Verification of Oncentra brachytherapy planning using independent calculation

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Abstract. This study was done to investigate the verification technique of treatment plan quality assurance for brachytherapy. It is aimed to verify the point doses in ¹⁹²Ir high dose rate (HDR) brachytherapy between Oncentra Masterplan brachytherapy treatment planning system and independent calculation software at a region of rectum, bladder and prescription points for both pair ovoids and full catheter set ups. The Oncentra TPS output text files were automatically loaded into the verification programme that has been developed based on spreadsheets. The output consists of source coordinates, desired calculation point coordinates and the dwell time of a patient plan. The source strength and reference dates were entered into the programme and then dose point calculations were independently performed. The programme shows its results in a comparison of its calculated point doses with the corresponding Oncentra TPS outcome. From the total of 40 clinical cases that consisted of two fractions for 20 patients, the results that were given in term of percentage difference, it shows an agreement between TPS and independent calculation are in the range of 2%. This programme only takes a few minutes to be used is preferably recommended to be implemented as the verification technique in clinical brachytherapy dosimetry.

1. Introduction
Brachytherapy is a treatment method which requires the delivery of radiation directly into or onto the surface of the area to be treated. In order to ensure the optimal treatment of patients, an institution must develop a suitable quality control (QC) programme for brachytherapy sources, equipment and the physical and clinical procedures [1]. A quick calculation check to evaluate the output of a treatment plan allows detection of any possible errors. Seeking a compromise for efficiency both in the time required for the extra calculation and in the level of reliability. The purpose of this study was to verify the point doses in ¹⁹²Ir HDR brachytherapy between Oncentra brachytherapy treatment planning and independent calculation software. To the specific review, this study compared the values of planned and independent calculated point doses of ¹⁹²Ir of rectum and bladder in HDR brachytherapy. These studies also compared the values of planned and independent calculated point doses based on prescription points. Lastly, it was the comparison of the values of planned and independent calculated point doses between pair ovoid applicator and full catheter set ups at rectum, bladder and prescription points.

2. Materials and method

2.1. Oncentra masterplan treatment planning system (TPS)
Nucletron Oncentra brachytherapy planning system 4.1 (Elekta, Stockholm, Sweden) was used to perform the clinical brachytherapy planning calculation. The protocol for brachytherapy dose calculations implemented in Oncetra Masterplan TPS was based on dose formalism defined by AAPM task group no. 43. One of the first essential steps to determine the dose distribution in brachytherapy is based on the determination of the source positioning in relation to the target volume and other anatomic characteristics of interest [2].

2.2. Independent calculation workbooks/spreadsheets
Independent calculation is a verification programme that has been developed to verify point dose calculation in brachytherapy treatment planning system. The system works in a workbook formed that represent software in order to calculate point dose independently.

Basically, the working principle of independent calculation programme is based on AAPM TG-43 dose formalism. The TG-43 updated formalism a point source (1D) model and a line source (2D) model to describe the dosimetric behaviour of the seed sources. The orientation of the source is taken into account using the anisotropy function along with the linear geometric factor, the radial dose function and the dose rate constant. In the point dose approximation, the anisotropy factor and the point geometry factor are used.

This verification programme considers the linear nature of the geometry of the sources such as the use of 2D general formalism proposed by TG-43 to perform the calculations. The verification programme has been designed on Microsoft Excel 2002 spreadsheets by a group of medical physicist [3]. All the required information which was included in the text file of the TPS plan was imported directly into the program through a simple interface step. The air-kerma strength with reference dates and times also required for the calculation. Those informations are all independently entered when carried out the verification.

In order to carry out the verification technique of Oncentra TPS, the data of a total of 20 patients with cervix cancer that undergoing brachytherapy were needed. The data consists of two fractions with 10 patients with pair ovoids applicator and 10 patients with a full catheter. Therefore, there were 40 cases were verified using independent calculation. Figure 1 shows the screenshots of independent calculation spreadsheets.

![Figure 1. The independent calculation worksheets on sagittal and transverse planes.](image)

3. Results and discussion
Figure 2(a) and (b) show the comparison of absolute doses between Oncentra treatment planning system and independent calculation at rectum and bladder for pair ovoid set up respectively. While figure 3 shows the comparison of absolute doses between Oncentra treatment planning system and independent calculation at the prescription point for pair ovoid set up.
Figure 2(a). Comparison of calculated absolute doses using Oncentra treatment planning system and independent calculation at the rectum.

Figure 2(b). Comparison of calculated absolute doses using Oncentra treatment planning system and independent calculation at the bladder.

Figure 3. Comparison of calculated absolute doses using Oncentra treatment planning system and independent calculation at the prescription point.

The comparison between the values of the planned and independent calculated point doses of $^{192}$Ir in HDR brachytherapy between pair ovoids applicator and full catheter for rectum and bladder were showed in figure 4(a) and (b) respectively. The verification of dose calculation at prescription points in the comparison between pair ovoids and full catheter set up were showed in figure 5.
Figure 4(a). Comparison between pair ovoids and full catheter set up for verification of dose calculation at the rectum.

Figure 4(b). Comparison between pair ovoids and full catheter set up for verification of dose calculation at the bladder.

Figure 5. Comparison between pair ovoids and full catheter set up for verification of dose calculation at prescription points.

The reported results showed that for a total sample of 40 cases most of the deviations between the TPS and the independent calculation programme are less than 2%. There were a few cases in ratio of 1:10 that showed deviation slightly greater, but it can be accepted due to small ratio.

4. Conclusions
As the conclusion, the independent calculation programme capable of meeting requirements for independent verification of clinical dosimetry, it can be utilized in all plans for intracavitary brachytherapy. Based on the results that were given in term of percentage difference, it shows a good agreement between TPS and independent calculation in the range of 2%. The absolute dose calculated was evaluated at rectum, bladder and prescription points for 40 clinical cases respectively. Confirmation of the accuracy of optimized calculations with verification evaluation technique is vital in
order to assure the accuracy of treatment. This independent verification of computer plan HDR brachytherapy provides a solid base to be applied for brachytherapy treatment.

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