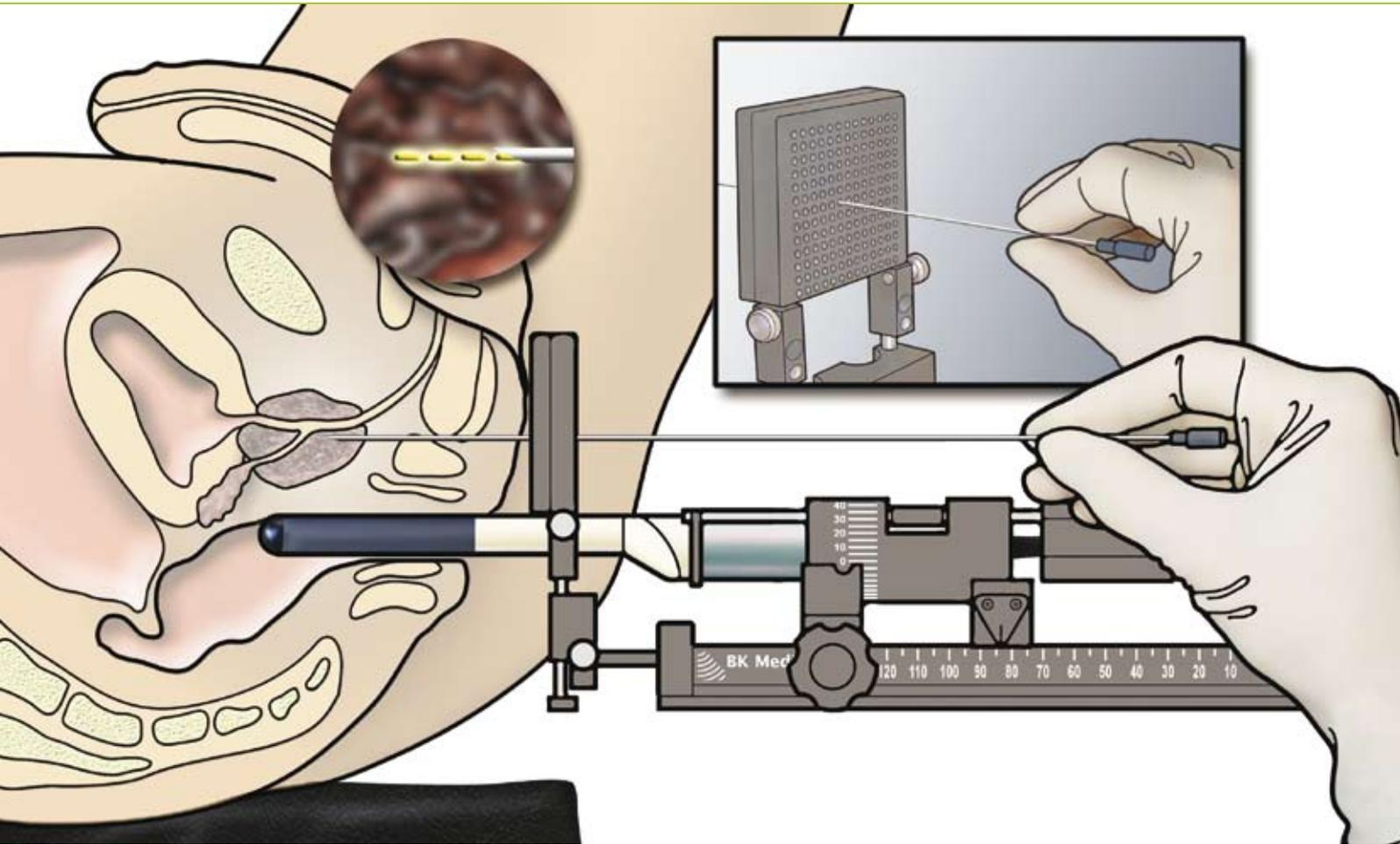




Transrectal ultrasound guided prostate brachytherapy

Application note



| Urology |



Transrectal ultrasound guided prostate brachytherapy

Author - Dr. Brendan Carey
Consultant Radiologist, Cookridge Hospital, Leeds, UK

Prostate Brachytherapy is an effective treatment for localized prostate cancer with high patient tolerability and acceptable morbidity outcome data. It is a technique that delivers a high dose of radiation to a small target volume of tissue, minimizing radiation side-effects to adjacent structures. Brachytherapy of the prostate can be delivered in two different ways: permanent seed implants using iodine or palladium seeds (Low Dose Rate, or LDR) or using temporary removable implants with iridium wires (High Dose Rate, or HDR). Biplane transrectal ultrasound is essential for accurate imaging guidance to place the radioactive sources into the prostate using a template guided transperineal technique.

Prostate cancer interventions have been greatly facilitated by developments in ultrasound transducer design and technology. Radiotherapy for prostate cancer can be delivered in different ways: conventionally, using external beam techniques, or by implanting the radioactive sources directly into the prostate (brachytherapy). The modern era of prostate brachytherapy began in the 1980's with the development of the closed transperineal implant technique using transrectal ultrasound guidance. Transrectal ultrasound guidance facilitates a closed percutaneous transperineal approach to the prostate for placement of radioactive sources. The development of biplane transrectal ultrasound transducer technology, like B-K Medical's 8848 transducer, has improved the safety and accuracy of the technique and the outcome data over recent years has confirmed that it is an effective treatment with high patient tolerance and

acceptable morbidity. Long term disease control is equivalent to the results for radical prostatectomy.

Prostate brachytherapy is a valid alternative to radical prostatectomy and external beam radiotherapy for localized prostate cancer.

The exact choice of brachytherapy technique will vary depending on the stage of the prostate cancer and disease-specific parameters such as the Serum PSA at presentation and the Gleason Score from the prostate biopsy. LDR Brachytherapy is performed with permanent implantation of radioactive "seeds" into the prostate, usually Iodine-125 with a half life of 60 days, although Palladium sources can also be used. HDR Brachytherapy uses temporary placement of iridium wires into the prostate, and these are then removed after the treatment is completed. Whatever technique is used, the transrectal ultrasound procedure is similar: the prostate is scanned to obtain an accurate volume and shape and this information is used by the radiation planning software to generate a 3-dimensional dose plan for each patient. The ultrasound data collected from this pre-treatment volumetric assessment, or Prostate Volume Study, is the basis for calculating the required number and location of sources for that particular patient and consists of both prostate volume acquisition and accurate 3-D volume rendered dosimetry. The radioactive sources are then inserted, transperineally, into the gland using a template-guided technique under real-time biplane ultrasound guidance, of which the B-K Medical 8848 biplane transducer together with the Pro Focus scanner are ideally suited.

Many brachytherapy variations have been

developed since the original description of the Seattle 2-stage technique, including various interactive implant techniques using real time ultrasound based dosimetry. However, transrectal ultrasound is the basis for all technique variations and similar principles apply.

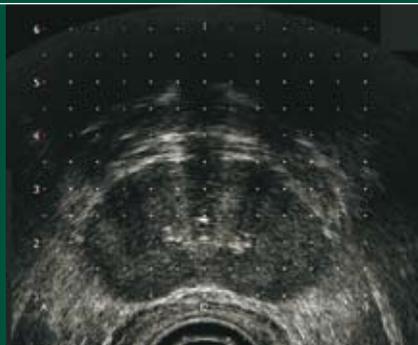
■ Transrectal ultrasound set-up

The procedure is performed in the operating room with the patient in the dorsal lithotomy position. General anaesthesia is generally used although, occasionally, spinal anaesthesia may be utilized. An inflatable stand-off can be used with the 8848 biplane transducer to permit elevation of the gland, if necessary, in order to obtain optimum access for needle positioning. The transducer is mounted in a stepping device that allows the prostate to be scanned systematically from base to apex using either sequential 5mm axial sections or a sagittal volume-based scanning technique. The bladder may be catheterised and radiographic contrast can be introduced into the bladder to facilitate fluoroscopy of the bladder base. Aerated ultrasound gel can also be used to delineate the urethra. An implant grid, mounted

onto the stepping unit, is placed against the perineum to guide needle and source placement within the prostate. This implant grid is calibrated to an on-screen superimposition of the grid matrix over the ultrasound image.

Advanced software in the B-K Medical Pro Focus scanner permits very accurate volume and surface outline calculations of the prostate and seminal vesicles. Pro Focus software also includes a matrix offset which can be programmed to compensate for any non-standard matrix and the 8848 transducer can be used for seed implantation with a choice of specially designed brachytherapy matrix templates.

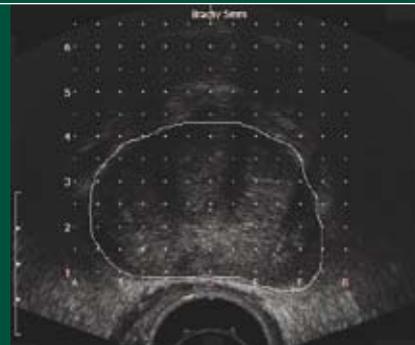
Using the ultrasound data, the requisite number and distribution of radioactive sources is calculated for the patient. The Urology Pro package with the Pro Focus scanner contains all the essential setups and measurements for precise volume studies, simultaneous biplane imaging and tissue harmonic imaging. Biplane ultrasound with the 8848 transducer allows each needle to be monitored as it is inserted transperineally into the prostate. The sources are then loaded into the prostate, through these needles, under direct, real-time ultrasound guidance. Great care



Transrectal ultrasound set-up: transverse image of the prostate with 5mm template overlay



Sagittal image of the entire prostate



Transverse view with contouring of the prostate



must be taken to avoid inadvertent trauma to the bladder, urethra and rectum during insertion. The procedure may utilize either the calculated pre-plan or newer intra-operative techniques now being developed which require continuous updating of the dose plan using feedback from ultrasound-based seed dosimetry. Biplane ultrasound with the 8848 greatly facilitates identification of needle and source deposition in the prostate and enhances the development of these newer implantation modifications. When the implant has been concluded, the prostate may be re-scanned to verify seed location for Low-Dose implants. For High-Dose implants, re-scanning may be used to ensure no source displacement prior to subsequent treatments depending on the radiation dose fractionation protocol used.

■ Morbidity

Most patients will experience some urinary symptoms after prostate brachytherapy and acute urinary retention generally occurs in about 15% of patients following LDR brachytherapy. Nocturia and daytime frequency are very common, and overall urinary morbidity does correlate with higher pre-treatment International Prostate

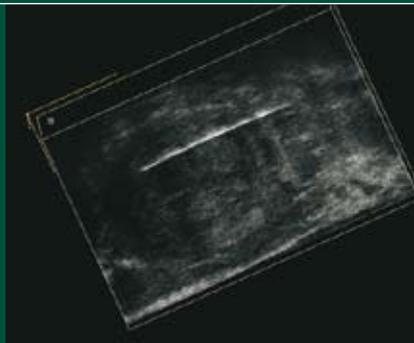
Symptom Score (IPSS) urinary scores. The relationship between urethral dose and urinary toxicity is unclear, although most patients benefit from routine use of alpha blockers (smooth muscle relaxants) during the initial weeks after implantation. Prolonged urinary catheterisation is unusual and surgery to improve urinary flow should be avoided, if at all possible, as it has a high risk of causing incontinence afterwards.

Rectal complications are uncommon and usually consist of self-limited proctitis. Long-term bowel dysfunction after brachytherapy is very unusual.

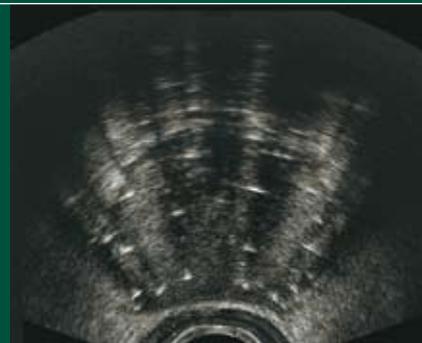
Preservation of sexual function after brachytherapy, as with other prostate cancer treatments, is difficult to assess. The only study using a validated quality of life scoring system reported that 6 years after prostate brachytherapy was used as monotherapy, 52% of the study's subjects maintained erectile function.

■ Biochemical Control

The development of prostate brachytherapy as an alternative to radical surgery and external beam radiotherapy has generated considerable clinical interest into its value and on clinical outcomes.



3D acquisition with needle inserted

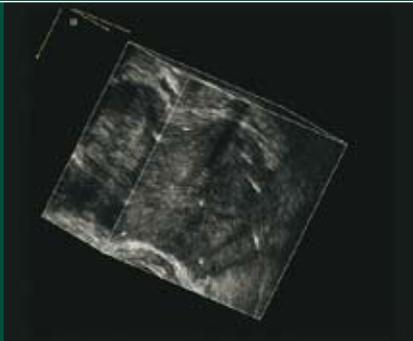


Transverse image of the prostate after seed implant

Prostate brachytherapy data has now matured as a treatment with consistent results reported from major centers in the US and Europe.

■ Conclusion

Prostate brachytherapy has become a widely accepted and valid method for the treatment of localized prostate cancer. Biplane transrectal ultrasound guidance, enabled by the B-K Medical 8848 transducer and the Pro Focus scanner with its specially designed Pro Package software and fully integrated 3D capabilities, greatly assists the safety and accuracy of the procedure.



3D Viewer: 3D and seeds.

REFERENCES

- 1. Holm H, Juul N, Pederson J et al. Transperineal 125 seed implantation in prostatic cancer guided by transrectal ultrasoundography *J Urology* 1983; 130:283-286
- 2. Potters L, Morgenstern C, Mullen E et al. L. Potters, C Morgenstern, E.E. Mullen, Fearn P, Jassal A, Kattan M. Twelve year outcomes following permanent brachytherapy in patients with clinically localized prostate cancer *Int J Radiat Oncol Biol Phys* 2004; 60: S183-S184.
- 3. Grimm P, Blasko J, Sylvester J, Meier R, Cavanagh W. 10-year biochemical (prostate-specific antigen) control of prostate cancer with brachytherapy *Int J Radiat Oncol Biol Phys* 2001; 51: 31-40.
- 4. Battermann J, Boon T, Moerland M. Results of permanent prostate brachytherapy, 13 years of experience at a single institution *Radiother Oncol* 2004; 71:23-28.
- 5. Ragde H, Abdel-Aziz A, Snow P et al. Ten-year disease free survival after transperineal sonography-guided Iodine-125 brachytherapy with or without 45-Gray external beam irradiation in the treatment of patients with clinically localized, low to high Gleason Grade prostate carcinoma. *Cancer* 1998; 83:989-1001.
- 6. Joseph J, Al-Qaisieh B, Ash D, Bottomley D, Carey B. Prostate-specific antigen relapse-free survival in patients with localized prostate cancer treated by brachytherapy *BJU Int* 2004; 94:1235-1238
- 7. Blasko J, Grim P, Sylvester J, Badiozamani K, Cavanagh W. Palladium-103 brachytherapy for prostate carcinoma. *Int J Radiat Oncol Biol Phys* 2000; 46: 839-850.
- 8. Brachman D, Thomas T, Hilbe J, Beyer D. Failure-free survival following brachytherapy alone or external beam irradiation alone for T1-2 prostate tumours in 2222 patients: results from a single practice. *Int J Radiat Oncol Biol Phys* 2000; 48: 111-117
- 9. D'Amico A, Whittington R, Malkowicz, S et al. Biochemical outcome after radical prostatectomy, external beam radiation therapy, or interstitial radiation therapy for clinically localized prostate cancer *JAMA*, 1998; 280: 969-974
- 10. Ash D, Al-Qaisieh B, Bottomley D, Carey B, Joseph J. The impact of hormone therapy on post-implant dosimetry and outcome following Iodine-125 implant monotherapy for localised prostate cancer *Radiother Oncol* 2005; 75: 303-306
- 11. Benoit M, Naslund M, Cohen J. RComplications after prostate brachytherapy in the Medicare population *Urol* 2000; 55:91-96
- 12. Bottomley D, Ash D, Al-Qaisieh B, et al. Side effects of permanent I125 prostate seed implants in 667 patients treated in Leeds *Radiother Oncol* 2007; 82: 46-49.
- 13. Ash D, Al-Qaisieh B, Gould K et al. Long term outcomes following iodine-125 monotherapy for localized prostate cancer: the Cookridge 10 year results *Clin Oncol (R Coll Radiol)*. 2007; S18

| B-K Medical |

With more than 30 years of commitment to ultrasound innovation, B-K Medical specializes in the development, manufacture and distribution of dedicated ultrasound solutions. B-K Medical headquarters are located near Copenhagen, Denmark and we have offices and distributors throughout the world.

A wholly owned subsidiary of Analogic Corporation



World Headquarters
Mileparken 34
DK-2730 Herlev
Denmark

Tel: +45 44 52 81 00 • Fax: +45 44 52 81 99 • www.bkmed.com