In-vivo-dosimetry (IVD) is mandatory in France since 2011 for all beams where this control is technically feasible. The most popular method remains the direct dose measurement by means of diodes or MOSFETs. However, these detectors are of limited use in the case of multiple complex fields. So with the widening use of modern techniques, such as intensity modulated radiotherapy or dynamic arc therapy, the use of diodes and MOSFETs for mandatory IVD is rendered obsolete.

As an alternative, a transit IVD system such as EPIgray® (DOSIsoft S.A.) can reconstruct the delivered dose for IMRT and dynamic arc therapy fields from portal images recorded during the treatment.

However, the recorded images of very small, complex, arc therapy fields give little additional information, such as body or bone delineation, for the interpretation of the IVD results and eventual deviations. In the perspective of developing additional tools for a successful analysis of the results, it is thus important to dig into all technical and clinical parameters influencing the dose outcome.

The observations made during a first analysis of the causes often cited for the failure of Quality Assurance controls, such as modulation and measurement point, are here presented.

## INTRODUCTION:

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## MATERIALS AND METHODS:

### Delivery System:

- **Linear Accelerator (Varian):**
  - 60kV, Synergy
  - 25MV, Clinac 21EX

- **EPID Images:**
  - Imaging in routine Tolerance

- **MVS:**
  - Siemens Allura Xper FD20, Philips i.Effect

- **Arti1000, EPImanager:**
  - IMRT planning tool

- **TPS Algorithm:**
  - Eclipse, Varian

### RappArc:

- **Eclipse, Varian:**
  - AAA, 2 Arcs

### Results:

#### Vero-dosimetry with EPIgray®:

**Simplified algorithm:**

1. **In vivo-dosimetry results:**
   - Distribution of Dose Deviations for 1055 IVD Controls

2. **Measurement point position:**
   - Influence of the position of the points in/out of the field at different delivery angles

3. **Dose rate variation:**
   - Influence of the changes in dose rate occurring during the delivery of an arc

4. **Modulation of the Multi-Leafs Collimator:**
   - Influence of the complexity and modulation of the MLC

#### Analyzed parameters:

- **Per arc, with total number of control points:**
  - Per control point CPi,
  - With N open leaves at position posi,

- **Point position index PI:**
  - Pli = \( \frac{1}{N} \sum_{p=1}^{N} |\text{Dose}_{\text{pred}} - \text{Dose}_{\text{rec}}| \)

- **Dose rate variation:**
  - Dose rate variance

- **Modulation complexity score:**
  - Leaf Sequence Variability Aperture Area Variability

#### In vivo-dosimetry results:

- **Dose deviation, per measurement site:**
  - Average dose deviation and standard deviation:

#### Conclusions:

Several plan parameters were here investigated: the position of the IVD point of measurement in the field/segment (Point Index), the planned variability of the dose rate during the plan delivery (Dose Rate Variation and Standard Deviation), and the complexity of the delivered arc (Modulation Complexity Score, Modulation Factor). Based on the analyzed plans, the following observations could be made:

1. The 90 analyzed plans present an average dose deviation of 1.7±1.7% over a total of 1055 controls.
2. A small shift in in-vivo-dosimetry results can be observed between primary (largest dose) and secondary (smaller dose) arcs.
3. The dose rate of dynamic arcs can be very variable, with a standard deviation of up to 56 MU/min.
4. A slight correlation can be observed between the standard deviation of the dose rate and the passing of an in-vivo-dosimetry control.
5. The plans in tolerance limits tend to have a lower dose rate deviation (under 100 MU/min).
6. The point index shows that measurement points spend in the field an average of 45% of the irradiation time.
7. The average modulation complexity score of 0.33 matches the literature.
8. However, no evident correlation can be detected between the position of the point in the field or the modulation complexity of the field and the results of the in-vivo-dosimetry controls.

To polish and refine these results, a second study will be conducted to include the type of treatment site, which may influence the complexity of the plan, the total planned dose, a correlation to clinical parameters, such as weight loss, and phantom studies.

**REFERENCES:**


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