HDR Prostate

Workflow and procedure description, as implemented at Virginia Commonwealth University, Richmond VA

1. The procedure takes place in our dedicated Brachytherapy Suite, which is both an OR procedure room and treatment room.
2. Routinely, the procedure (needles insertion and treatment planning) is based on ultrasound images alone for the first fraction. If subsequent fractions are to be delivered (typically we deliver HDR prostate treatments in 1-2 fractions, combined with EBRT), either fluoroscopy or CBCT is used to assess implant reproducibility.
3. Imaging equipment is Acuity (Varian Medical Systems) for fluoroscopy and CBCT and Hawk 2102 EXL ultrasound scanner (B&K) with a Civco MicroTouch digital stepper. Planning software for HDR prostate is Vitesse V2.0 and BrachyVision 10.0 (Varian Medical Systems). Treatment delivery uses a VariSource iX (Varian Medical Systems) remote afterloader and delivery software.
4. Workflow:
   a. Time out procedure. Patient is identified.
   b. Patient is placed in lithotomy position. Under anesthesia, the ultrasound rectal probe is inserted and HDR template mounted on the stepper.
   c. A series of ultrasound images are acquired and placement of needles is determined by physician and physicist, typically 12-16 needles. Anatomical structures (prostate, urethra, rectum, …) are contoured.
   d. Needles are inserted using live ultrasound imagining guidance. A physicist inserts corresponding needles in the TPS, explicitly confirming the entry point in the template.
   e. After all needles are inserted, a new set of images is acquired, depicting both anatomy and needles (applicators).
   f. Needles tracks (initially parallel with the probe) are refined to match the ultrasound images and correct for deviations from rectilinearity. Contours are adjusted to correct for variations (e.g. swelling) occurring during needle insertion. Once finalized, images, applicators and contours are exported as DICOM files, from Vitesse and imported in BrachyVision.
   g. Treatment plan and dose optimization takes place using BrachyVision. Final plan is approved by physician. An independent dose calculation (essentially a point dose calculation using an Excel spreadsheet) is carried out to confirm TPS dose calculations. Plan is exported to the afterloader workstation.
   h. A printout of the HDR template showing needle positions and channel numbers is used to connect each of the needles (applicators) to the corresponding channel of the afterloader. Prior to the actual connection in the afterloader, each needle and its connected corresponding transfer tube are measured using a wire ruler (Varian Medical Systems) and the total
length, corrected for the presence of the QuickConnect, introduced in the interactive menu in the iX software.

i. After final checks, treatment is delivered.

j. If the fraction delivered is the last fraction of the HDR component of the treatment, needles are removed and patient sent to recovery room.

k. If the delivered fraction is not the last one, patient is recovered, then placed from the full lithotomy position (stirrups) in a slightly elevated position using MICK Leg Support (Mick Radio-Nuclear Instruments, Inc.)

l. Prior to removing the patient from the Brachytherapy Suite, a series of fluoroscopy images/CBCT dataset are acquired. Similar images acquired prior to subsequent fractions will be used to assess the needles positions relative to markers placed during the procedure, thus insuring the reproducibility of the dose delivery.
**HDR Prostate**

Workflow and procedure description, as implemented at Memorial Sloan Kettering Cancer Center, New York, NY

These procedures assume routine periodical/daily QA of all systems (imaging, planning, treatment delivery etc)

1. The procedure takes place in our dedicated Brachytherapy Suite, which has both an OR procedure room and a treatment room, both HDR capable.
2. Needles insertion, is based on ultrasound images alone. Treatment planning is based on intraoperative CBCT (or CT if CBCT images are of poor quality). 2 fractions will be delivered on day 0 if treatment course is in combination with EBRT; 4 fractions will be delivered on Days 0 and 1 if a monotherapy treatment. Florosscopic images are obtained in the OR (DRRs are generated if CT rather then CBCT is used for planing) for the purpose of confirming reproducibility at the time of treatment. A second CBCT/CT may be acquired as well for this purpose.
   a. Imaging equipment is O-arm (Medtronic Navigation) for fluoroscopy and CBCT and Preirus ultrasound scanner (Hitachi Medical) with a Civco MicroTouch digital stepper. Planning software for HDR prostate is BrachyVision 10.0 (Varian Medical Systems). A home grown program is used to assist in independent check of the treatment plan. Treatment delivery uses a GammaMed Plus (Varian Medical Systems) remote afterloader and delivery software. Additional hardware used, includes Contours HDR templates (usually small, but large is available as well), flexiguide HDR catheters, and Mick Leg Support for patient immobilization (all from Mick Radio-Nuclear Instruments, Inc).
3. Workflow:
   a. Time out procedure. Patient is identified. Anesthesia is induced.
   b. Patient is placed in lithotomy position. The HDR template mounted on the stepper and the ultrasound rectal probe is inserted.
   c. Gold fiducial are inserted in the gland for treatment verification (as well image guidance if EBRT is to follow)
   d. A series of ultrasound images are acquired to ensure proper visualization of the gland, and placement of needles by physician follows (typically 16-20 needles). Needles are inserted using live ultrasound imagining guidance.
   e. A therapist and physician mark and confirm needle entry point in the template, on a dedicated form.
   f. US is removed; couch extension is put in place and patients legs are place on the Mick Leg Support; Cystoscopy is performed to ensure proper tenting of the bladder wall by the needles.
   g. A set of CBCT or CT images is acquired for planning, depicting both anatomy and needles (applicators). (if CT images are taken, Stylets are
removed to minimize metal artifacts). Patient is sent to the recovery room while treatment planning is done.

h. Treatment planning: Images are imported in the TPS; anatomical structures: prostate, urethra, rectum, and bladder are contoured. If necessary additional structures are outlines as well (e.g. boost region, bowel, etc). Needle tracks are entered and correlated with template entry points recorded in the OR. Dose optimization takes place using BrachyVision. Final plan is approved by physician.

i. Plan is exported to the afterloader workstation. An independent dose calculation using in house software is done based on the exported treatment file, to independently reconstruct the implant and perform multiple dose-to-point calculations.

j. A printout of the HDR template showing needle positions and channel numbers is used to connect each of the needles (applicators) to the corresponding channel of the afterloader.

k. Positions of catheters are verified with respect to fiducial markers using fluoroscopy.

l. After final checks, treatment is delivered, and patient is survey as per protocol.

m. If the fraction delivered is the last fraction of the HDR component of the treatment, needles are removed and patient is released from the hospital.

n. Treatment fractions are delivered at least 4 hours apart.