

## Reply to 'Comments on 'Single-Arc IMRT?''

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## LETTER TO THE EDITOR

## Reply to ‘Comments on ‘Single-Arc IMRT?’

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The letter by Verbakel *et al* confirms that arc IMRT is indeed a fast growing hot topic. They have now treated more than 110 patients with great efficiency using Varian’s RapidArc system, which is impressive. The publications cited by Verbakel *et al* in support of their claims are all abstracts from conference presentations or unpublished (as of November 2008 (the final-form date of our note)) papers. Nevertheless, we have no doubt that Verbakel *et al* did their work with great care and that their patients benefited from the shorter treatment times compared with *their* standard IMRT method. In this brief reply we wish to point out, however, that the letter by Verbakel *et al* does not negate anything we stated in our note, and that it rather provides a good specific example for what we said in more general terms.

First of all, Verbakel *et al* approach the arc IMRT problem from a completely different angle than we did in our previous note (Bortfeld and Webb 2009). While they compare ‘product A’ (their implementation of Varian RapidArc) with ‘product B’ (Varian sliding window IMRT planned with Eclipse), we looked at the Single-Arc IMRT technique from an intentionally ‘philosophical’ point of view. From a comparison of product A with product B it is very difficult to draw general conclusions. It is not normally possible to generalize the results to similar products, not even to other versions of the same product. This is of course a problem that we face everywhere in our field. Conversely, we were, and still are, genuinely interested in exploring the *scientific basis* of the potential advantages (and disadvantages) of *Single-Arc* in comparison with other more established techniques. What do we gain (or lose) by rotating the gantry and moving the multileaf collimator continuously as compared to treating from a fixed number of pre-selected angles, and very importantly what could be the physical basis of any such gain (or loss)? Incidentally, in the early days of IMRT we faced a similar problem with dynamic versus step-and-shoot IMRT, and eventually came up with some equations that provided the answers (Webb 2001). Because our objectives are so different from those of Verbakel *et al* we believe that most of their criticism of our work misses the point. In particular, we wish to make it clear that we did not at all intend to flatter or criticize particular companies or their products. It is probably unfortunate that one company chose to extract specific sentences from our note and put them on their website.

One of our conclusions was that treatment plan comparisons of different treatment modalities such as Single-Arc and standard IMRT (S-IMRT) are generally challenged by

the fact that one cannot easily separate the potential of a treatment delivery technique from the underlying treatment planning or optimization method. Verbakel *et al* provide a good example for this finding. Their result that the use of RapidArc reduces the treatment delivery time by 6–11 min compared with the standard sliding-window IMRT technique could mean two things: the RapidArc technique could indeed be inherently superior to the standard IMRT technique. However, it could also mean that their specific planning method for S-IMRT is inefficient, for example by producing fluence maps that are unnecessarily complex. In fact, it has been shown that by use of planning methods that favour simpler fluence maps, such as direct-aperture optimization, the treatment delivery time can be reduced by a factor of 3–7 (Shepard *et al* 2002, Kuperman *et al* 2008). This gain in efficiency is of the same order of magnitude as that reported by Verbakel *et al* for RapidArc. The bottom line here is that we do believe that techniques like RapidArc and VMAT have an efficiency advantage compared to S-IMRT but that this advantage has been overstated in the work by Verbakel and others for the reasons mentioned above and in our note.

We wish to re-emphasize an important point from our note, namely that with all these techniques we need to carefully evaluate the tradeoff between treatment time and quality of dose conformality. There is a risk to compromise quality for a gain in speed. Moreover, we should not only look at potential reductions of the treatment time for a given quality of the treatment plan, but also at potential improvements of the treatment plan without increasing the treatment time, by using techniques like RapidArc or VMAT.

Our note was a first step towards a general theory and we accept a limited one. We still believe that there is no published general theory explaining exactly how Single-Arc IMRT in its various forms relates to the ‘conventional’ IMRT methods, i.e. a theory that informs, directs and facilitates treatment-plan optimization.

## References

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