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Dosimetric Comparison of Oncentra (Ir-192) and SagiPlan (Co-60) HDR Brachytherapy Planning Systems in Gynaecologic Tumors Using Different Applicator Sizes

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Abstract

Objective: This study aims to compare the dosimetric outcomes of high-dose-rate (HDR) brachytherapy plans using Co-60 and Ir-192 sources implemented through SagiPlan and Oncentra treatment planning systems (TPS), respectively, across different applicator volumes.

Methods: CT-based HDR brachytherapy plans were developed using both SagiPlan (Co-60) and Oncentra (Ir-192) TPS for 30 cervical cancer patients. Applicator sizes of 35 cm^3, 30 cm^3, and 25 cm^3 were evaluated. Dosimetric parameters including D90% (dose covering 90% of HR-CTV), conformity index (CI), and organ-at-risk (OAR) doses were analyzed. Total Reference Air Kerma (TRAK) was also assessed.

Results: Oncentra (Ir-192) showed improved D90% values with decreasing applicator size: 93.05% (35 cm^3), 97.03% (30 cm^3), and 96.35% (25 cm^3). Conversely, SagiPlan (Co-60) D90% declined from 96.15% to 89.71%. CI was higher with Oncentra (0.72 vs. 0.68 average). OAR sparing was consistently better with Oncentra, with rectal D2cc reduced by up to 5%. TRAK values were similar between systems.

Conclusion: Ir-192 plans generated by Oncentra provide improved target coverage and OAR sparing in smaller applicators compared to Co-60 plans using SagiPlan. These findings emphasize the importance of source selection and TPS capabilities in optimizing brachytherapy outcomes.

Keywords: HDR brachytherapy, oncentra, sagiplan, gynecological tumors

Introduction

Radiotherapy is one of the primary modalities of treatment in the management of malignancies, with curative and palliative results achieved through the precise administration of ionizing radiation to the diseased tissues while minimizing the dose to the surrounding healthy tissue.[1–9] Brachytherapy is one of several radiotherapeutic methods that offer molecular selectivity, delivering high radiation doses to a specific location with rapid dose fall-off, thereby sparing the proximate organs-at-risk (OARs). It is this characteristic property that gives brachytherapy an added advantage in the treatment of gynecological malignancies, where essential organs and structures, such as the bladder, rectum, and sigmoid colon, are near the original cervix vault.[10]

The standard of care regarding the treatment of gynecological tumors (including locally advanced cervical cancer) now involves High-Dose-Rate (HDR) brachytherapy. During HDR brachytherapy, a highly radioactive source is pinned temporarily in or around the tumor location, such as in the treatment of ductal carcinoma in situ of the breast. It administers treatment quickly within a brief timeframe and offers more flexibility in scheduling and radiation safety.[11] The most widely used isotopes in HDR brachytherapy are Iridium-192 (Ir-192) and Cobalt-60 (Co-60). Ir-192 has traditionally been used simply because of its more desirable physical properties (such as the high dose rate and steep dose gradient, which permit its usage for treating irregular volumes of tumors conformally). However, in recent years and more frequently in less affluent environments, Cobalt-60, with a longer half-life (~5.27 years, compared to Ir-192 at ~73.8 days), has gained popularity due to its lower source replacement cycle and cost.[12]

The applicators chosen, such as tandem and ovoid, tandem and ring, or vaginal cylinders, have a significant influence on dose distribution, organ sparing, and treatment outcome. Such applicators differ in terms of loading pattern, geometry, and use, depending on the extent and location of the tumor. To enable high-quality and individualized brachytherapy, it is necessary to understand the interactions among the type of applicator, the choice of source, and the optimization of the treatment planning system (TPS).[13,14]

Using modern brachytherapy planning systems, including Oncentra Brachy (Elekta) and SagiPlan (Eckert & Ziegler), advanced imaging, dose optimization algorithms, and applicator libraries are offered to create patient-specific treatment plans.[15,16] The two systems adhere to the AAPM TG-43 dosimetric formalism, which forms the basis for the uniform computation of dose distributions in water-equivalent media.[17] These systems can be evaluated by examining the following dosimetric metrics: target coverage indices (e.g., D90), conformity and homogeneity indices (e.g., CI, HI), and doses to Organs-at-Risk (OARs) (e.g., D2cm^3 to the bladder, rectum, and sigmoid). In studies of cervical and vaginal cancer, specifically, a combination of HDR brachytherapy and external beam radiotherapy (EBRT) is associated with improved local control and overall survival. Comparative analysis in terms of treatment planning systems, such as Oncentra and SagiPlan, is crucial for evaluating the consistency of plan quality, dose distributions, source behavior, and treatment efficiency. Such

assessments play a vital role in the system's selection process, standardization of clinical protocols, and subsequently in improving patient outcomes.[18,19]

This study aimed to compare the treatment planning of HDR brachytherapy using Oncentra (Co-60) and SagiPlan (Ir-192) for gynecological malignancy tumors, applying different applicator sizes.

Materials and Methods

This is a retrospective clinical study employing a convenience sampling technique conducted at the Baghdad Center of Radiotherapy and Nuclear Medicine, Baghdad, Iraq, and the Warith International Cancer Institution (WICI), Karbala, Iraq. The study was conducted between May 2023 and May 2025. The study received approval from the ethics committee at the Faculty of Science, Mansoura University under the code: Sci-Phy-Ph-2022-116 dated August 1st, 2022. Ethical consent was signed from each patient prior to the study.

This study comprised a total of 75 female patients diagnosed with locally advanced gynecological cancers, primarily cervical cancer, who had received an HDR brachytherapy. The selection of female patients was made based on the quality of the available axial CT images and the availability of all information about the applicators. The patients had a history of external beam radiotherapy (EBRT) with high-dose-rate (HDR) brachytherapy using tandem, ovoid, or ring applicators. Overall, each patient had CT-based planning with a 3-mm slice thickness. In High-Risk Clinical Target Volume (HR-CTV) and Organs-at-Risk (OARs), such as the bladder, rectum, and sigmoid colon, the following structures were contoured according to the ICRU Report 89 recommendations. The reconstruction contouring was performed by radiation oncologists experienced in the standard treatment planning process. Two treatment planning systems (TPS) for HDR brachytherapy were utilized namely Oncentra Brachy 1.05 (Elekta, Sweden) and SagiPlan 1.0 (Eckert & Ziegler BEBIG, Germany). The CT dataset of each patient and applicator reconstruction was loaded into each system independently to generate a plan using the same applicator set.

Two sources were assessed. The first one is Iridium-192 (Ir-192). The source activity and characteristics of this source are paired with the Elekta Flexitron afterloader. The latter is Cobalt-60 (Co-60), a source property tailored to SagiNova after-loader requirements. All dose calculations were performed in a water-equivalent medium using the AAPM TG-43 formalism. There are three applicators involved in this study, which depend on the patient's standards. The applicators' sizes are 35 cm, 30 cm, and 25 cm.

Both systems were planned to receive a total dose of 7 Gy per fraction to the HR-CTV, simulating a typical clinical dose of a multi-fractionated HDR protocol. The manual Dwell time optimization was used, and graphical dose shaping achieved a 100% isodose line coverage of 90% or more of the HR-CTV (D90 = 7 Gy and 0.15 cGy to the normal tissue), minimizing $D2cm^3$ to the rectum, bladder, and sigmoid. Individual planning for each case was conducted in both TPS, utilizing Ir-192 and Co-60, to facilitate evaluation. The dosimetric and geometric parameters that were calculated and compared are as follows: Target Coverage, including D90 and V100; Organs-at-Risk (OARs), such as the $D2cm^3$ of the bladder, rectum, and sigmoid; and the Conformity Index (CI), which is the ratio of the prescription isodose volume to the HR-CTV volume.

Statistical calculations were performed using SPSS v29. A paired sample *t*-test was applied to compare the dosimetric results of Oncentra and SagiPlan, as well as the Applicators of Co-60 and IR-192. The one-way ANOVA test was used to compare the three applicator types. Statistically significant results were taken to be a *P*-value of less than 0.05.

Results

A dosimetric comparison was conducted between the SagiPlan and Oncentra HDR brachytherapy planning systems, utilizing both Cobalt-60 (Co-60) and Iridium-192 (Ir-192) radioactive sources across three different clinical cases involving varying target volumes.

Coverage of Tumors

Regarding the clinical target volume (CTV), each case was computed with the same set of values by both planning systems, indicating unanimity in volume calculation and reconstruction. In the 35 cm applicator, the CTV was 58.86 ± 9.74 cm^3; in the 30 cm applicator, it was 64.45 ± 9.13 cm^3; and in the 25 cm applicator, it was 47.80 ± 6.57 cm^3.

The D90% dose results shown in Table 1 and Figure 1, which are covered by 90% of the CTV, were significantly better in SagiPlan compared to Oncentra in the 35 cm applicator with Co-60 (96.15 ± 4.34% versus 93.05 ± 4.23%). In the 30 cm applicator, the D90% for Ir-192 was 98.63 ± 14.79% and 97.03 ± 14.60% in SagiPlan and Oncentra, respectively. SagiPlan remains the better choice. Remarkably, Oncentra, using Ir-192, had a D90% of 96.35 ± 7.18% in the 25 cm applicator, while SagiPlan recorded 89.71 ± 16.71%.

Various applicator volumes (35 cm^3, 30 cm^3, and 20 cm^3) of the dosimetric effect were compared in the SagiPlan planning system, which utilizes the Co-60 source. The volume treated by the 30 cm^3 applicator is significantly higher than that by the 35 cm^3 applicator and the 20 cm^3 applicator, respectively. The difference in CTV between the applicators was significant ($P = 0.0476$).

The D90% values indicated that the 30 cm^3 applicator covered the highest dose, whilst the 35 cm^3 applicator covered the second-highest dose. The lowest coverage was observed with the 20 cm^3 applicator, although not statistically significant ($P = 0.1026$).

Table 1. **The 90% coverage of dose using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm^3 applicators**

	35 cm^3 Applicator		30 cm^3 Applicator		25 cm^3 Applicator	
	SagiPlan (Co60)	Oncentra (Ir192)	SagiPlan (Co60)	Oncentra (Ir192)	SagiPlan (Co60)	Oncentra (Ir192)
D90%	96.15 ± 4.34	93.05 ± 4.23	98.63 ± 14.79	97.03 ± 14.60	89.71 ± 16.71	96.35 ± 7.18
***P*-value**	< 0.00001		0.3977		0.05021	

Conformity Index (CI)

The difference in values between the prescribed isodose and the target volume in Table 2, as assessed by the Conformity Index (CI), was slightly greater with the Ir-192 plans. With the 35 cm applicator of Co-60, SagiPlan recorded a CI of 0.73 ± 0.03, which scored significantly higher than Oncentra at 0.62 ± 0.03. Comparable results were observed in the 30 cm applicator using both systems (SagiPlan: 0.74 ± 0.05, Oncentra: 0.74 ± 0.04) for Ir-192. CI values in the 25 cm applicator were revealed as 0.69 ± 0.10 for SagiPlan and 0.73 ± 0.04 for Oncentra, favoring Oncentra slightly, as shown in Figure 2.

The applicator size had a significant influence on the Conformity Index (CI) ($P < 0.00001$), with the most conformed applicator setting being 30 cm^3 and the remaining two being 35 cm^3 and 20 cm^3.

Total Reference Air Kerma (TRAK)

On all the systems, as shown in Table 3, the values of Total Reference Air Kerma (TRAK) were greater with Co-60 than with Ir-192. In the 35 cm applicator, SagiPlan had a Co-60 TRAK of 3.61 ± 0.28 mGy, significantly higher than Oncentra, which had a value of 3.32 ± 0.27 mGy. In the 30 cm

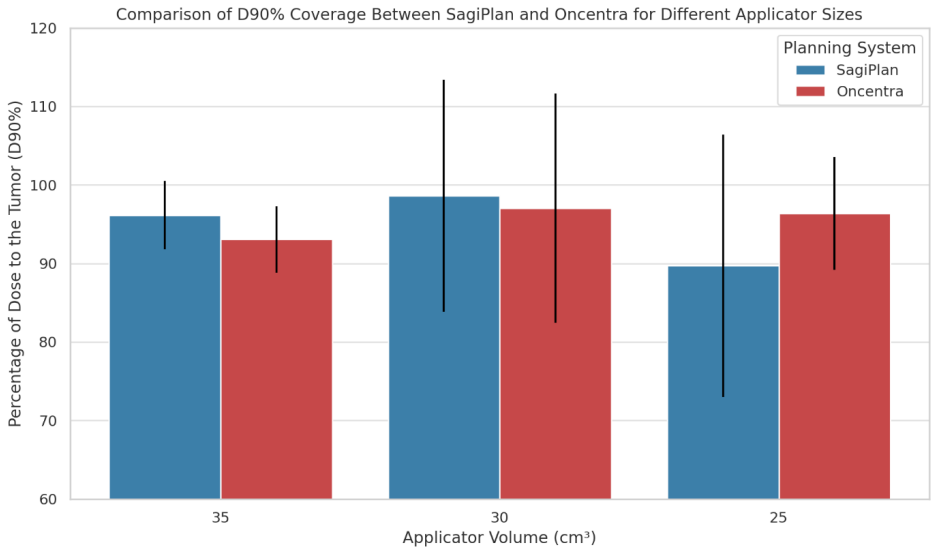

Fig. 1 **D90% comparison between Sagiplan and Oncentra planning systems across applicator sizes (35 cm^3, 30 cm^3, and 25 cm^3).**

Table 2. **The CI using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm^3 applicators**

	35 cm^3 Applicator		30 cm^3 Applicator		25 cm^3 Applicator	
	SagiPlan (Co60)	Oncentra (Ir192)	SagiPlan (Co60)	Oncentra (Ir192)	SagiPlan (Co60)	Oncentra (Ir192)
CI	0.73 ± 0.03	0.62 ± 0.03	0.74 ± 0.05	0.74 ± 0.04	0.69 ± 0.10	0.73 ± 0.04
***P*-value**	< 0.00001		0.78443672		0.13435	

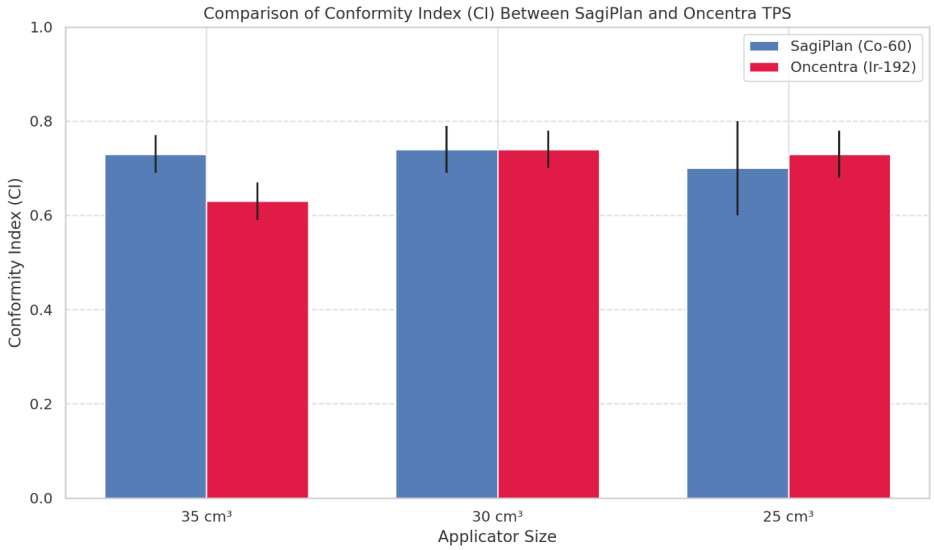

Fig. 2 **Comparison of the Conformity Index (CI) using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm^3 applicators.**

applicator, Ir-192 values were almost identical in both systems: 2.97 ± 0.34 mGy (SagiPlan) and 2.98 ± 0.26 mGy (Oncentra). The 25 cm applicator showed a slight difference between SagiPlan and Oncentra TRAK (2.49 ± 0.17 mGy and 2.51 ± 0.16 mGy), as shown in Figure 3. Likewise, in TRAK, at volumes of 35 cm^3, 30 cm^3, and 20 cm^3, the applicator values decreased significantly, indicating a decrease in total radiation output at smaller volumes ($P \leq 0.00001$).

Organs-at-Risk (OARs) Dosimetry

The organ-at-risk results are presented in Table 4. The Rectum D2cm^3 values shown in Figure 4 for the 35 cm applicator using Co-60 were 4.65 ± 0.27 Gy (SagiPlan) and 4.05 ± 0.26 Gy (Oncentra), indicating a significantly higher exposure in SagiPlan. In the 30 cm applicator with Ir-192, Oncentra yielded a higher rectal dose (4.88 ± 0.70 Gy) than SagiPlan (4.55 ± 0.77 Gy). The 25 cm applicator showed relatively consistent doses between the two systems, with SagiPlan at 4.54 ± 0.56 Gy and Oncentra at 4.58 ± 0.31 Gy.

For the Bladder D2cm^3, as shown in Figure 5, a similar trend was noted. In the 35 cm applicator with Co-60, SagiPlan reported 4.65 ± 0.60 Gy, which is significantly higher than the Oncentra value of 4.05 ± 0.59 Gy. For Ir-192 in the 30 cm applicator, SagiPlan recorded 4.27 ± 0.60 Gy compared to 4.08 ± 0.40 Gy in Oncentra. The 25 cm applicator demonstrated slightly lower bladder doses in SagiPlan 4.21 ± 0.74 Gy compared to 4.38 ± 0.38 Gy in Oncentra.

Table 3. **The Total Reference Air Kerma (TRAK) using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm^3 applicators**

	35 cm^3 Applicator		30 cm^3 Applicator		25 cm^3 Applicator	
	SagiPlan (Co60)	**Oncentra (Ir192)**	**SagiPlan (Co60)**	**Oncentra (Ir192)**	**SagiPlan (Co60)**	**Oncentra (Ir192)**
TRAK (mGy)	3.61 ± 0.28	3.32 ± 0.27	2.97 ± 0.34	2.98 ± 0.26	2.49 ± 0.17	2.51 ± 0.16
***P*-value**	< 0.00001		0.66118		0.1862	

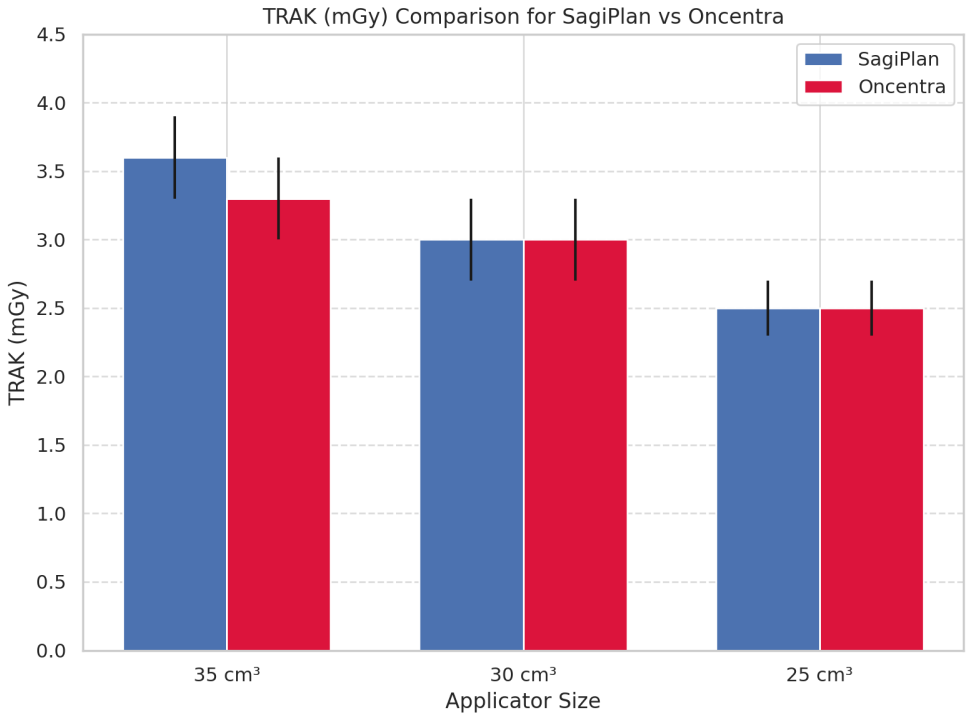

Fig. 3 **Comparison of the TRAK (mGy) using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm^3 applicators.**

Table 4. **The comparison of organs-at-risk using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm^3 applicators**

OARs	35 cm^3 Applicator		30 cm^3 Applicator		25 cm^3 Applicator	
	SagiPlan (Co60)	**Oncentra (Ir192)**	**SagiPlan (Co60)**	**Oncentra (Ir192)**	**SagiPlan (Co60)**	**Oncentra (Ir192)**
Rectum (D2 cm^3)	4.65 ± 0.27	4.05 ± 0.26	4.55 ± 0.77	4.88 ± 0.70	4.54 ± 0.56	4.58 ± 0.31
P-value	< 0.00001		0.23836		0.35177	
Bladder (D2 cm^3)	4.65 ± 0.60	4.05 ± 0.59	4.27 ± 0.60	4.08 ± 0.40	4.21 ± 0.74	4.38 ± 0.38
P-value	< 0.00001		0.6067		0.29952	
Sigmoid (D2 cm^3)	3.27 ± 0.98	2.69 ± 0.95	2.67 ± 0.77	2.47 ± 1.08	3.12 ± 0.99	3.47 ± 1.04
P-value	< 0.00001		0.6549		0.39069	

Fig. 4 **Comparison of the Rectum dose using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm³ applicators.**

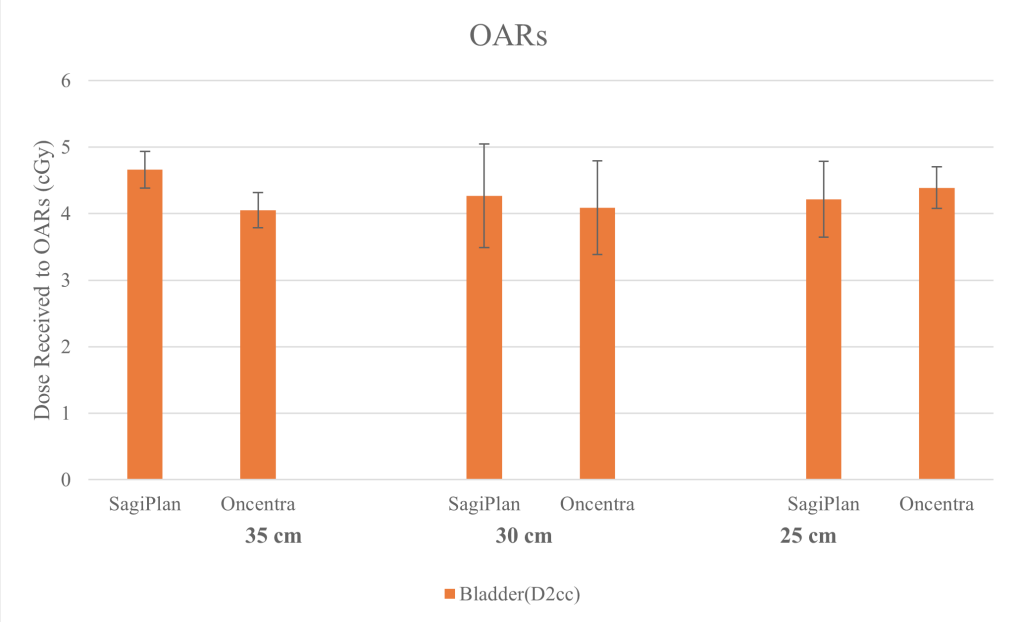

Fig. 5 **Comparison of the Bladder dose using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm³ applicators.**

The Sigmoid D2cm³ results shown in Figure 6 revealed greater variation. In the 35 cm applicator, using Co-60, SagiPlan produced a dose of 2.47 ± 1.08 Gy, which was significantly higher compared to 2.69 ± 0.95 Gy in Oncentra. With Ir-192 in the 30 cm applicator, the sigmoid dose dropped to 2.67 ± 0.77 Gy in SagiPlan and 2.47 ± 1.08 Gy in Oncentra. In the 25 cm applicator, SagiPlan showed a dose of 3.12 ± 0.99 Gy, whereas Oncentra showed a higher dose of 3.47 ± 1.04 Gy.

In the case of OARs, the values of the rectum D2cm³ were reasonably similar between the applicators, with no statistically significant difference (P = 0.7232). This indicates that there was no significant discrepancy in the values of the rectum D2cm³, which varied by 4.54 ± 0.56 Gy to 4.65 ± 0.27 Gy. The same trend occurred when it came to bladder Volume, where the 35 cm³, 30 cm³, and 25 cm³ applicators were also measured, with a P-value of 0.6513. The sigmoid D2cm³ showed more variability, with the lowest dose found with the 30 cm³ applicator, followed by the 25 cm³ applicator, and the maximum dose at 35 cm³, reaching the margin of significance (P = 0.0679).

Discussion

This study compared the dosimetric performance of two established high-dose-rate (HDR) brachytherapy treatment planning systems (SagiPlan and Oncentra Brachy) using both

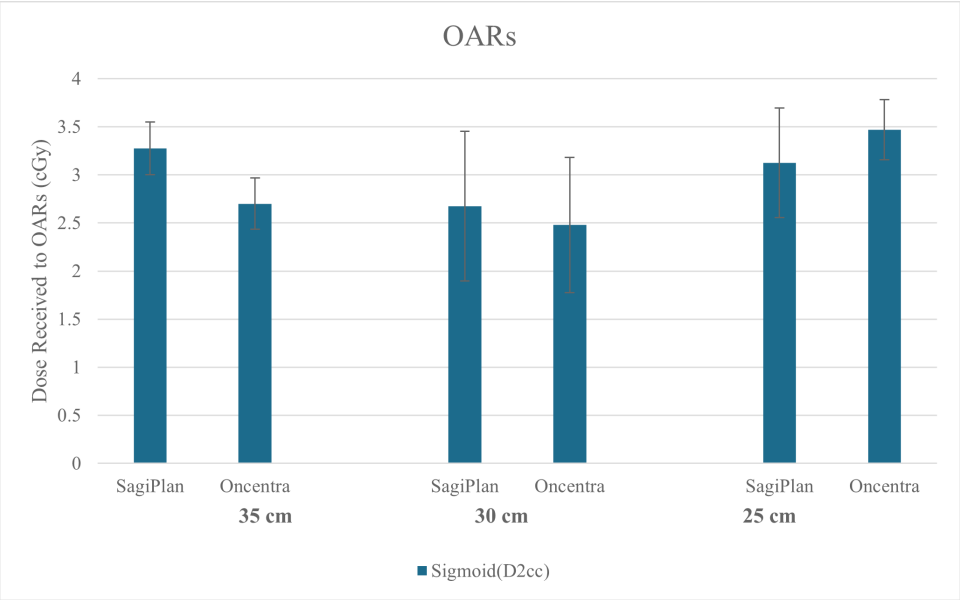

Fig. 6 **Comparison of the Sigmoid dose using SagiPlan versus Oncentra planning systems with 35, 30, and 20 cm³ applicators.**

Cobalt-60 (Co-60) and Iridium-192 (Ir-192) sources in the treatment of gynecological tumors. The comparative analysis focused on target coverage, conformity, dose to organs-at-risk (OARs), and treatment delivery parameters such as TRAK. The findings offer valuable insights into source selection and TPS-specific optimization behavior, particularly for treatments of cervical and vaginal cancers.

Target Coverage (D90%)

In SagiPlan (Co-60-based), as the applicator volume decreased from 35 cm³ to 30 cm³ and then to 25 cm³, the D90% coverage declined overall, from 96.15% to 98.63% and ultimately dropped to 89.71%. While the intermediate increase at 30 cm³ may suggest momentary geometric conformity, the significant drop at 25 cm³ highlights a fundamental limitation in SagiPlan's ability to maintain target coverage in smaller volumes. This decline is attributed to the physical properties of Co-60, including its higher photon energy and longer active source length, which resulted in a broader penumbra and less refined dose sculpting in constrained geometries. In contrast, Oncentra TPS, which utilized the Ir-192 source, demonstrated improved D90% values as the applicator size decreased (93.05% at 35 cm³, 97.03% at 30 cm³, and 96.35% at 25 cm³). Comparable studies[20] have similarly observed that, with optimized applicator placement, both Ir-192 and Co-60 sources achieved clinically comparable target coverage, where the D90 differences remained non-significant under optimized planning.

The comparison of D90% tumor coverage across different applicator sizes reveals a notable divergence in behavior between the SagiPlan and Oncentra treatment planning systems (TPS), influenced primarily by source characteristics and system optimization algorithms. Multiple comparative studies[21–23] have demonstrated comparable clinical efficacy for Co60 and Ir192 sources in gynecological HDR cases. These findings agree with our results: while Co60 plans (especially in SagiPlan) showed slightly lower D90% than Ir192, target coverage remained within clinically acceptable ranges (>90%). Notably, radiobiological modeling revealed no significant differences in tumor control probability (TCP) or equivalent dose metrics, although Co60 occasionally resulted in modestly lower organ-at-risk (OAR) doses, particularly in EQD2 comparisons.

Conformity Index

Dose conformity in HDR brachytherapy planning was significantly dependent on these factors. SagiPlan was found to provide a CI of 0.73 ± 0.03 using Co60 and the 35 cm³ applicator, compared to the Ir-192 plan of Oncentra (CI = 0.62 ± 0.03), and the comparison was statistically significant. Although planning with Ir 192 yielded comparable CI values in the 30 cm³ applicator (0.74 ± 0.05 vs. 0.74 ± 0.04), Oncentra led SagiPlan marginally in the 25 cm³ applicator (0.73 ± 0.04 vs. 0.69 ± 0.10). Applicator size had a powerfully relevant influence on CI ($P < 0.00001$), with each dimension being the most agreeable overall in terms of applicator size, specifically 30 cm³.

Factors such as these were observed to agree with the dosimetric investigations of Ir 192 compared to Co 60, indicating no significant difference in conformity between the two when clinically matching applicator geometries were used. An example is the findings of Tormo et al.,[24] which reported similar CI values in the tissue implanted in vaginal cylinders between the two radionuclides. Likewise, the analysis of Sinnatamby et al.,[25] on breast and gynecologic interstitial implants revealed minimal CI differences (less than 3.0, $P = 0.05$) when the source type was changed.

Moreover, clinical comparisons provided by Tu et al.,[26] indicate that applicator geometry is the primary determinant of conformity, which sometimes outweighs the clinical effects of the sources. Higher-sized applicators, sized to match the target, enhance coverage and conformity. Mismatching a choice of applicator that is too small or oversized violates precision. The 30 cm³ applicator used in the same study appeared to be optimally matched to target volumes, as indicated by the EMBRACE protocols that size matching is essential for conformity.

Primarily, while both SagiPlan and Oncentra can produce comparable conformity results, the appropriateness of the applicator is pivotal. In our study, the 30 cm³ applicator consistently performed best, regardless of TPS or isotope, reinforcing prior literature that emphasizes the importance of applicator fit. When applicator geometries are well-matched, Co60 and Ir192 deliver equivalent plan conformity under modern TG-43 planning.[17]

The dosimetric comparison demonstrated that both planning systems, Oncentra and SagiPlan, yielded clinically acceptable results with Iridium-192 and Cobalt-60 sources, effectively covering the target. These findings align with the results of Tormo Ferrero et al.,[24] which recorded no significant difference in HR-CTV coverage between Ir-192 and Co-60, with variations typically within 1–3%.

Total Reference Air Kerma (TRAK)

This study confirmed that TRAK values were consistently higher in Co60 plans than Ir192 across all applicator sizes. In the 35 cm³ applicator, SagiPlan's Co60 TRAK (3.61 ± 0.28 mGy) exceeded Oncentra's Ir192 TRAK (3.32 ± 0.27 mGy). For the 30 cm³ and 25 cm³ applicators, TRAK values were similar between the two systems (~2.97–2.51 mGy), reflecting comparable target volumes and dwell geometries. Notably, TRAK decreased significantly with smaller applicators ($P = \leq 0.00001$), consistent with the well-established correlation between TRAK and the prescription isodose. This volume dependency was also confirmed in multicenter studies, as described by Yaparpalvi et al.,[27] showing a strong relationship between TRAK and treated volume across various applicator types. The clinical implications of lower TRAK with smaller applicators include a reduced integral dose and potentially shortened treatment time. However, while TRAK is a practical surrogate for isodose surface volume, it does not directly correlate with OAR doses or biological effects and should not replace detailed dosimetric evaluation.

Organs-at-Risk (OARs) Dosimetry

The dosimetric study of organs-at-risk (OARs) revealed different trends in SagiPlan using Co-60 and Oncentra using Ir-192 with various applicator sizes. SagiPlan provided rectum and bladder D2cm³ values that were higher than those offered by Oncentra (4.05 Gy) in each of the three applicators (35 cm³, 30 cm³, and 25 cm³), implying that Co-60 could lead to some increased OAR dose in a larger applicator. The above difference can be characterized by the fact that Co-60 has both more gamma energy and a greater dose of penumbra, which has been reported in other studies like Palmer et al.,[28] and Zaman et al.,[29] where the Co-60 resulted in up to 10 percent greater rectal doses than with Ir-192 when the planning conditions were not significantly different. Nevertheless, Oncentra delivered a larger rectal dose of 2 cm³ (4.88 Gy) than SagiPlan (4.55 Gy), whereas the bladder dose was lower in Oncentra (4.08 Gy vs. 4.27 Gy) in the case of the 30 cm³ applicator with Ir-192. These results can be attributed to the variance in the source dwell time modulation and optimization algorithms in the two systems. In the 25 cm³ applicator, a similarity in rectal and bladder dose between the two systems was observed, with an insignificant difference in the clinical aspect.

The sigmoid D2cm³ results showed greater variability. The Co-60 plans accredited by SagiPlan delivered a lower dose to the sigmoid (2.47 Gy) in the 35 cm³ applicator compared to the Oncentra plans (2.69 Gy). In the 25 cm³ applicator, however, an opposite trend occurred (3.12 Gy vs. 3.47 Gy, respectively). The lowest sigmoid dose was in Oncentra with the 30 cm³ applicator. Such variations can be attributed to the anatomical variability of the sigmoid colon and physical distances around the dwell positions, specifically applicators of smaller sizes. The near-miss significance difference in sigmoid D2cm³ ($P = 0.0679$) is yet another piece of evidence that applicator shape and patient anatomy, respectively, influence doses to this organ. Such data is in line with that of Dulaney et al.,[30] which indicated that the placement of applicators influences the bladder and sigmoid doses more than the radionuclide does.

Notably, non-statistically significant variations of the rectum and bladder doses as a result of the change in applicator size ($P = 0.7232$ and 0.6513, respectively) indicate that the choice of source is of second importance behind planning technique and applicator geometry. These results emphasize the importance of carefully planning the treatment and selection of applicators to optimize brachytherapy outcomes. High-order optimization capabilities in SagiPlans as well as Oncentra may have contributed to the overcoming of inherent physical discrepancies between Co-60 and Ir-192, allowing for clinically similar OAR protection.

Regarding exposure to the organ-at-risk (OAR), Oncentra showed better results in most cases, particularly for the bladder and rectum, in the Co-60 treatment. The range of rectum D2cc values was 2.70 to 4.89 Gy, and bladder D2cm³ was 4.05 to 4.66 Gy, somewhat lower than the averages suggested by Tormo Ferrero et al.,[24] (5.054.601 Gy). This evidence confirms the limits indicated by Niatsetski et al.,[31] in the review and Richter et al., as the doses of OARs may vary by several percent depending on the TPS and optimization procedure, despite using the same isotope and applicator. Altogether, the trends in coverage conformity and OAR doses were found to be reasonable, based on previously reported results, and do not exceed all clinically approved values.

As reported by Niatsetski et al.,[31] Co-60 and Ir-192 yield nearly identical dose distributions inside treatment volumes, but Co-60 requires thicker shielding and longer dwell times, leading to higher room shielding and TRAK. These logistics are reflected in our data: Co60 plans consistently showed higher TRAK and more prolonged treatment durations in both TPSs. Yet Oncentra's optimization engine had managed dose concentration on the target more effectively while reducing OAR exposure.

As demonstrated by Srivastava et al.,[32] variations in source anisotropy and TPS-specific optimization methods can yield measurable effects on dose uniformity and OAR doses. This study observed disparities in CI and OAR D2cm³, especially with Co60, highlighting that while raw physical dosimetry is similar, the planning algorithm and afterloader model significantly influence real-world dosing outcomes.

This trend suggests that Ir-192's smaller source size, higher dose gradient, and the Oncentra system's advanced inverse planning algorithms allow better dose conformity in compact spaces. The finer step sizes and increased optimization flexibility contribute to precise dwell time modulation, making it more effective in smaller applicators. This inverse performance trend is further supported by corresponding organ-at-risk (OAR) dosimetry. SagiPlan exhibited worsened OAR sparing with decreasing applicator size, likely due to

Co-60's broader dose gradient and reduced spatial control, which limits selective dose avoidance. Conversely, Oncentra's Ir-192-based plans consistently achieved better conformity and lower OAR doses, benefiting from sharper dose fall-off and superior optimization protocols.

Conclusion

Both SagiPlan (Co-60) and Oncentra (Ir-192) HDR brachytherapy planning systems demonstrated effective treatment planning capabilities. However, notable differences were observed in specific parameters. The SagiPlan system provided superior target coverage (D90%), particularly with larger applicator sizes (35 cm^3 and 30 cm^3), while Oncentra showed favorable results in smaller applicators (25 cm^3). The highest conformity and optimal dose distribution were achieved using the 30 cm^3 applicator. Higher TRAK values of Co-60 plans resulted from the higher energy output of these plans. In general, both systems work relatively well; however, the type of sources used and the size of applicators have a significant effect on the dosimetric parameters as well as the quality of treatment. Although both systems maintained acceptable doses to organs-at-risk, the choice of applicator size and source type significantly influenced the overall dosimetric quality of the plans. The analysis of this study underscores that SagiPlan's performance deteriorates with smaller applicators due to Co-60's geometric and dosimetric constraints, while Oncentra excels under these conditions owing to Ir-192's physical advantages and superior algorithmic control. This highlights the critical importance of matching TPS, radionuclide type, and applicator geometry to ensure optimal tumor coverage and minimal exposure to surrounding healthy tissue.

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Conflicts of Interest

None.

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