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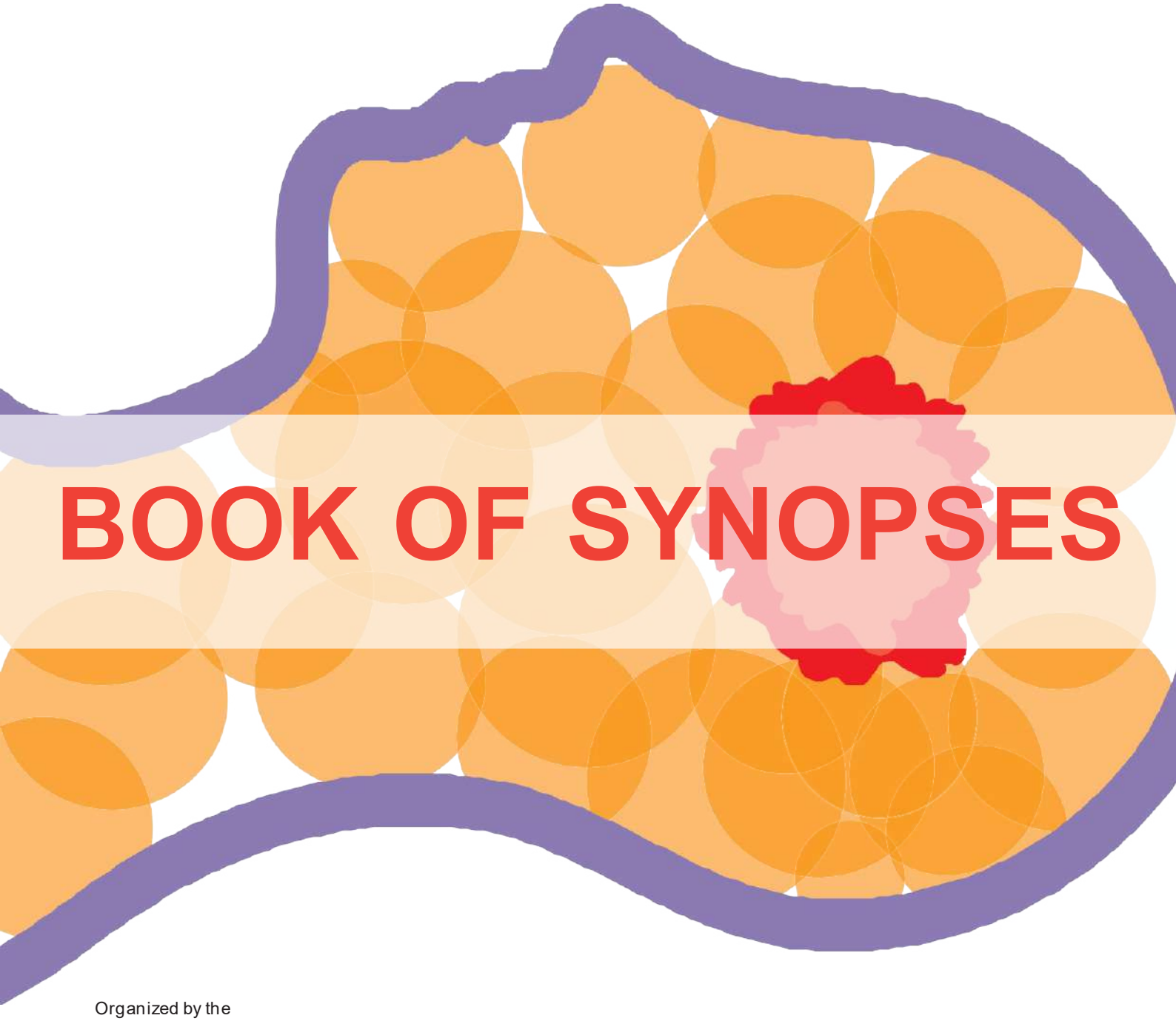

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# MP-EP03 #105 Statistical Control Process in Tomotherapy pre-treatment QA, Rosa Petit

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## BACKGROUND AND OBJECTIVE

Intensity Modulated (IM) techniques, both static and dynamic, include a variety of uncertainties that make it more prone to errors during dose planning and delivery. That is why patient-specific QA is essential in identifying abnormal discrepancies between the calculated dose and the delivered one.

In IM patient specific pre-treatment QA, it can be useful to introduce statistical control processes (SPC), which can be defined as quality control methods that use statistical analysis of the information to track and inspect a process over time.

We applied the SPC methodology to gamma γ analysis results in helical Tomotherapy™ (Accuray) pre-treatment verifications, using ArcCheck™ (Sun Nuclear) as a QA tool, to establish tolerance limits and action thresholds for different anatomical sites (abdominal area, head & neck, breast plus supraclavicular nodes (SVC) and prostate). The final purpose of this research is both to promote detection of eventual delivery problems before the treatment dose and to monitor the system performances over time.

## METHODS

The parameters selected to determine the tolerance and action limits in pre-treatment QA measurements using ArcCheck™ were the γ-index passing rate obtained with two criteria: 3%, 3 mm - local normalization (γ33L) and 3%, 2 mm - global normalization (γ32G). The calculation of the patient plan on ArcCheck™ was carried out with Tomotherapy "Delivery Quality Assurance" method available in the planning station, which also allows for absolute dose calculation in the center of the phantom, where an ionization chamber can be placed.

Tolerance limits at the institution's local level were evaluated with the method proposed in AAPM TG218[1] report, a guide that specifies patient safety standards for measurements prior to treatment. AAPM TG218 proposal requires a minimum of 20 pre-treatment QA measurements. Here, absolute dose measurement and γ33L analysis were evaluated on 623 cases (abdominal 145, breast + SVC 141, head & neck 93, and prostate 244); γ32G analysis was performed on a subset of 241 measurements (abdominal 50, breast + SVC 55, head & neck 40, and prostate 96).

## RESULTS AND DISCUSSION

The tolerance and action limits that were established according to the anatomical area can be seen in Table 1:

Table 1: Averages, standard deviation, lower control limits, upper control limits and action limits of γ 3%, 3 mm, γ 3%, 2 mm and dose difference percentage.

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| Test | Area | Average (%) | Standard deviation (%) | LCL (%) | UCL (%) | AL (%) |
|---|---|---|---|---|---|---|
| ***γ 3%, 3 mm Local*** | Abdominal | 93.84 | 0.44 | 76.85 | -- | 72.87 |
| | Breast + SVC | 88.71 | 0.48 | 75.35 | -- | 60.29 |
| | Head & Neck | 96.95 | 0.09 | 90.69 | -- | 87.25 |
| | Prostate | 95.89 | 0.17 | 88.40 | -- | 82.45 |
| ***γ 3%, 2 mm Global*** | Abdominal | 98.54 | 0.04 | 96.12 | -- | 92.36 |
| | Breast + SVC | 96.67 | 0.16 | 90.04 | -- | 84.50 |
| | Head & Neck | 96.92 | 0.17 | 89.99 | -- | 84.44 |
| | Prostate | 97.77 | 0.06 | 93.21 | -- | 90.19 |
| **Dose difference test** | Abdominal | 0.94 | 0.03 | -2.95 | 5.02 | 5.56 |
| | Breast + SVC | 1.06 | 0.89 | -22.04 | 26.09 | 28.52 |
| | Head & Neck | 0.76 | 0.01 | -1.83 | 4.00 | 4.27 |
| | Prostate | 0.93 | 0.03 | -2.27 | 4.73 | 5.53 |

Different tolerance and actions limits were found for different anatomical locations. The highest Lower Control Limit (LCL) for the γ33L criterion were for head & neck (90.96 %) and prostate (88.40%), indicating that they are a very stable process in helical Tomotherapy. The lowest LCL were found for breast + SVC (75.35 %) and abdomen (76.85 %). These treatments generally involve large volumes, and it may be difficult to position the ArcCheck in order to efficiently sample the dose distribution with the diodes while preserving suitable positioning of the central ionization chamber in a full dose, low gradient region.

The action limits determined for γ33L also followed the same pattern described above, that is, head & neck (87.25 %) and prostate (82.45 %) as the highest values, with breast + SVC (60.29 %) and abdomen (72.87 %) as the lowest values.

For the γ32G criteria, the highest LCLs were observed for abdominal site (96.12 %) and prostate (93.21 %); the lowest LCLs were breast + SVC (90.04 %) and head & neck (89.99 %). The same happened with the action limits, with abdomen (92.36 %) and prostate (90.19 %), followed by breast + SVC (84.50 %) and head & neck (84.44 %).

The γ results for breast + SVC are not surprising; these treatments involve a large volume of very low doses and gradients where local γ always gives suboptimal results if a high threshold is not applied (10% in our analysis).

As far as the percentage difference of the absolute dose measured with the ionization chamber is concerned, the smallest values were those with the highest LCL and Action Limits: head & neck (average difference of 0.76%) and prostate (average difference of 0.93 %). The high variability and control levels for breast + SVC are due to the fact that ArcCheck positioning in these cases often results in the ionization chamber placed in a low dose and/or high gradient region.

## CONCLUSIONS

Tolerance and action limits for different anatomical sites were successfully established. Following the protocol described in AAPM TG 218[1], the tolerance limits were compared with

the action limits, concluding that the tolerance limits are within the action limits. This indicates that the process can continue to be monitored under current conditions.

Setting tolerance and action limits locally helps to understand and validate the performance of IMRT QA over a period of time. In this way, negative results that may affect patients can be avoided and prevented.

An interesting side result of this study is that comparing results between the "historical" parameters γ33L and the new AAPM suggested γ32G, the gamma passing rates are definitively better with the latter. This denotes how important it is to know the behaviour of both parameters when changing from one focus to the other.

## REFERENCES

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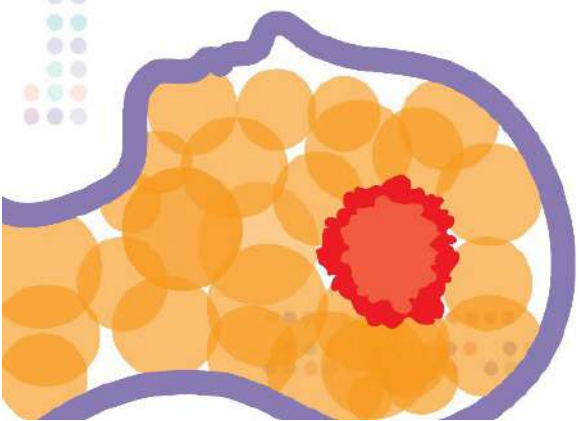

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