

**To Plan or not to Plan: Multiple High Dose Rate (HDR) Brachytherapy Insertions.
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ABSTRACT:

High dose rate (HDR) brachytherapy is commonly used for treating cervical cancer. The RPC has observed that some institutions calculate the dose distribution for only the first of multiple insertions. The institution assumes the doses given to points A, B, rectum and bladder don't vary with insertion when the loading is unchanged. Through retrospective reviews, the RPC has found that these doses differ from one insertion to the next.

Records of 70 HDR patients were examined, from 33 oncologists at 25 institutions. These patients were treated with tandem and ring (T&R) or with tandem and ovoid (T&O) applicators. The first fraction doses were compared with those reported by the institution for each subsequent fraction, using a 15% agreement criterion.

With the T&R applicator, doses at point A, B, rectum and bladder from subsequent applications deviated from the first by 15% or more in 0%, 29%, 39% and 43% of insertions, respectively. For the T&O applicator, deviation occurred in 22%, 49%, 66% and 70% of insertions, respectively. The geometry of the T&R applicator may force conformation of point A doses. These results indicate reliance on a plan representing the first insertion to predict doses from all insertions of a course of therapy can frequently lead to errors.

This work was supported by PHS grant CA 10953 awarded by NCI, DHHS.

Introduction:

The Radiological Physics Center (RPC) performs retrospective chart reviews of patients who were treated using high dose rate (HDR) brachytherapy. The RPC has observed that there are some institutions that only calculate the dose distribution for the first of multiple insertions. The institution makes the assumption that the doses to point A, B, bladder and rectum do not vary with insertion when the loading remains the same. Through retrospective reviews, the RPC has found that these doses do in fact differ from one insertion to the next.

METHODS:

Records of 72 HDR patients were examined, from 33 oncologists at 25 institutions. These patients were treated with tandem and ring (T&R) or with tandem and ovoid (T&O)

applicators. The first fraction doses were compared with those reported by the institution for each subsequent fraction.

The RPC recalculated the doses to points A, B, bladder and rectum for each insertion for 47 of the 72 HDR brachytherapy patients. This was done for 14 T&R and 33 T&O. Points A, B, bladder and rectum were determined using the definitions found in ICRU 38¹ (Figures 1 and 2). The first fraction doses were compared to each subsequent fraction, using a 15% agreement criterion. The 15% criterion is the acceptable agreement when evaluating brachytherapy doses for protocol patients. Point doses were not calculated by the RPC for the remaining 25 patients because we have confidence in the institutions' calculations of dose (some of the doses were not reported for the bladder, rectum and point B).

RESULTS:

When performing retrospective reviews of brachytherapy charts the RPC uses a $\pm 15\%$ criterion for dose acceptability. This criterion was used to determine how well each subsequent insertion agreed with the first insertion for points A, B, bladder and rectum. Data were compiled for 56 applications using tandem and ovoid and 16 applications using tandem and ring sets of insertions.

With the T&R applicator, doses to points A, B, bladder and rectum for subsequent applications had a deviation in dose from the first application by $\pm 15\%$ or more in 13%, 72%, 75% and 56% of insertions, respectively. For the T&O applicator, deviations exceeding $\pm 15\%$ occurred in 22%, 47%, 75% and 83% of insertions, respectively.

Summation of Dose Deviation

T&R	A _{right}	A _{left}	B _{right}	B _{left}	Bladder	Rectum
At least 1 insertion $\geq \pm 15\%$	6%	19%	75%	69%	75%	94%
2 or more insertions $\geq \pm 15\%$	0%	6%	50%	50%	56%	50%

T&O	A _{right}	A _{left}	B _{right}	B _{left}	Bladder	Rectum
At least 1 insertion $\geq \pm 15\%$	21%	23%	54%	50%	75%	83%
2 or more insertions $\geq \pm 15\%$	7%	14%	24%	28%	40%	51%

Table 1: This is a summary of the percentages where at least one insertion exceeded a dose of $\pm 15\%$ and two or more insertions exceeded a dose of $\pm 15\%$ compared to the doses stated for the first insertion.

Definitions of Points A & B

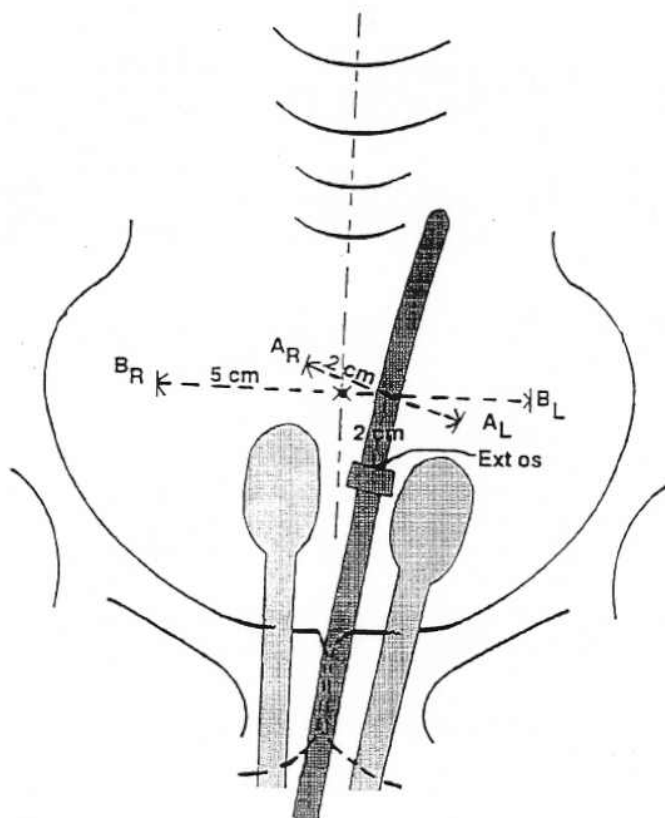


Figure 1

Description of ICRU Bladder/Rectal Dose Reporting Points

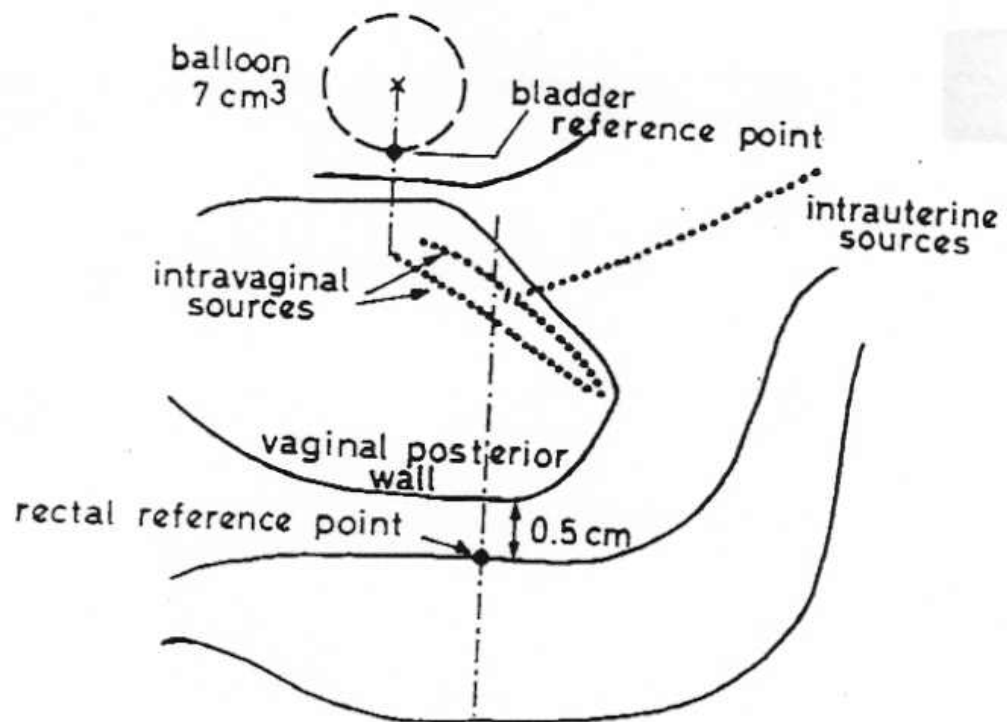
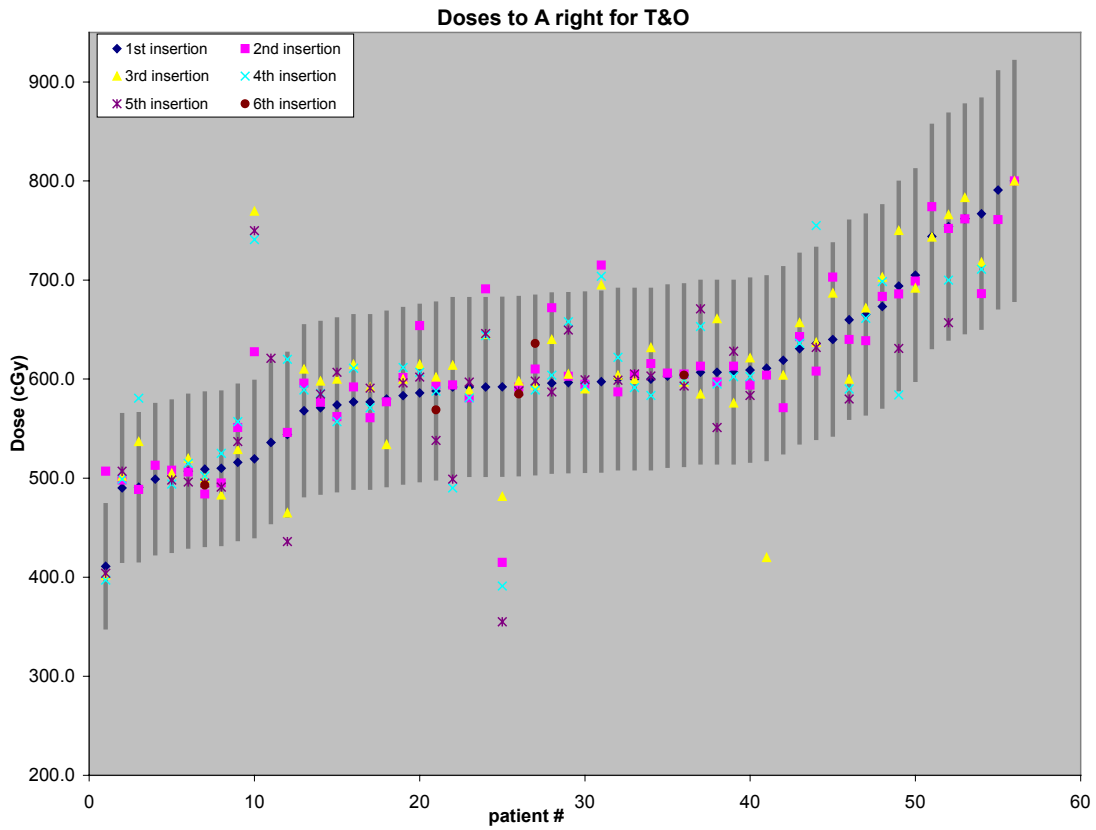
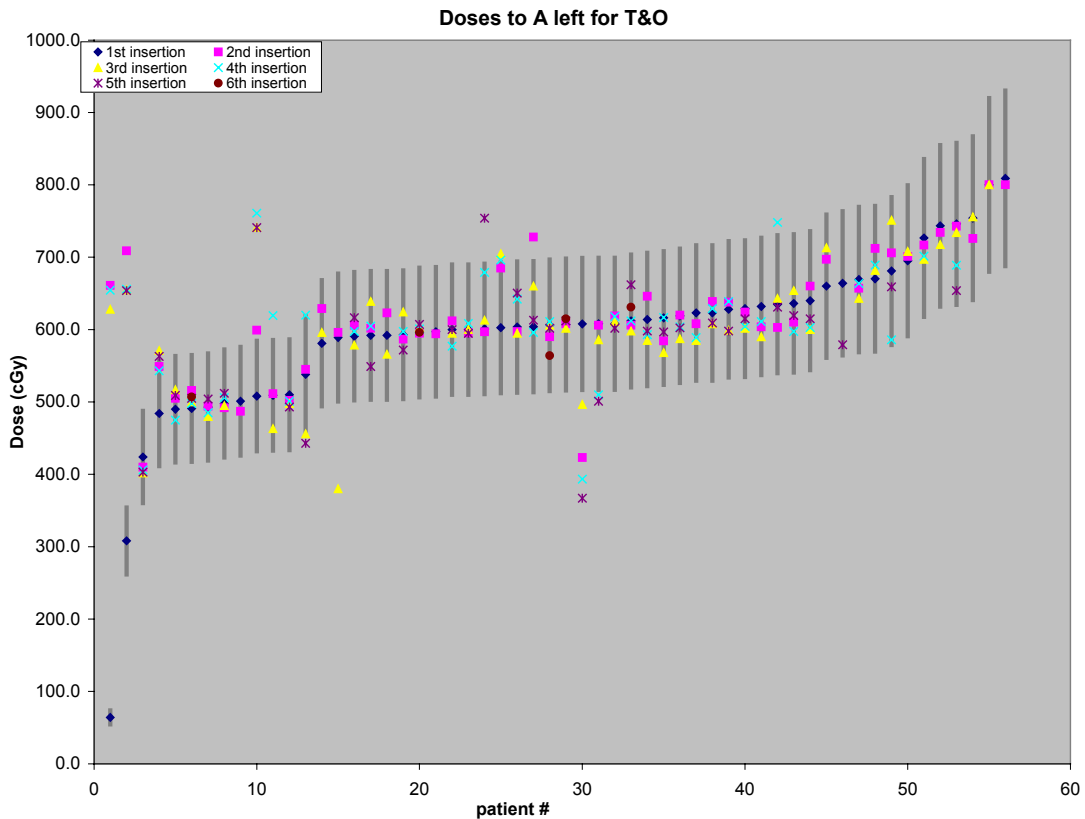
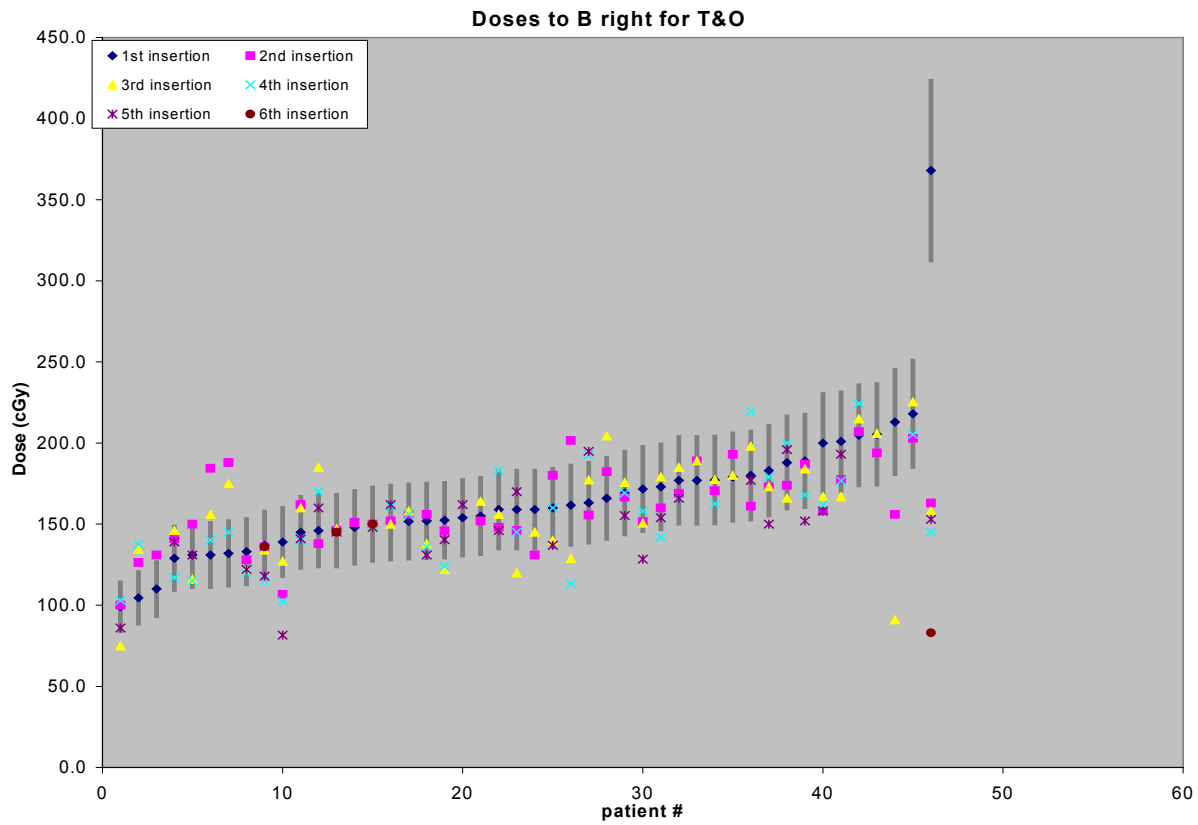


Figure 2

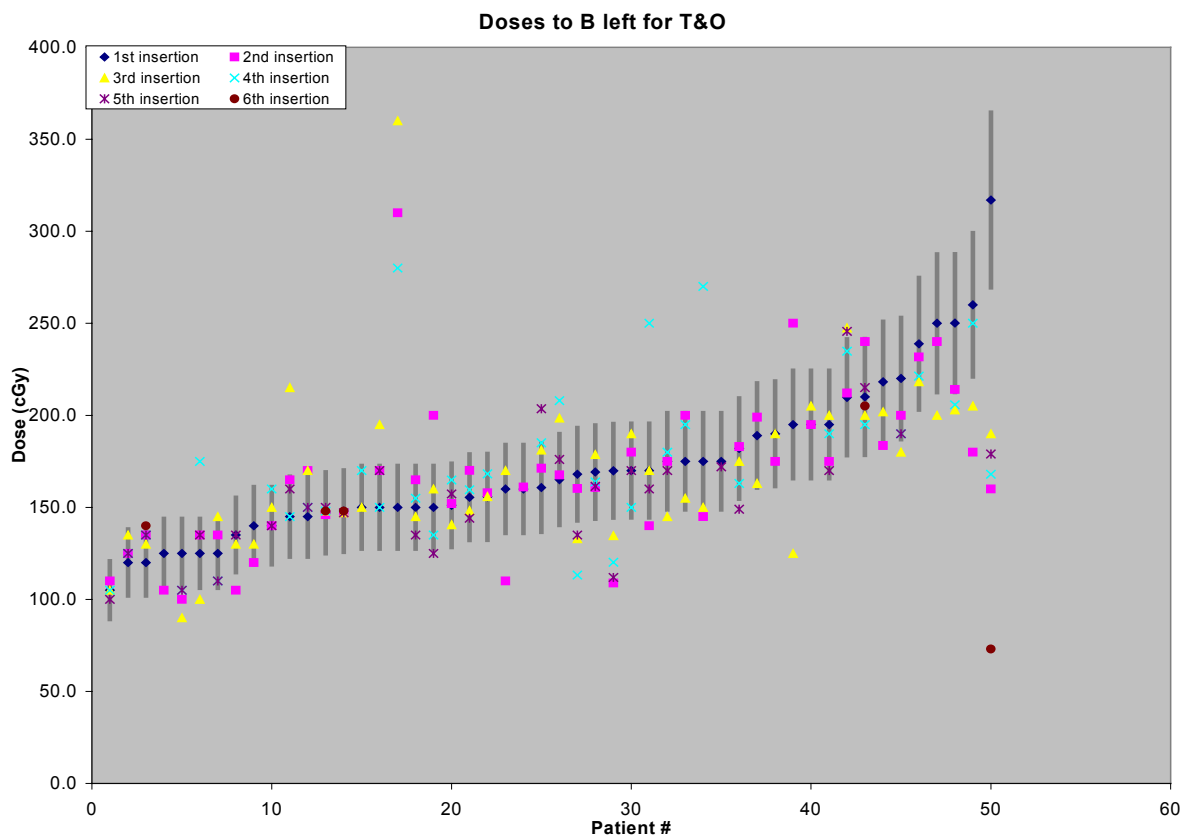


Figures 3 & 4. The prescription point for HDR cervix brachytherapy is point A. For the tandem and ovoid applicator, 21% of patient charts contained at least one insertion showing $\geq 15\%$ dose variation from the first insertion at point A_{right}. For point A_{left}, 23% of charts showed this variation. 7% and 14% of the charts contained two or more insertions with $\geq 15\%$ variations from the first insertion at A_{right} and A_{left} respectively.





Figures 5 & 6. For the tandem and ovoid applicator, 54% of patient charts contained at least one insertion showing $\geq 15\%$ dose variation from the first insertion at point B_{right}. For point B_{left}, 50% of charts showed this variation. 24% and 28% of the charts contained two or more insertions with $\geq 15\%$ variations from the first insertion at B_{right} and B_{left} respectively.



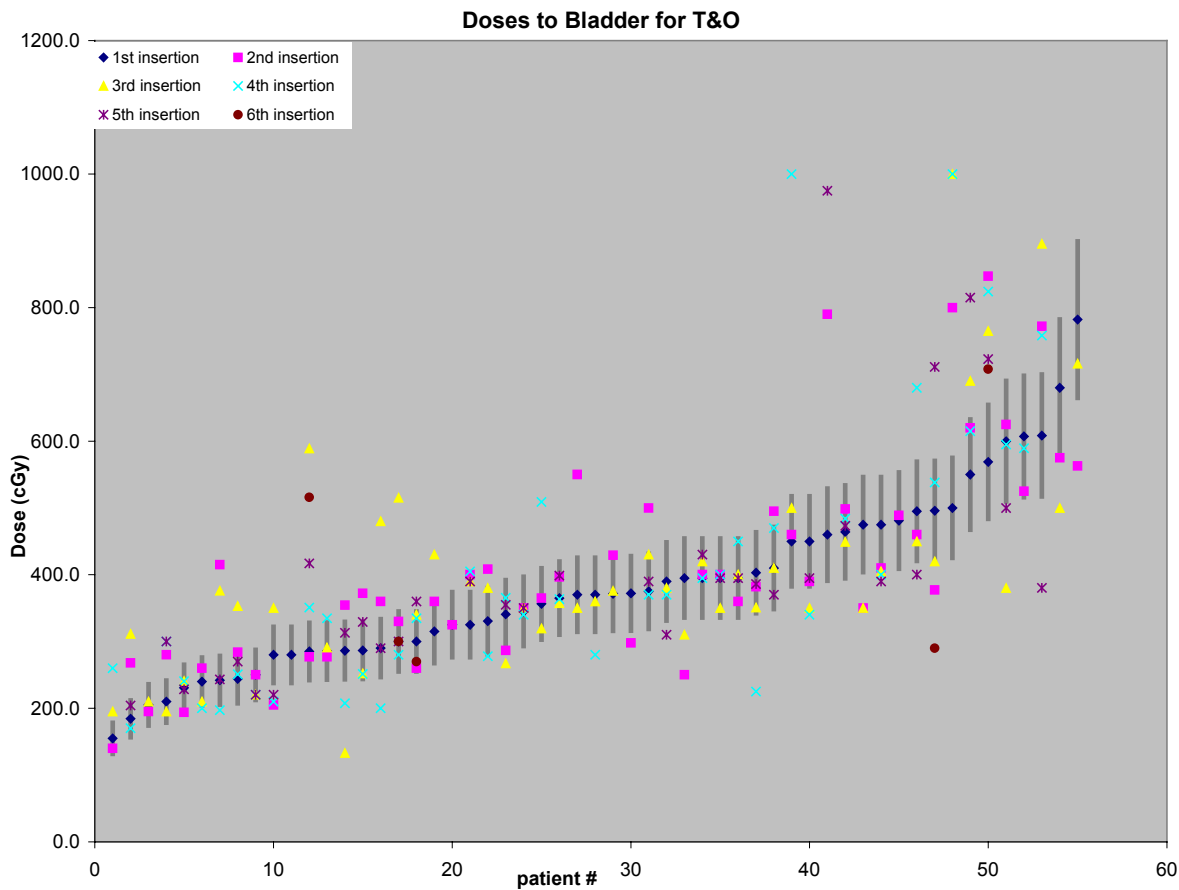


Figure 7. For the tandem and ovoid applicator, 75% of the patient charts had at least one insertion for which the dose to the bladder varied from the dose calculated for the first insertion by at least $\pm 15\%$. 40% of the charts contained two or more insertions with $\geq 15\%$ variations from the first insertion at the bladder point.

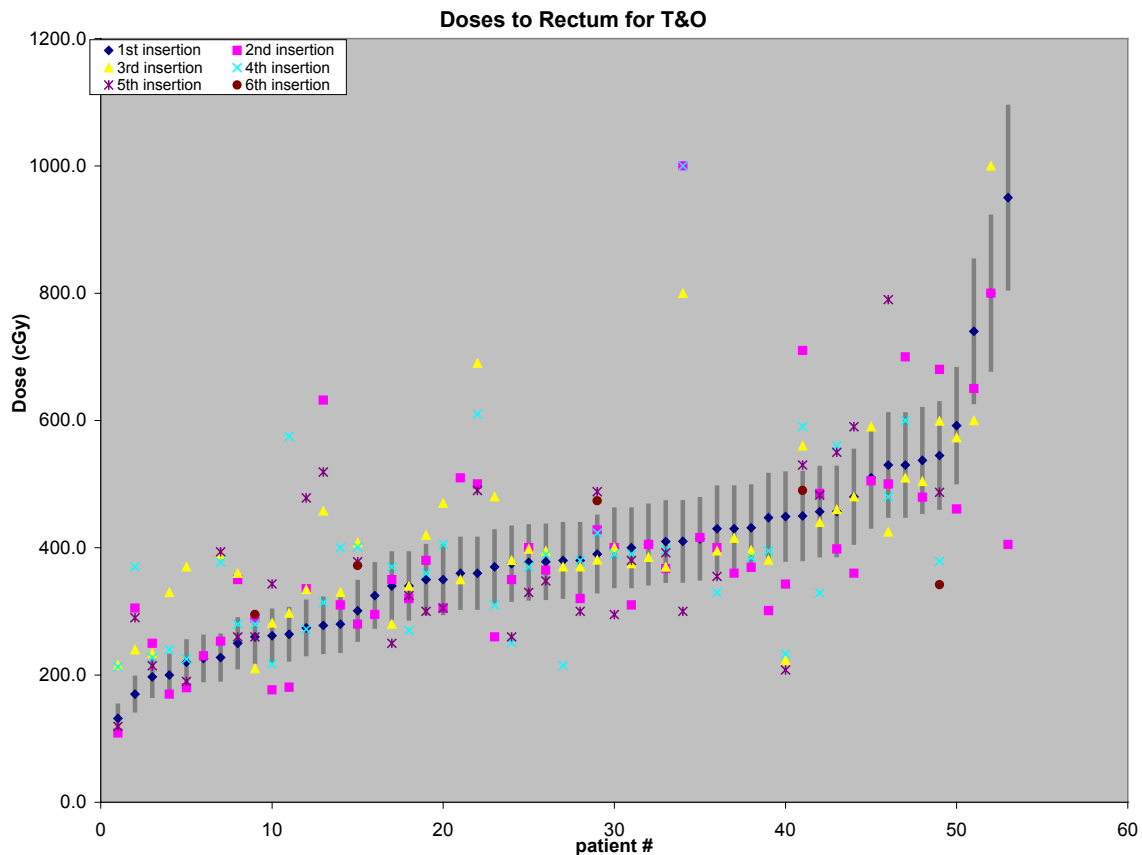
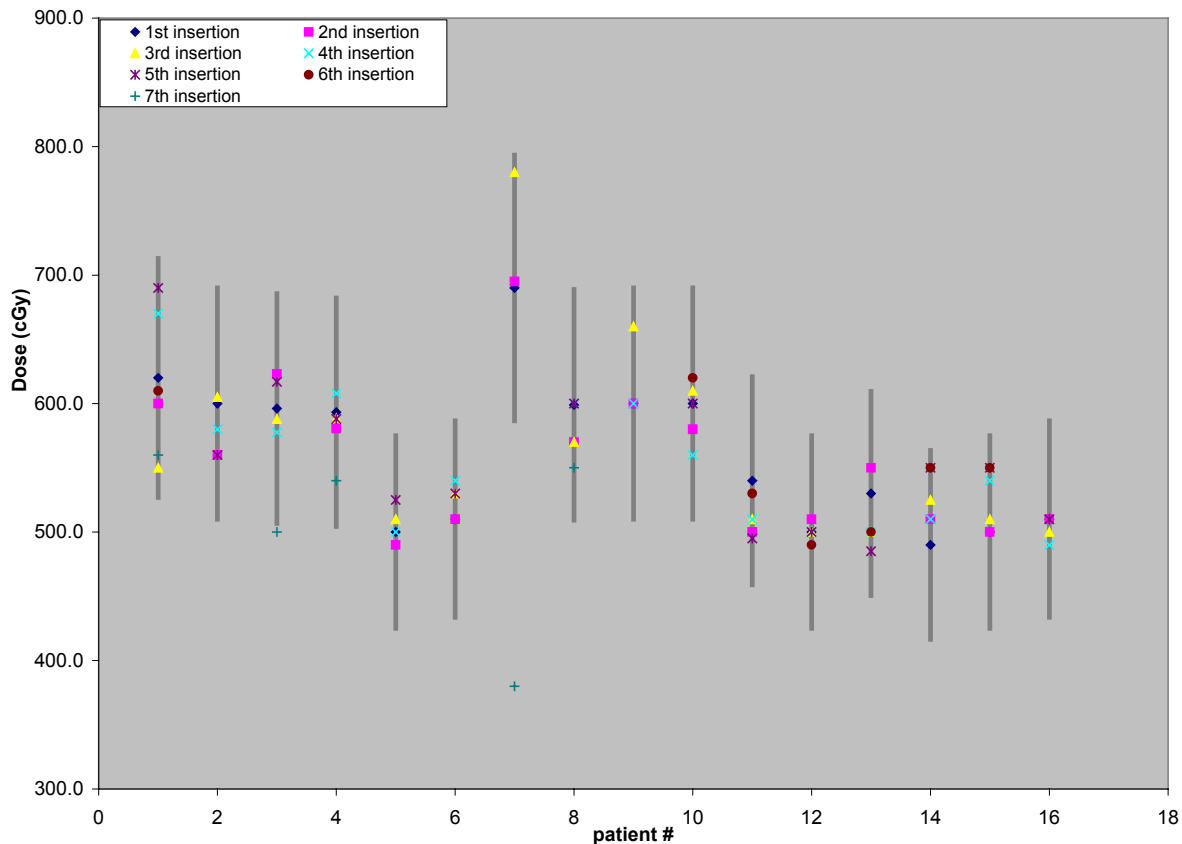


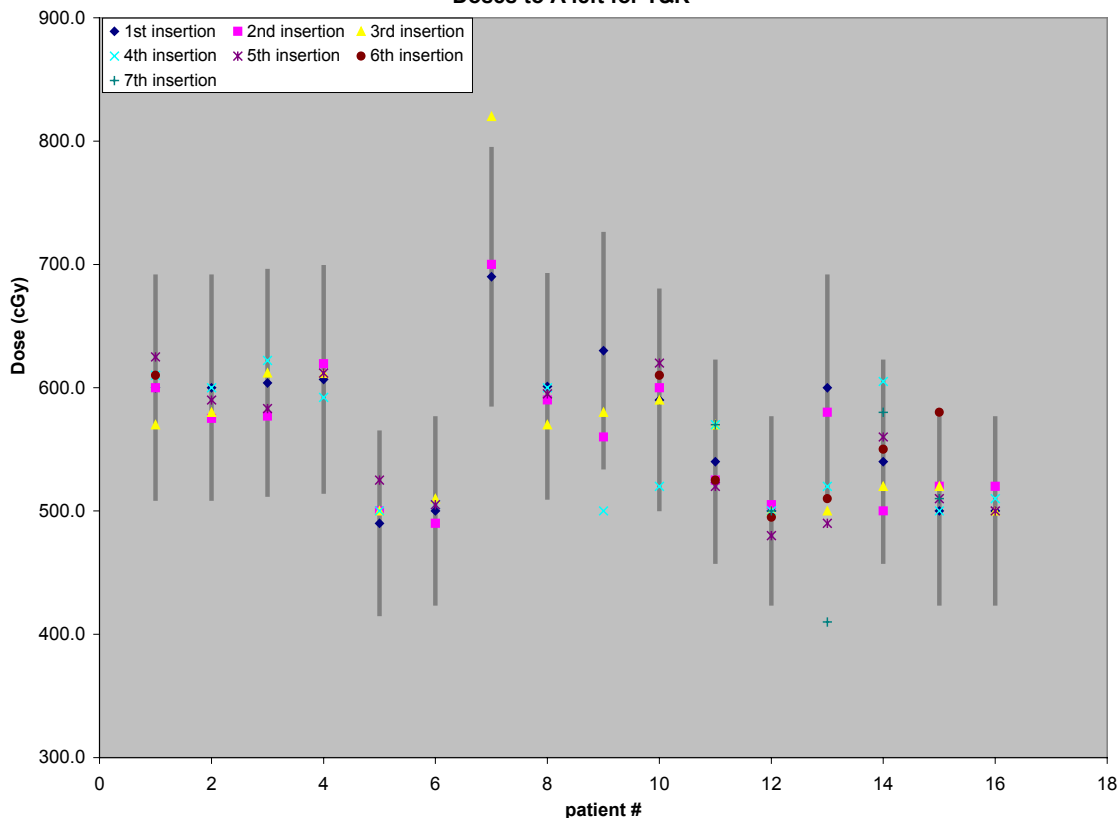
Figure 8. For the tandem and ovoid applicator, 83% of the patient charts had at least one insertion for which the dose to the rectum varied from the dose calculated for the first insertion by at least $\pm 15\%$. 51% of the charts contained two or more insertions with $\geq 15\%$ variations from the first insertion at the rectal point.

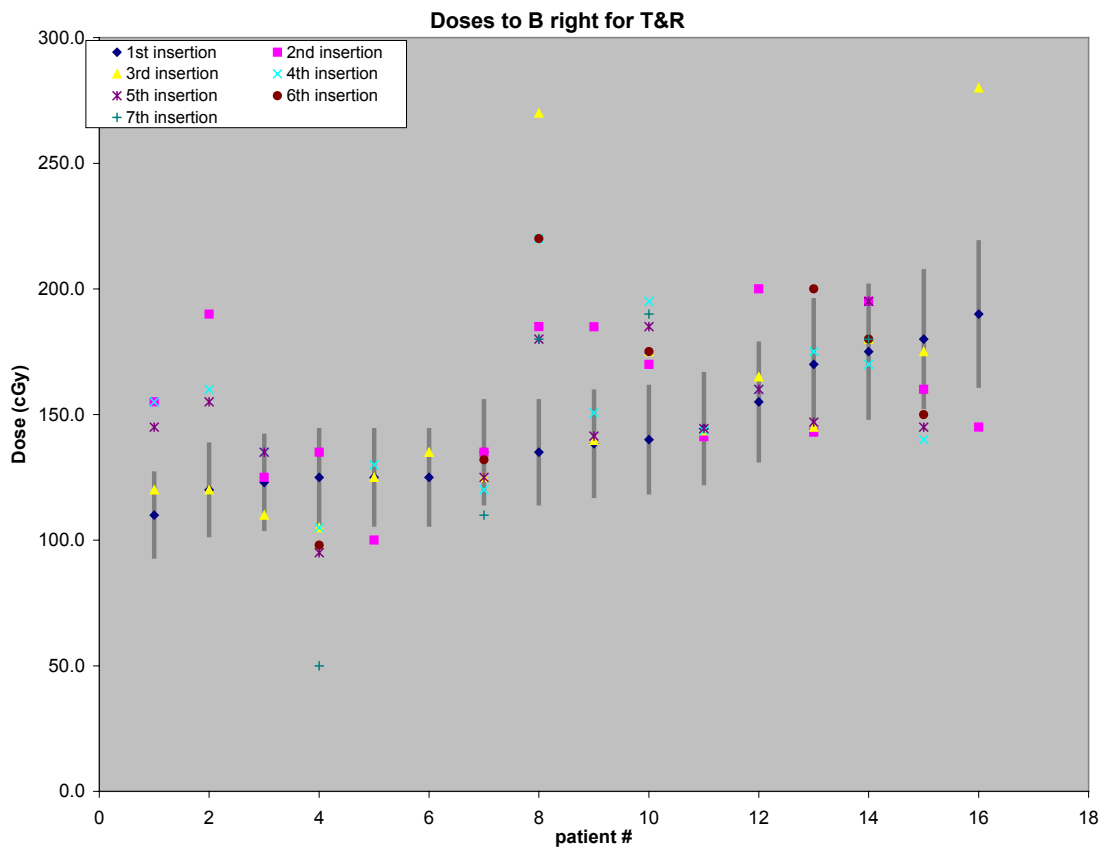
Doses to A right for T&R



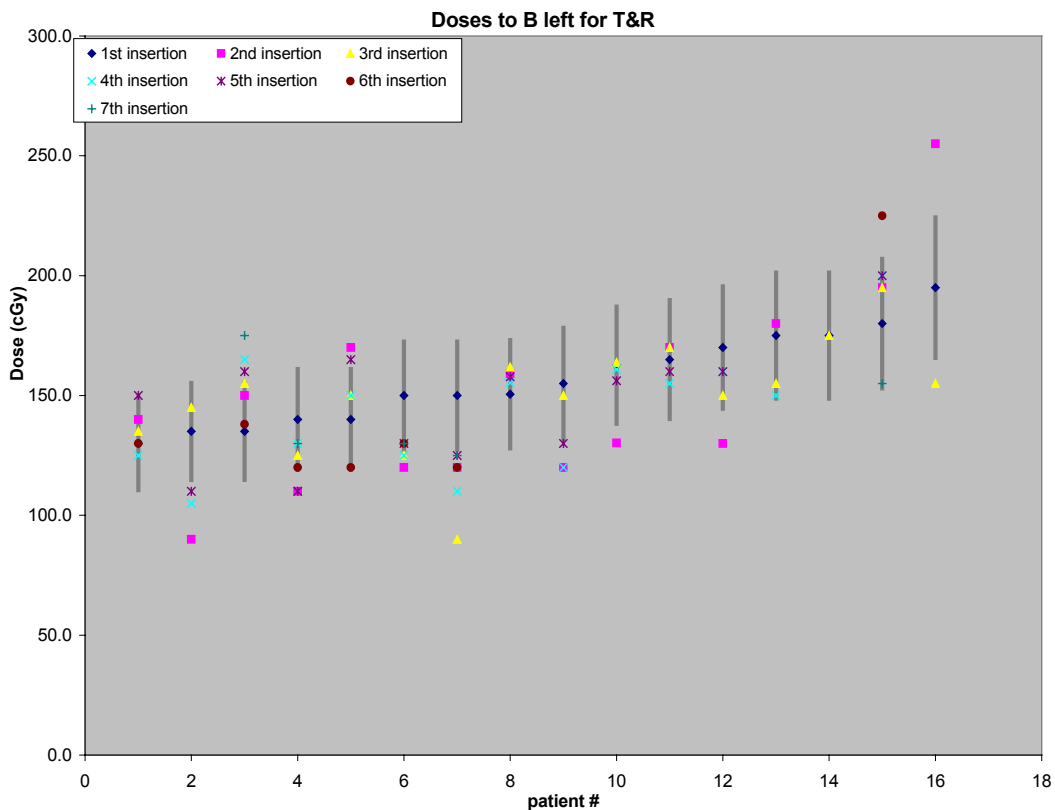
Figures 9 & 10. The prescription point for HDR cervix brachytherapy is point A. For the tandem and ring applicator, 6% (one patient) of patient charts contained at least one insertion showing $\geq 15\%$ dose variation from the first insertion at point A_{right}. For point A_{left}, 19% of charts showed this variation. 0% and 15% of the charts contained two or more insertions with $\geq 15\%$ variations from the first insertion at A_{right} and A_{left} respectively.

Doses to A left for T&R





Figures 11 & 12. For the tandem and ring applicator, 75% of patient charts contained at least one insertion showing $\geq 15\%$ dose variation from the first insertion at point B_{right}. For point B_{left}, 69% of charts showed this variation. 50% and 50% of the charts contained two or more insertions with $\geq 15\%$ variations from the first insertion at B_{right} and B_{left} respectively.



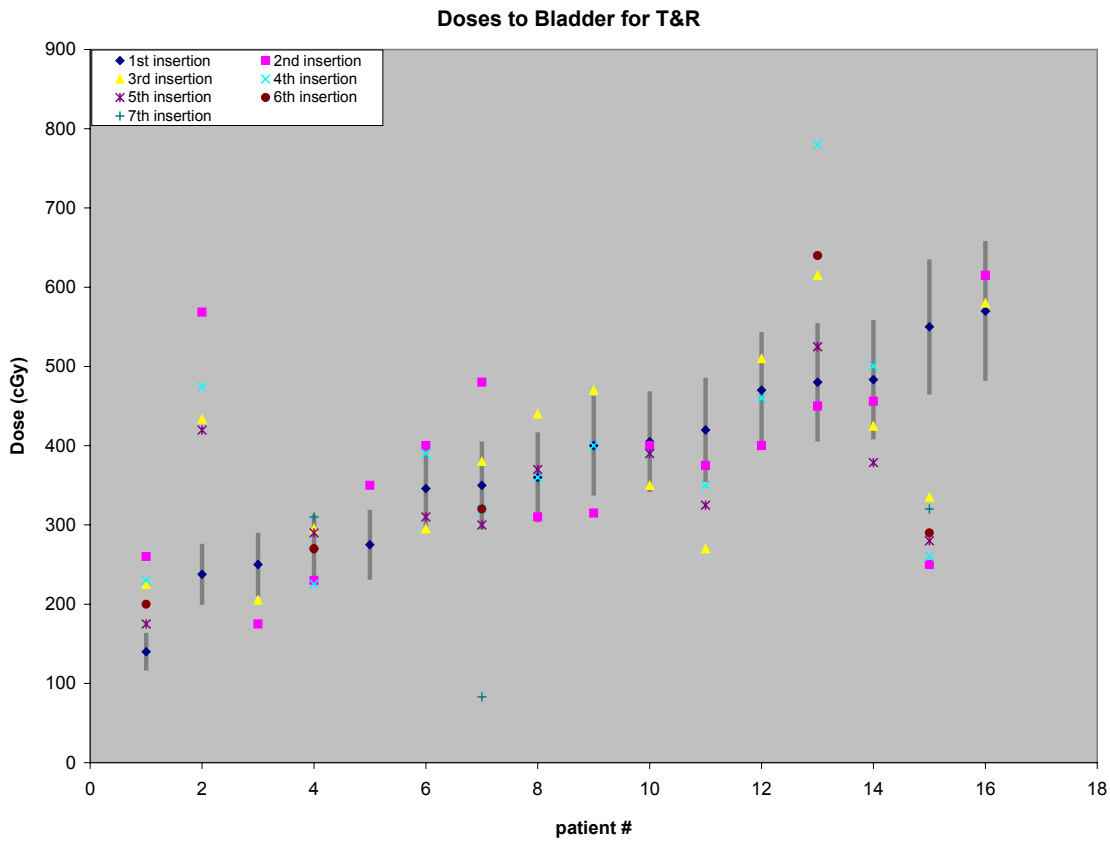


Figure 13. For the tandem and ring applicator, 75% of the patient charts had at least one insertion for which the dose to the bladder varied from the dose calculated for the first insertion by at least $\pm 15\%$. 56% of the charts contained two or more insertions with $\geq 15\%$ variations from the first insertion at the bladder point.

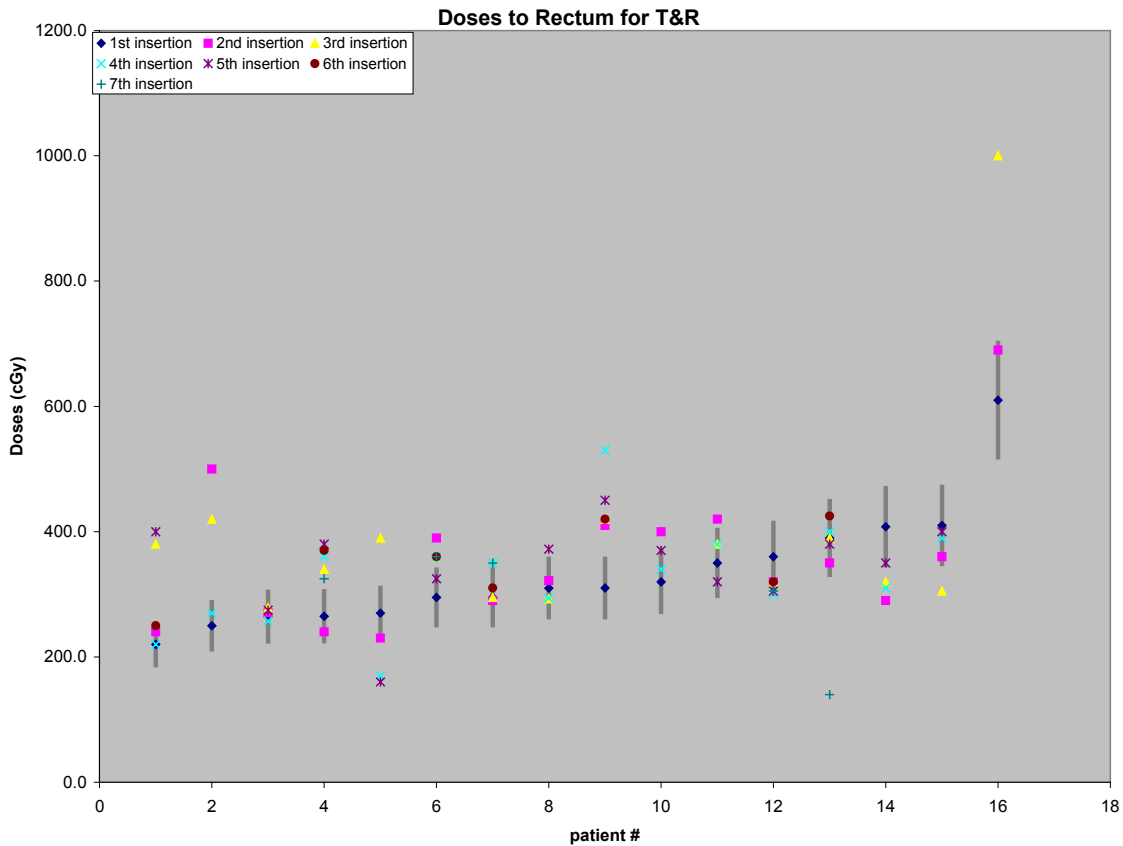


Figure 14. For the tandem and ring applicator, 94% of the patient charts had at least one insertion for which the dose to the rectum varied from the dose calculated for the first insertion by at least $\pm 15\%$. 50% of the charts contained two or more insertions with $\geq 15\%$ variations from the first insertion at the rectal point.

SUMMARY:

A number of physicists and physicians have indicated that they believe it is unnecessary to calculate doses for each HDR insertion beyond the first one. This belief is based on the fixed geometry of the T&R applicator. There are even some who believe a T&O applicator, which is not a fixed geometry, can be inserted reproducibly from one insertion to the next. It has been shown even though the applicator may have reproducible geometry, it is difficult to insert the applicator reproducibly from one insertion to another, due to anatomical changes^{2,3}.

When institutions assume that all insertions are geometrically identical to the first, dosimetric errors at one or more of the dose points for subsequent insertions may be significant. The data show that relying on a dosimetry plan for the first insertion to predict doses for subsequent insertions frequently leads to errors in excess of 15%.

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REFERENCES:

1. ICRU (1985). International Commission on Radiation Units and Measurements, *Dose and Volume Specification for Reporting Intracavitary Therapy in Gynecology*, ICRU Report 38 (International Commission on Radiation Units and Measurements, Bethesda, Maryland).
2. Bahena JH, Martinez A, Yan D, et al. Spatial reproducibility of the ring and tandem high-dose rate cervix applicator. *Int J Radiat Oncol Biol Phys* 1998;41:13-19.
3. Hoskin PJ, Cook M, Bouscale D, Cansdale J. Changes in applicator position with fractionated high dose rate gynaecological brachytherapy. *Radiother Oncol* 1996;40:59-62.