# 4D Brachytherapy: a real-time brachytherapy technique for the management of prostate cancer

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# 4D Brachytherapy

## A real-time brachytherapy technique for the management of prostate cancer

**R Soares[1], J Uribe[1], S Uribe-Lewis[1], J Money-Kyrle[2], S Khaksar[2], R Laing[2], SEM Langley[1]**

(1) Dept. of Urology, Royal Surrey County Hospital; (2) Dept. of Oncology, St. Luke's Cancer Centre, Guildford, United Kingdom

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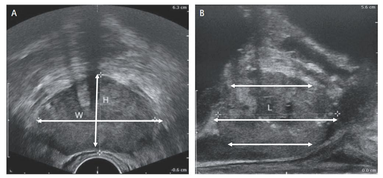
**INTRODUCTION:** 4D Brachytherapy ( *www.4Dbrachytherapy.com* ) is a novel low dose rate (LDR) brachytherapy approach for prostate cancer (PCa) that uses pre-loaded **stranded seeds** in the periphery (to optimise dose and minimise seed migration) and real-time planning of **loose seeds** centrally (to minimize urethral radiation) as a **one stage** real-time 45-minute implant .

This combination was made possible by the development of a computerised nomogram, derived from over 1,000 dosimetric plans, that can predict the required number of seeds and their positions in the prostate.

It is based on **5** preoperative transrectal ultrasound measurements taken in an outpatient setting.




We assessed treatment outcomes of 4D Brachytherapy and compared with conventional two-stage (2S) method.

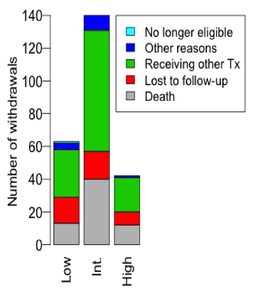
**METHODS:** Analysis of 3,262 men who underwent LDR brachytherapy in a single institution using prospectively collected data. Patients were included for analysis if they had over three years post-implant follow-up and a minimum of 4 PSA measurements (one pre-treatment).

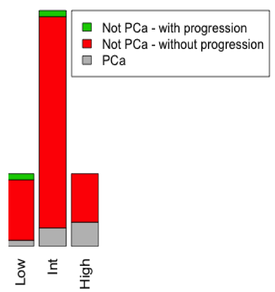
Disease risk stratification was done by D'Amico classification. Biochemical failure was defined by a PSA nadir plus 2 ng/ml without a return to levels below the nadir plus 2 value (i.e. not a bounce). Treatment failure consisted of a biochemical failure and/or documented clinical failure and withdrawal from the database.

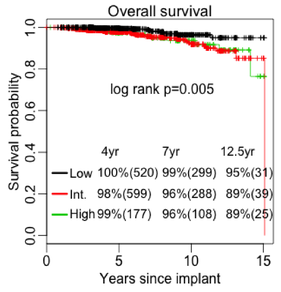
Categorical data were analyzed using Pearson's Chi-squared test or Fisher's exact test and continuous data with unpaired two-tailed tests.

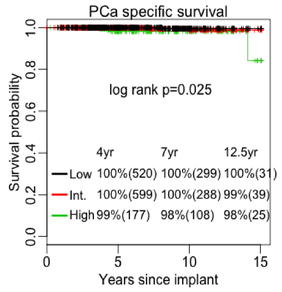
**RESULTS:** We compared outcomes of **1,063** men treated with 2S and **854** men with 4D Brachytherapy.

Median follow-up times were **10.3** and **4.8** years (*p<0.001*) for 2S and 4D cases, respectively.

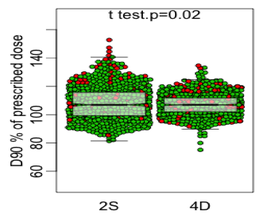


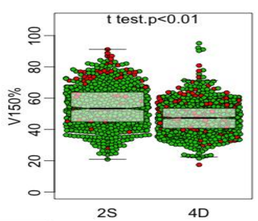



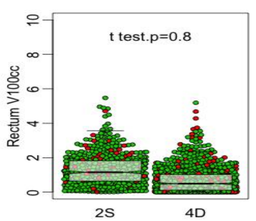



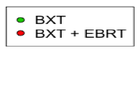



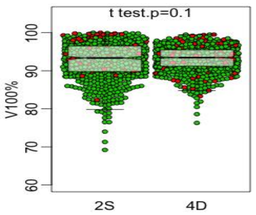

Post−implant dosimetry showed that 4D resulted in reduced variance compared to 2S cases (*p<0.009*).

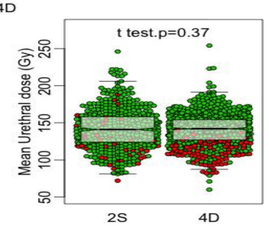


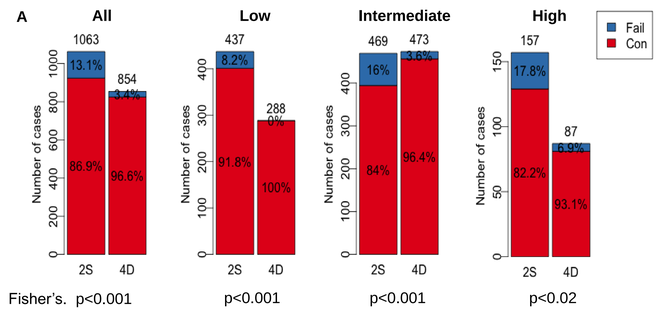



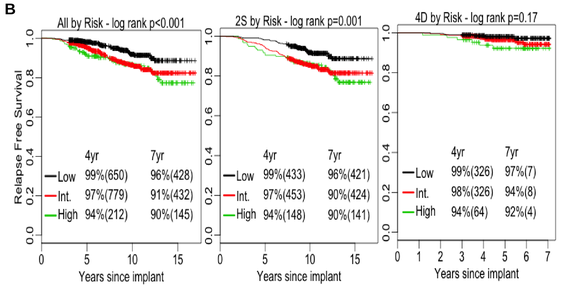



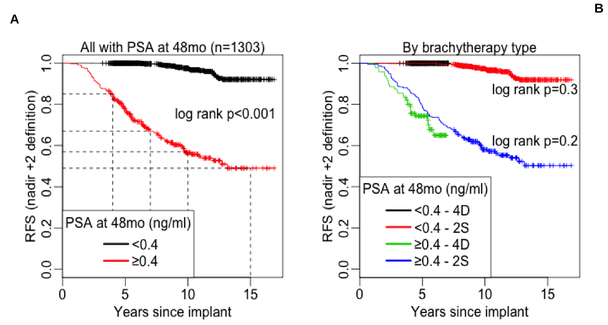

| | IQRs | |
|---|---|---|
| | 2S | 4D |
| D90% | 16.6 | 9.7 |
| V100% | 6.7 | 4.3 |
| V150% | 19.1 | 12.8 |
| R_V100cc | 1.2 | 0.9 |
| MUD(Gy) | 34.0 | 27.1 |
| Mean of IQRs | 15.5 | 10.9 |
| t.test p-value | 0.009 | |

**Clinical** and **biochemical** control were significantly improved with 4D Brachytherapy vs 2S in **low** (*p<0.001*), **intermediate** (*p<0.001*), and **high** risk (*p<0.02*).



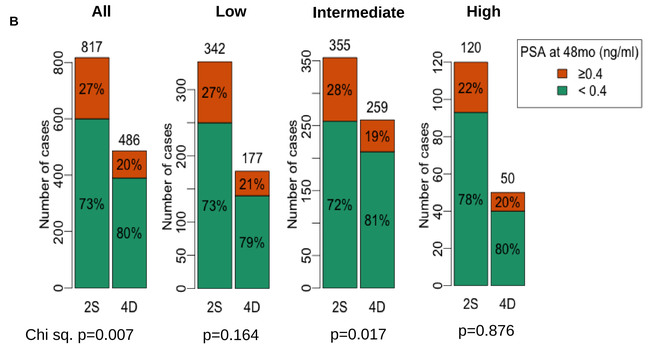




To control for follow-up length time bias between techniques, a PSA cut-off of **0.4** ng/ml at 48 months was used as a surrogate marker for failure. This again showed significantly more patients **failed treatment** with **2S** relative to 4D (*p<0.01*). Approximately **50 %** of patients whose PSA was **≥0.4ng/ml at 4 years** ultimately developed biochemical failure for both groups.

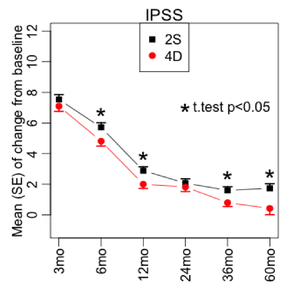


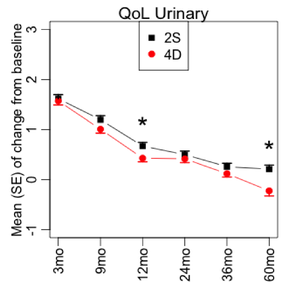


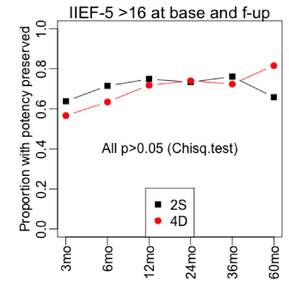


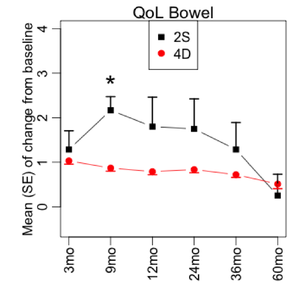



4D Brachytherapy patients showed significantly better **IPSS** (*p<0.01*) and **urinary quality of life** (*p<0.001*), while there was similar **potency preservation** in the 2 groups (*p=0.4*).




**CONCLUSIONS: 4D Brachytherapy, compared to conventional 2S technique, was associated with reduced dosimetry variance, improved biochemical control and reduced treatment toxicity.**