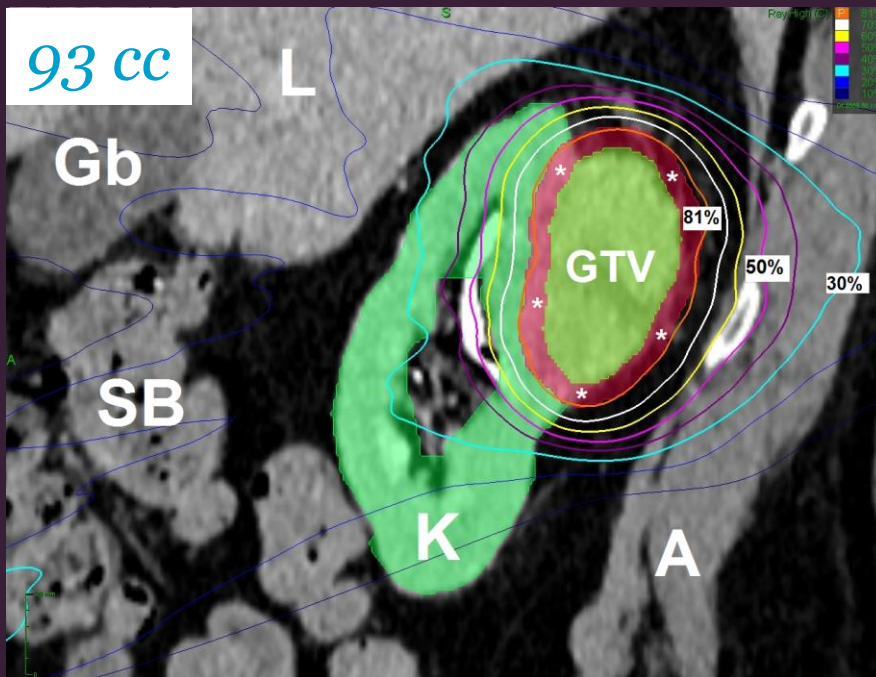


# Results: patients

- 22 patients
- Mean PTV volume: 44 cc (10–157)
- Mean combined kidney volume 299 cc (195–525)

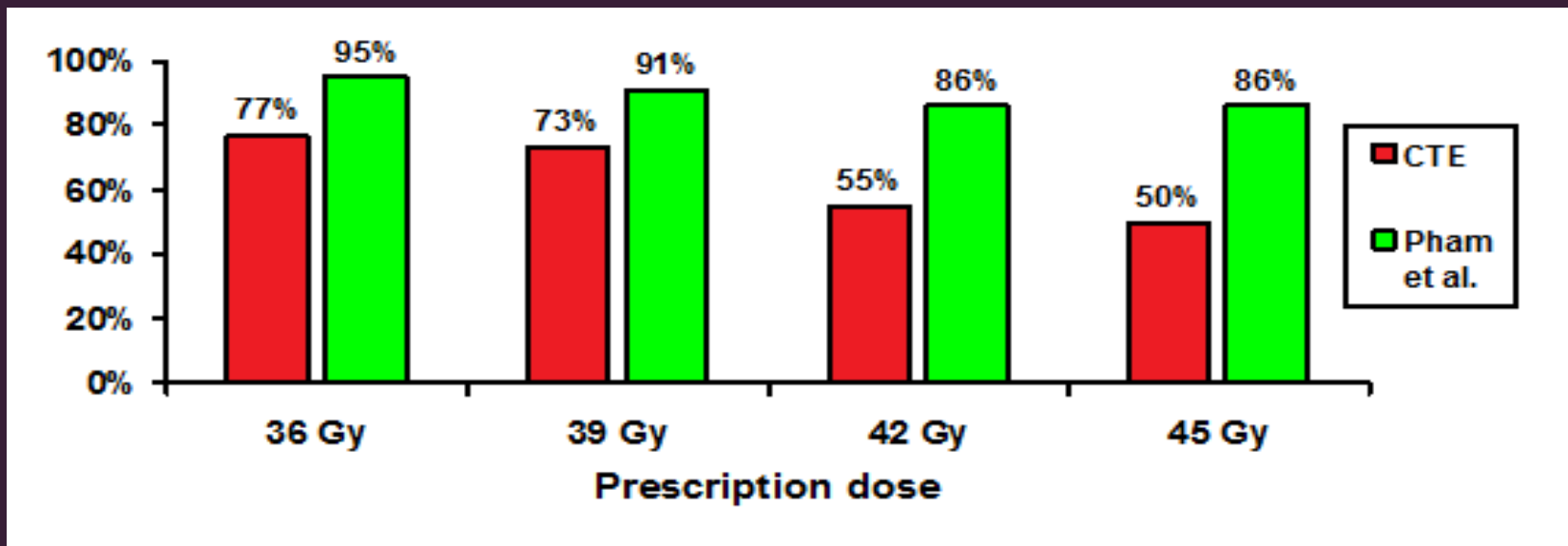


# Results: plans



# Results: outcomes

Percentage of plans achieving all dose constraints for a given dose.



# Results: outcomes

Reasons for failing to achieve a successful (45 Gy in 3 fractions) plan.

Dose constraint	Failures	Reason for failure	
		Small bowel constraint	Renal constraint
CTE	11 (50%)	Point max.: 4 5 cc constraint: 2 Total: 6	5
Pham et al.	3 (14%)	3	n/a



# Results: kidney doses

Mean, median, and maximum doses to ipsilateral and contralateral kidneys.

Dose constraint	Ipsilateral kidney dose (Gy)		Contralateral kidney dose (Gy)		
	Mean	Median	Mean	Median	Maximum
CTE	11.6 (6.7-19)	7.5 (1.8-16)	1.8 (1.0-3.8)	1.7 (1.0-4.3)	5.4 (2.0-11)
Pham et al.	13.6 (5.7-25)	9.3 (1.6-22)	2.0 (1.0-4.0)	1.9 (1.0-4.6)	5.5 (2.5-11)



# Conclusions

- Careful consideration of dose and constraints
- To use meaningful doses: may need to have renal cancer specific constraints – e.g. CTE, but use Pham et al. constraints where these cannot be achieved (40–50%)



# The future

- In view of competing modalities, vital to get good prospective data with large numbers
- CTE
- Consideration of including:
  - Larger tumours
  - M1 patients where Rx of primary indicated





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