Conformal arc radiotherapy planned with Pinnacle^3

Jeff Anderson Regional Cancer Center

Who/where
Jeff Anderson Regional Cancer Center (JARCC), Meridian, Mississippi, USA
A branch of the Jeff Anderson Regional Medical Center (JARMC) moved into a new facility in 2003, making state-of-the-art cancer treatment a reality in this area of Mississippi. The cancer center is equipped to provide treatment for all types of cancer, and sees about 180 outpatients a day for radiation or chemotherapy treatments.

Challenge
All patients at JARCC receive highly individualized plans and the team is continuously looking for new and better ways to treat tumors. Having had prior experience with conventional arc techniques, the team decided to find out if Pinnacle^3 conformal arc functionality could render superior treatment plans for certain types of cancers.

Solution
The Philips Pinnacle^3 radiation treatment planning platform has a robust and open architecture, allowing dosimetrists and physicists to try different scenarios and combine inverse and forward planning techniques. With the conformal arc planning feature in Pinnacle^3, users can combine conformal hemi-arcs and static IMRT beams resulting in plans that provide superior dose distributions, simple delivery scenarios and allow the use of higher radiation energies.

Why use conformal arc delivery techniques?

Arc rotational therapy itself is not new. As early as the 1960's, arcing delivery techniques were used to irradiate tumors with dynamic gantry angle, to overcome the adverse effects of the relatively low energies that were available at the time. When higher energies became available, superior treatment plans could be delivered using static fields. With the advent of multileaf collimators, however, the advantages of an arcing beam could be exploited once again. By dynamically changing the aperture to follow the shape of the target as the gantry rotates, a highly conformal dose distribution can be realized. While not a universal technique, certain tumors and tumor shapes can be treated advantageously with conformal arcs.

When the necessary software technology for planning conformal arc treatments became available, the team at JARCC decided to investigate its value. Utilizing the Pinnacle^3 radiation treatment planning system, Chief Medical Physicist Paul King and his team developed a technique combining a conformal hemi-arc with static IMRT beams.

Left to right; Kranthi K. Kandagatla, MS, DABR medical physicist;
R. Scott Anderson, MD, FACR medical director;
R. Paul King, MS, DABR chief physicist and RSO;
Greg L. Thompson, RT(R)(T), certified medical dosimetrist;
Otis H. Johnson, BSRT(T) medical dosimetrist.

How did you develop the optimal planning technique?

The team at JARCC started out by combining conformal arcs with lateral wedged fields. While the results were admirable, the flexibility of Pinnacle^3 to mix and match beams and delivery modalities allowed them to replace these fixed fields with intensity modulated beams. The improvements in the plans were unmistakable. Direct machine parameter optimization (DMPO) enhanced the plans even further, by modulating the leaf positions in forward-planned beams for a more

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Greg L. Thompson RT(R)(T), CMD certified medical dosimetrist (left) and R. Paul King, MS, DABR chief physicist and RSO.

accurate fine tuning of the dose. Using this approach, the team learned that the best plans are based on a conformal hemi-arc, with added static IMRT beams used like a brush to "paint" homogeneity into the dose distribution and to eliminate hot spots.

Radiation Oncologist Dr. Russell Scott Anderson refers to the resulting solutions as "hybrid planning" and adds, "Pinnacle[3] is such a friendly yet robust platform, and we especially appreciate that it gives us the ability to try out different things, and most importantly, examine the results in great detail. We are extremely scrupulous in mapping and verifying the effectiveness of our plans prior to releasing them for actual patient treatment. By evaluating multiple plans for overall isodose delivery, DVH information, and dose allocation to both target and critical structures, we have found that conformal arc plans typically achieve superior dose distribution in comparison to other delivery techniques."

How do you determine when conformal arc plans are most effective?

Describing the typical workflow at the center, Dr. Anderson explains, "Our focus is on delivering the best possible plan. We develop a variety of solutions for each individual patient, including a 3D conformal plan, an IMRT plan and an arc plan. During our review sessions the dosimetrists have to justify why they recommend a particular plan. Having built up their expertise, they now intuitively know for which cancer sites and tumors, shaped arc therapy plans may render superior results."

The team has found that conformal arc plans are particularly suitable for treating centrally located tumors that are round, such as those found in the prostate and the abdomen. They also concluded that conformal arcs may be less suitable for odd shaped and concave tumors and that nearby critical structures may dictate creative changes in arc angle and aperture definition.

"Conformal arc based IMRT plans produce superior conformality, target dose homogeneity, and excellent critical structure avoidance using high-energy X-rays and a multileaf collimator in a way that is both efficient and robust."

R. Paul King, MS
Chief Medical Physicist

Dosimetrist Otis Johnson adds that while extreme care is given to every plan, Pinnacle[3] makes arc planning of more routine cases a lot easier. "Due to the experience we have in this particular area, the planning process for prostate cases is now pretty straightforward. For other sites it may take a few more trials, but by applying our knowledge of what a conformal arc can accomplish, we arrive at an optimal solution fairly quickly."

The ability of Pinnacle[3] to combine inverse and forward planning techniques is seen by the team as a key advantage to create superior conformal arc plans, and the integration of direct machine parameter optimization (DMPO) has significantly streamlined the planning process.

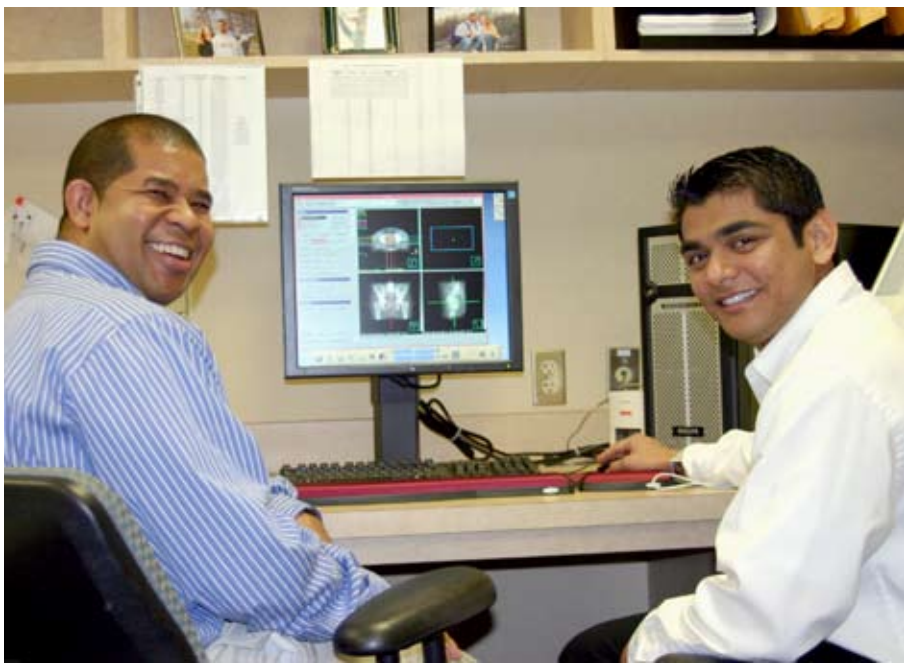
Additional benefits from conformal arc plans

The fact that conformal arc plans improve the treatment workflow and get the patient off the table more quickly is seen as an important added benefit. The radiation therapists at JARCC have given very favorable feedback in regards to the delivery of the plans. Also, since the dose is not delivered through heavily modulated fields, the MU to dose ratio is reduced, which allows them to exploit the benefits of high beam energies.

What do you see as drivers of change in radiation therapy?

The team at JARCC sees the future of radiation therapy in the convergence of multiple technologies such as stereotactic localization, IMRT, IGRT, adaptive planning, DMPO and conformal arc therapies. These and other innovations will be used individually, or in concert, to enhance patient treatment. An emerging approach to radiotherapy delivery is the use of inversely optimized intensity modulating arc beams. Adding intensity modulation to dynamic conformal arc treatments can greatly enhance the ability to conform the dose away from sensitive organs while matching the therapeutic dose to the tumor.

Medical Physicist Kranthi Kandagatla considers conformal arcs as a stepping stone to achieving even greater conformality and control. He states, "By using conformal arcs we are moving in the direction of modulated arc therapies, which I see as the next logical step. Today we can develop superior plans that accomplish dose homogeneity in each segment with conformal arc. Modulating the dose at every segment will greatly enhance our ability to develop arc plans for different cancer sites with larger inhomogeneities as well."



Otis H. Johnson, BSRT(T) medical dosimetrist (left) and Kranthi K. Kandagatla, MS, DABR medical physicist.

In addition to their innovative approach to developing arc therapy plans, the team at JARCC is actively developing and implementing a variety of other ideas. "As we are moving in the direction of intensity modulated arc therapy (IMAT), we are integrating conformal arcs into our IMRT planning. We are searching for solutions to overcome the hurdles we face in the implementation of IGRT. We don't look at these as independent but as parallel paths. For us, the immediate next step will be to move into CT-based IGRT to give us the ability to confirm our treatment plans on a daily basis. Specifically, we want to be more confident about where we are putting our dose, so we can reduce our margins and spare more adjacent structures. Once we have that confidence, the move to IMAT will be easier thanks to our experience with Pinnacle^3 and the conformal arc work we have done," says Chief Medical Physicist R. Paul King. "The bottom line is that we will keep pushing the envelope in order to develop the best possible treatment plans for our patients. The flexibility of the Pinnacle^3 platform is helping us achieve these goals, and today we are confident we will be able to continue to do so, whatever new technologies and clinical insights the future may bring."

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