Dosimetry advantages of intraoperatively built custom-linked seeds compared with loose seeds in permanent prostate brachytherapy

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Abstract

Purpose: The aim of this study was to compare the implant quality between intraoperatively built custom-linked seeds (IBCL) and loose seeds (LS) retrospectively.

Material and methods: This study included 74 prostate cancer patients who were treated with permanent prostate brachytherapy (PPB) using IBCL (n = 37) or LS (n = 37) between July 2014 and June 2016. Dose-volume histogram (DVH) parameters, seed migration, and operation time were compared between the IBCL and LS groups. In addition to the standard target volume of the whole prostate gland, DVH parameters for prostate plus a 3 mm margin (CTV) were evaluated.

Results: In intraoperative planning, prostate V150 was lower (54.8% vs. 59.6%, p = 0.027), and CTV V100 (88.1% vs. 85.6%, p = 0.019) and D90 (98.5% vs. 92.6%, p = 0.0033) were higher in the IBCL group compared with the LS group. In post-implant dosimetry, prostate V100 (96.9% vs. 95.2%, p = 0.020), CTV V100 (85.6% vs. 81.7%, p = 0.046), and CTV D90 (94.2% vs. 86.5%, p < 0.001) were higher, and prostate V150 (57.1% vs. 64.5%, p = 0.0051) and CTV V150 (31.5% vs. 35.7%, p = 0.046) were lower in the IBCL group compared with the LS group. Regarding DVH changes between intraoperative planning and post-implant dosimetry, the decrease in prostate D90 was significantly lower in the IBCL group than in the LS group (–1.16% vs. –4.17%, p < 0.001). For the IBCL group, the operation time was slightly but significantly longer than that for the LS group (50.5 minutes vs. 43.7 minutes, p = 0.011). However, the seed migration rate was significantly lower in the IBCL group than in the LS group (5% vs. 41%, p < 0.001).

Conclusions: Intraoperatively built custom-linked is more advantageous than LS in terms of dosimetric parameters and migration.

Key words: brachytherapy, intraoperatively built custom-linked seeds, iodine-125, prostate cancer, seeds.
Intraoperatively built custom-linked seeds and loose seeds combines seeds and connectors into seed trains of variable length and seed-to-seed spacing [21]. IBCL has advantages of less seed migration and stability due to intraoperative linking [22,23,24,25]. This IBCL method may improve the dose volume histogram of the target and organs at risk (OAR) compared with conventional LS. In addition, IBCL was also advantageous in intraoperative customization compared with suture-embedded type strand seeds [26]. However, several studies have reported the advantages and disadvantages of IBCL [21,22,23,24]. Although IBCL reduces seed migration by linking seeds to each other, the nature of this feature also prolongs the operation time compared with LS. So far, three reports have demonstrated slight improvements in the dosimetric parameters for the prostate, urethra, and rectum by IBCL compared with LS [21,23,24]. Nevertheless, these reports only evaluated the dosimetric parameters of the whole prostate gland without evaluating those of CTV.

From July 2014, we began implementing IBCL in PPB. We hypothesized that IBCL improves the dosimetric parameters of CTV due to stable peripheral seed placement. The aim of this study was to compare the implant quality between IBCL and LS.

Material and methods

Patient characteristics

In June 2016, the retrospective analysis protocol was approved by the Investigational Review Board of the Faculty of Medicine of Kindai University. Between July 2014 and June 2016, all 74 prostate cancer patients who were treated with PPB using IBCL or LS in this period were subsequently enrolled in this study. Patient summary and treatment characteristics are shown in Table 1. Initial prostate cancer risk classifications were performed according to the National Comprehensive Cancer Network Guidelines [27]. During the aforementioned period, two patients were treated with PPB on the same day. One patient was treated with IBCL and the other was treated with LS. Two radiation oncologists decided the type of seeds to be used. In some cases, we selected IBCL for patients with very small prostates because we believed that IBCL would improve the post-implant dosimetry of the prostate.

Brachytherapy technique

To determine the number of seeds to be used, all patients underwent a transrectal-ultrasound examination (TRUS) 2-4 weeks prior to implantation. The prescribed brachytherapy dose was 144 Gy for the monotherapy, and 100 or 110 Gy for the combined therapy group. The combined therapy group further received supplemental external beam radiotherapy (sEBRT) with 40 or 45 Gy in 20 or 25 fractions. For combined therapy, intermediate-risk disease was treated with 100 Gy of brachytherapy, followed by 40 Gy/20 fractions of sEBRT, and high-risk disease was treated with 110 Gy of brachytherapy, followed by 45 Gy/25 fractions of sEBRT according to the National Comprehensive Cancer Network Guidelines. On the day of implantation, lumbar anesthesia was performed by the urologist. TRUS images in the axial plane were imported into the Variseed (Varian Medical Systems, Palo Alto, CA, USA) brachytherapy planning system at 2.5 mm slice spacing. The prostate, urethra, and rectal wall were contoured and reviewed by a single radiation oncologist. The CTV was defined as the prostate contour surrounded by a 3 mm margin that excluded the rectal wall. The initial

| Table 1. Patient summary and treatment characteristics |
|------------------------------------------------------|
| Factor | IBCL group (n = 37) | LS group (n = 37) | p-value |
|--------|---------------------|------------------|---------|
| Age (years) | Range, 54-80; Median, 68 | Range, 50-77; Median, 70 | 0.88 |
| T stage | 0.83 |
| 1c/2a/2b/2c/3a | 13/15/3/3/3 | 13/15/3/5/1 |
| Gleason score | 0.33 |
| 3+3/3+4/3+5/4+3/4+3/≥8 | 12/9/4/12 | 15/14/2/6 |
| PSA (ng/ml) | Range, 3.5-38; Median, 6.7 | Range, 3.4-17.6; Median, 6.0 | 0.53 |
| Risk classification | 0.11 |
| Low/Intermediate/High | 10/13/14 | 12/19/6 |
| Positive biopsy rate (%) | 0.12 |
| Range, 6-100; Median, 20 | Range, 5-55; Median, 17 |
| Neo-adjuvant hormonal therapy | 0.030 |
| Yes/No | 18/19 | 9/28 |
| Prescribed BT dose | 0.99 |
| 144 Gy fr monotherapy | 18 | 21 |
| 100 or 110 Gy for combined therapy | 19 | 16 |

IBCL – intraoperatively built custom link seeds, LS – loose seeds, PSA – prostate specific antigen, BT – brachytherapy
Intraoperative plan was developed using the Nomogram Planning module (CR Bard, Covington, GA, USA). The seed number and location were modified manually from the initial plan as the modified uniform loading strategy [28]. In general, 70-80% of seeds were inserted in the peripheral prostate area and 20-30% of seeds were loaded to the internal area, and planned extracapsular placement was not performed in both the IBCL and LS groups. The loading technique, seed distribution, and dose-volume histogram (DVH) goal were not adjusted regardless of the type of seed or prescribed brachytherapy dose. Especially, planned extracapsular placement was not performed in both LS and IBCL groups. Based on the initial modifications, DVH and dose distribution were re-calculated using a real-time intraoperative dosimetry technique. The DVH goals in the intraoperative plan were as follows: \( V_{100} \) of prostate (the percentage of prostate volume receiving at least 100% of the prescribed dose) > 95%; \( D_{90} \) of prostate (dose to 90% of prostate volume) between 115-135% of prescribed dose; \( UD_{10} \) (dose to 10% of urethral volume) < 140% of prescribed dose; \( RD_{cc} \) (dose to 2 cc of rectal volume) < 100% of prescribed dose. The CTV dosimetry parameters were evaluated, although each CTV parameter was not made as an intraoperative planning DVH goal. After the initial plan was completed, 2 to 4 needles were inserted into the peripheral posterior sector to fix the prostate. Needle insertion was performed by a single urologist (TM). Peripheral needles and internal needles were inserted from the anterior sector and from the posterior sector under guidance from TRUS sagittal imaging. For careful rectal dose, needles near the rectum were inserted under the guidance of TRUS axial imaging. For a large rectal dose, needles were inserted from the posterior sector under guidance from TRUS axial imaging. The final intraoperative planning dosimetry was fitted after re-calculation based on the prostate volume determined by TRUS images. Loose seeds (Oncoseed; GE Healthcare, Medi-Physics, Arlington Heights, IL, USA) were implanted using a Mick applicator (Mick Radio Nuclear Instruments, Mount Vernon, NY, USA). IBCL seeds (Brachysource; CR Bard, Covington, GA, USA) were assembled using a Quicklink device (CR Bard, Covington, GA, USA) prior to implantation. Zauls et al. [23] have described the detailed mechanisms of constructing IBCL, and we applied the same devices in our study. The operation time was obtained from the patient’s exposure records. Operation time was defined as the time from the first seed implanted to the last seed implanted.

**Post-implant analysis**

Post-implant dosimetry was performed using computed tomography (CT) images taken 1 month after implantation. In these scans, 0.625 mm thick slice images were obtained. As urinary catheters were not employed in post-implant CT images, urethra contours were identified proportionally to the location on the planning ultrasound. A single radiation oncologist performed the post-implant dosimetry for all patients. The prostate, urethra, and rectal wall were contoured. To compare the DVH changes between TRUS-based intraoperative planning and post-implant analysis, the CTV was identified in the same way as in intraoperative planning. The rectal wall was contoured using the same slices that were used for the CTV contour. In both intraoperative planning and post-implant dosimetry, the values for \( V_{100} \), \( V_{150} \), and \( D_{90} \) of the prostate, and CTV, urethral \( D_{10} \) and rectal \( D_{cc} \) were calculated.

The incidence of seed migration was evaluated using chest-abdomen-pelvic plain X-ray films and CT exams obtained 1 day and 1 month after implantation. The number of migrated seeds was counted using X-ray, and detailed site of migration and distance from the prostate were evaluated using CT. Seed migration was defined as a seed distant from the prostate (≥ 1.5 cm). A seed that dropped into the base of the seminal vesicle (< 1.5 cm from the prostate) was not defined as a migrated seed.

**Statistical analysis**

The two-sample Welch’s \( t \)-test for continuous data and \( \chi^2 \) test for categorical data were used to compare the baseline characteristics and the outcomes of interest between the IBCL and LS groups. One-way analysis of variance was used to compare the differences between intraoperative planning and post-implant dosimetry. Repeated measure analysis of variance was used to test the relationship between IBCL and LS on comparison of intra-operative planning, and post-implant dosimetry and prostate volume. Probability (\( p \)) values of < 0.05 were considered significant. Data processing and statistical analyses were carried out using Ekuseru-Toukei 2012 (Social Survey Research Information Co., Ltd, Tokyo, Japan).

**Results**

**Demographics**

Post-implant dosimetry analysis was performed for all 74 patients. There was a significant difference between the IBCL and LS groups in the number of patients undergoing neo-adjuvant hormonal therapy (Table 1). However, no significant differences were observed in the patients’ age or risk classifications.

**Dosimetric parameters**

There was no significant difference between the two groups in prostate volume, implanted seed number, seed activity, or seed number per prostate volume (Table 2). On comparison of planned dosimetry, the \( V_{150} \) of the prostate was lower (54.8% vs. 59.6%, \( p = 0.027 \)), and \( V_{100} \) (88.1% vs. 85.6%, \( p = 0.019 \)) and \( D_{90} \) (98.5% vs. 92.6%, \( p = 0.0033 \)) of CTV were higher in the IBCL group than in the LS group. No significant differences were observed in urethral or rectal dose. Table 3 shows the post-implant dosimetry. The prostate \( V_{100} \) (96.9% vs. 95.2%, \( p = 0.020 \)), CTV \( V_{100} \) (85.6% vs. 81.7%, \( p = 0.0012 \)), and \( D_{90} \) (94.2% vs. 86.5%, \( p < 0.001 \)) were higher, and \( V_{150} \) of the prostate (57.1% vs. 64.5%, \( p = 0.020 \)) and CTV (31.5% vs. 35.7%, \( p = 0.046 \)) were lower in the IBCL group. Figure 1 describes the change in DVHs from intraoperative planning to post-implant dosimetry. The data revealed significant interactions between type of seed and DVH changes in prostate \( D_{90} \) (–1.16% vs. –4.17%, \( p < 0.001 \)) and rectal dose (5.78% vs. -0.36%, \( p = 0.024 \)). In the LS group, prostate volume significantly decreased compared with intra-
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operative planning and post-implant dosimetry (−1.56 ml, \( p < 0.001 \)). A significant correlation between type of seed and volume change was observed (−0.17 ml for IBCL group vs. −1.56 ml for LS group, \( p = 0.011 \)).

**Operation time and seed migration**

Table 4 describes the operation time and details of the site of seed migration. In the IBCL group, the mean operation time was slightly but significantly longer than in the LS group (50.5 minutes vs. 43.7 minutes, \( p = 0.011 \)). The percentage of patients with seed migration in the IBCL group was significantly lower than in the LS group (5% vs. 41%, \( p < 0.001 \)). In addition, no seed migration other than into the seminal vesicle was observed in the IBCL group.

**Discussion**

This study demonstrated the dosimetric advantages of IBCL over LS for PPB. Several reports comparing DVH

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### Table 2. Intraoperative planning

| Factor                              | IBCL group \((n = 37)\) | LS group \((n = 37)\) | \( p\)-value |
|-------------------------------------|--------------------------|-----------------------|-------------|
| Prostate volume (ml)                | 24.9 (19.2-32.9)         | 28.3 (26.1-35.2)      | 0.086       |
| Implanted seed number               | 62 (50.79)               | 70 (60-75)            | 0.24        |
| Seed activity (number of patients)  | 11.0 MBq/13.1 MBq        | 31/6                  | 0.74        |
| Seed number/Prostate volume (ml)    | 2.59 (2.26-2.80)         | 2.36 (2.11-2.67)      | 0.087       |

DVHs in US plan

| Factor                              | IBCL group \((n = 37)\) | LS group \((n = 37)\) | \( p\)-value |
|-------------------------------------|--------------------------|-----------------------|-------------|
| Prostate V100 (%)                   | 97.7 (2.10)              | 96.9 (1.88)           | 0.13        |
| Prostate V150 (%)                   | 54.8 (8.08)              | 59.6 (9.76)           | 0.027       |
| Prostate D90 (% of PD)              | 120.9 (9.93)             | 119.6 (8.20)          | 0.55        |
| CTV V100 (%)                        | 88.1 (4.17)              | 85.6 (4.72)           | 0.019       |
| CTV V150 (%)                        | 43.9 (6.63)              | 45.5 (7.88)           | 0.34        |
| CTV D90 (% of PD)                   | 98.5 (8.24)              | 92.6 (8.00)           | 0.0033      |
| UD10 (%)                            | 131.1 (9.15)             | 129.7 (10.32)         | 0.56        |
| RD2cc (% of PD)                     | 66.8 (8.70)              | 64.5 (5.39)           | 0.17        |

Prostate volume, implanted seed number, and seed number/prostate volume are shown as medians (interquartile range: 25\(^{th}\) percentile – 75\(^{th}\) percentile). Dose volume histograms are shown as means (standard deviation)

IBCL – intraoperatively built-custom link seeds, LS – loose seeds, US – ultrasound, PD – prescribed dose, V100 – target volume receiving at least 100\% of PD, V150 – target volume receiving at least 150\% of PD, D90 – percentage of PD to 90\% of target volume, UD10 – percentage of PD to 10\% of urethral volume, RD2cc – percentage of PD to 2 cc of rectal volume

### Table 3. Post-implant dosimetry at 1 month

| Factor                              | IBCL group \((n = 37)\) | LS group \((n = 37)\) | \( p\)-value |
|-------------------------------------|--------------------------|-----------------------|-------------|
| Prostate volume (ml)                | 24.8 (22.5-31.0)         | 26.7 (24.7-32.9)      | 0.27        |
| Prostate V100 (%)                   | 96.9 (2.87)              | 95.2 (2.92)           | 0.020       |
| Prostate V150 (%)                   | 57.1 (11.27)             | 64.5 (10.55)          | 0.0051      |
| Prostate D90 (% of PD)              | 119.8 (11.65)            | 115.5 (10.14)         | 0.10        |
| CTV V100 (%)                        | 85.6 (4.34)              | 81.7 (5.27)           | 0.0012      |
| CTV V150 (%)                        | 31.5 (8.14)              | 35.7 (7.68)           | 0.046       |
| CTV D90 (% of PD)                   | 94.2 (9.34)              | 86.5 (8.52)           | < 0.001     |
| UD10 (%)                            | 141.2 (14.10)            | 145.5 (15.95)         | 0.23        |
| RD2cc (% of PD)                     | 61.0 (10.18)             | 64.1 (11.15)          | 0.23        |

Prostate volume is shown as median (interquartile range: 25\(^{th}\) percentile – 75\(^{th}\) percentile). Dose volume histograms are shown as means (standard deviation)

IBCL – intraoperatively built-custom link seeds, LS – loose seeds, US – ultrasound, PD – prescribed dose, V100 – target volume receiving at least 100\% of PD, V150 – target volume receiving at least 150\% of PD, D90 – percentage of PD to 90\% of target volume, UD10 – percentage of PD to 10\% of urethral volume, RD2cc – percentage of PD to 2 cc of rectal volume

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Fig. 1. Change in prostate volume and dose-volume histograms from intraoperative planning to post-implant dosimetry for the intraoperatively built custom-linked seeds (IBCL) group and loose seeds (LS) group.

IBCL – intraoperatively built custom-linked seeds, LS – loose seeds, PD – prescribed dose, V100% – target volume receiving at least 100% of PD, V150% – target volume receiving at least 150% of PD, D90% – percentage of PD to 90% of target volume, Urethral D10% – percentage of PD to 10% of urethral volume, Rectal D2cc – percentage of PD to 2 cc of rectal volume.
parameters between IBCL and LS found that prostate DVH did not differ between the two groups [22,23,24,25]. However, Jarusveicius et al. demonstrated that some DVH parameters were significantly different between IBCL and LS [21]. In contrast to the analysis methods used in the previous reports, this study compared DVH parameters that included the prostate with a 3 mm treatment margin (CTV). The CTV coverage was significantly higher in the IBCL group compared with the LS group in both intraoperative planning and in post-implant dosimetry. It is thought that the periprostatic treatment margins are important for brachytherapy [7,8]. EPE is commonly seen in surgical specimens even at the early stages of the disease [12,13,14,29]. Sohayda et al. reported that most EPEs in low-risk prostate cancers were within 3.3 mm of the prostate [14]. Schwartz et al. also demonstrated that the risk of EPE over 6 mm in length was low for prostate cancers with favorable clinical parameters [29]. Therefore, delivering a greater radiation dose to the CTV is important. At the same time, the V150 of the prostate both in intraoperative planning and in post-implant dosimetry was significantly lower in the IBCL group compared with in the LS group. As higher V150 leads to greater urethral and bowel toxicities [30], reducing the V150 by IBCL may be beneficial for the patient’s quality of life.

To deliver the prescribed dose to the target volume, radioactive seeds should be placed beneath and as close as possible to the prostate capsule. Though, LS not embedded in a vicryl structure were sometimes accidentally replaced into the extraprostatic area, and easily migrated to distant sites. In contrast, IBCL is more stable due to linkage and replacement into the extraprostatic area, and migrating to the distant sites is rare. This linkage allows the brachytherapist to place radioactive seeds in the beneath of the prostate capsule, and this feature improves dosimetry parameters of CTV. Although most EPE (within 3 mm) can be treated by peripheral, but within the prostate, seed placement [31,32], the treatment margin was unstable due to several factors such as operator differences and post-implant volume change [31]. In addition, effects of source placement error may be large in peripheral dose [33]. An ongoing randomized phase 3 study testing BT monotherapy vs. BT with EBRT for intermediate-risk prostate cancer (RTOG-0232) demonstrated comparable biochemical control with BT monotherapy [34]. Therefore, implant quality for the treatment margin is required for brachytherapy. As such, stable seed location using IBCL may be helpful in peripheral placement.

In this analysis, we were able to apply a higher brachytherapy dose to CTV using IBCL without increasing seed migration. Although extraprostatic placement was not planned in this study, higher brachytherapy dose to CTV was achieved in the intraoperative plan. This may have occurred by seed replacement during implantation. As peripheral prostate gland dose is susceptible to seed movement, the extracapsular dose is also easily affected by seed movement [33]. Regarding V150, the high V150 in the LS group may have been caused by seed overlap due to seed replacement during and after implantation. IBCL was more stable than LS due to seed linkage, reduced overlap, and decreased dose hot spots. Seeds stability may also have effects until 1 month after post-implant dosimetry. In this study, the decrease in prostate D90 was lower in the IBCL group than in the LS group (p < 0.001). Limited reports were available comparing the oncological outcome between loose type and strand type of seeds. Hinnen et al. described an improved 5-year biochemical control for loose seeds compared with strand type seeds [35]. The author suspected that poorer post-implant prostate D90 values for the strand type group due to seed movement after implantation led to the poor biochemical control. In the trial, they used sutured-embedded seeds as strand seeds. Lower intraoperative customization ability should be observed with sutured-embedded type of strand seeds compared with IBCL [26]. In our study, the IBCL group achieved more stable prostate dosimetry compared with the LS group. It is known that a high biological effective dose in post-implant dosimetry is correlated with good biological control [36]. Thus, we believe that these seeds and dosimetric stability for IBCL may lead to improved oncological outcomes. However, in this study, prostate volume significantly decreased only in the LS group (p < 0.001) after implantation. This difference may have been caused by the significant difference in neo-adjuvant hormonal therapy use between the two groups (Table 1). Neo-adjuvant hormonal therapy is sometimes used to decrease prostate volume [37], although neo-adjuvant hormonal therapy is known to affect post-implant dosimetry. Ash et al. described that lower prostate D90 values were observed in patients treated with neo-adjuvant hormonal therapy due to prostate volume re-growth after seed implantation [38]. In this study, a significantly larger number of patients was treated with neo-adjuvant hormonal therapy in the IBCL group. Terminating hormonal

### Table 4. Operation time and seeds migration

| Factor                  | IBCL group (n = 37) | LS group (n = 37) | p-value |
|-------------------------|---------------------|------------------|---------|
| Operation time (min)    | Mean, 50.5; SD 12.6 | Mean, 43.7; SD 9.0 | 0.011   |
| Patient(s) with seeds migration | 2 (5%)              | 15 (41%)         | < 0.001 |
| Seminal vesicle         | 2                   | 6                |         |
| Pelvic region           | 0                   | 8                |         |
| Chest                   | 0                   | 2                |         |

IBCL = intraintraoperatively built-custom link seeds, LS = loose seeds, SD = standard deviation.
therapy and the re-growth after implantation in the IBCL group caused significant prostate volume difference between the two groups. In the LS group, effects of prostate shrinkage after implant were suspected to be greater than in the IBCL group. However, the effect of volume reduction on dosimetry was expected to be a higher dose to the prostate [39], and the high prostate D90 decrease after implantation in the LS group may not have been affected by this volume reduction.

Several studies have reported the merits of IBCL over LS [21,22,23,24,25]. Jarusevicius et al. reported that IBCL improved prostate dose homogeneity, and decreased urethral and rectal dose for 160 Gy of the prescribed dose, whereas prostate D90 in post-implant dosimetry was lower with IBCL compared with LS [21]. Katayama et al. compared IBCL and LS using sector analysis, and demonstrated that IBCL improved the anterior base prostate sector coverage for 144 Gy of the prescribed dose [25], whereas no significant difference was observed in whole prostate dosimetry. On the other hand, Ishiyama et al. found no dosimetric advantage with IBCL compared with LS for 145 Gy of the prescribed dose [22]. In contrast to this prior study, our results demonstrated that IBCL significantly improved the prostate V100 in post-implant dosimetry, and provided stable prostate D90 compared with LS. The difference in these results may be caused by inter-operator and/or inter-institute variability, including implanting strategy. Jarusevicius et al. hypothesized that seed movement during and after implantation in IBCL may reduce prostate D90 [21]. They reported that seed movement may occur by anchoring in the surrounding tissue [40]. In our study, as each seed was planned to be inserted inside the prostate, no seed movement inferior to the prostate apex was observed. Ishiyama et al. stated that they implanted several seeds outside the prostate gland only in the case of IBCL [22]; therefore, this different strategy may have contributed to the different results. Katayama et al. reported significantly higher intraoperative phase prostate D90 in the LS group, whereas this difference was not observed in post-implant dosimetry [25]. Although the dosimetric change was not tested in the study, IBCL may provide more stable dosimetry than LS. Our study had similar results with previous studies that reported less seeds migration and longer operation times.

There were several limitations to this study. First, this was a retrospective study, and there were several selection biases. In patient characteristics, the use of neo-adjuvant hormonal therapy was significantly higher in the IBCL group. This demographic difference may have affected the post-implant prostate volume and dosimetry. Second, as post-implant dosimetry analyses were performed using CT without a urethral catheter, there were uncertainties in the prostate and urethra delineations. However, as all post-implant dosimetry analyses were done by one radiation oncologist (MI), inter-observer variability was limited in this study. Third, we did not use Brachysource as loose seeds. Brachysource has gold-core in titanium capsules, different from Oncoseed. This gold-core marker improves fluoroscopic visibility; therefore, this difference in seeds components may affect intraoperative planning dosimetry.

Brachysource also causes minimal CT metal artifacts compared with Oncoseed. Post-implant dosimetry in Oncoseed patients may have more uncertainty in seeds identification and prostate contour compared with Brachysource. In addition, Brachysource has squared ends that aid in reducing seeds movement compared with Oncoseed, which has a rounded surface. To clarify the advantages of the intraoperatively built-custom system, comparison between IBCL and LS using the same Brachysource is warranted.

**Conclusions**

IBCL has several advantages over LS such as reduction in seeds migration. Furthermore, IBCL can help achieve high CTV coverage and prostate homogeneity in intraoperative planning, and prevent the decrease in prostate D90 in 1 month post-implant dosimetry.

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**Disclosure**

Authors report no conflict of interest.

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