



# Resection arthroplasty in radiation-induced osteonecrosis of the hip

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## ABSTRACT

**Purpose:** The purpose of this study was to evaluate the choice of appropriate surgical procedure through follow-up of postoperative results in patients with radiation-induced osteonecrosis of the hip.

**Materials and methods:** From January 1990 to December 2010, 25 patients underwent surgery for hip osteonecrosis after pelvic irradiation, for a total of 31 cases. The mean patient age was 61.6 years and the mean follow-up period was 60.4 months. There were 28 cases of primary total hip arthroplasty, three cases of primary resection arthroplasty, and six cases of secondary resection arthroplasty after total hip arthroplasty failure. The THA group was classified into two groups according to the period of operation: 1990~2000 and 2001~2010. THA and resection arthroplasty were compared retrospectively.

**Results:** In the 16 cases of primary total hip arthroplasty (1990~2000), 8 cases (50%) had a failed acetabular component. In 12 cases of primary total hip arthroplasty (2001~2010), two cases (16.7%) had a failed acetabular component and two cases (16.7%) had an infection. Six cases underwent resection arthroplasty after total hip arthroplasty. There were no complications in the nine cases of resection arthroplasty. Seven of the nine cases (77.7%) had pain relief. The mean VAS scores of the resection arthroplasty group were lower than those of the total hip arthroplasty group at the time of the latest follow up ( $P=0.04$ ).

**Conclusions:** The failure rate of total hip arthroplasty used in radiation necrosis has decreased. Therefore, total hip arthroplasty should be the primary surgical method in patients with radiation-induced osteonecrosis of the hip. Resection arthroplasty is limited as first-line therapy due to functional problems. Its use should be limited to pain control in low-demand elderly patients.

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## 1. Introduction

Treatment of radiation-induced osteonecrosis of the hip is an unsolved problem in the field of orthopedic surgery. Currently, it is possible to limit the weight load by non-operative methods. Various surgical treatment methods such as total hip arthroplasty and resection arthroplasty are also available. Of these, total hip arthroplasty is the more commonly performed surgical procedure. However, there is a high rate of failure due to progression of bone defects and coexisting weakening of the acetabular bone due to irradiation.<sup>1,2</sup> Complications such as prosthesis infection have also been reported. In previous studies of total hip arthroplasty after irradiation, the failure rate of the acetabular component ranged from 44% to 52%.<sup>3,4,5</sup> However, the failure rate was low in a recently published paper.<sup>6,7,8</sup>

Although various studies have reported problems after total hip arthroplasty, none have provided a clear solution to this

problem. Therefore, we investigated the failure rate by THA period and compared clinical outcomes of resection arthroplasty and THA in patients with radiation-induced osteonecrosis of the hip. The purpose of this study was to evaluate the choice of appropriate surgical procedure through follow-up of postoperative results in patients with radiation-induced osteonecrosis of the hip.

## 2. Materials and methods

From January 1990 to December 2010, 25 patients (for a total of 31 cases) underwent surgery for hip osteonecrosis after pelvic irradiation. The mean age of the patients was 61.6 years (range, 47–77 years) and all patients were female. The mean radiation dose delivered to the pelvis was 4869 rad (range, 4000–6100 rad) and the mean follow-up period was 60.4 months (range, 20–130 months).

There were 28 cases of primary total hip arthroplasty. The THA group was classified into two groups according to the period of operation: 1990~2000 and 2001~2010. There were 16 cases in the 1999–2000 group and 12 cases in the 2001–2010 group

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**Table 1**  
THA operation 1990–2000.

No (Hip)	Age/Sex	Site	Follow-up (months)	Original Diagnosis	Total Radiation dose(cGy)	THA to Failure (months)	Note
1	56/F	Right	44	Cervical Ca.	4500	(–)	
2	47/F	Left	84	Cervical Ca.	5400	61	
3	52/F	Left	37	Cervical Ca.	5000	24	Periprosthetic Infection
4	54/F	Right	63	Cervical Ca.	4800	(–)	Die
5	54/F	Left	63	Cervical Ca.	4800	12	Die
6	67/F	Left	20	Cervical Ca.	4000	(–)	
7	67/F	Left	53	Cervical Ca.	4600	(–)	
8	57/F	Right	44	Cervical Ca.	4500	23	Die
9	57/F	Left	44	Cervical Ca.	4500	12	Die
10	66/F	Right	130	Cervical Ca.	4800	(–)	
11	66/F	Left	130	Cervical Ca.	6100	73	
12	70/F	Right	60	Cervical Ca.	4600	(–)	
13	53/F	Right	60	Cervical Ca.	4600	23	
14	55/F	Left	68	Cervical Ca.	4050	(–)	
15	66/F	Left	36	Cervical Ca.	4800	12	
16	55/F	Right	96	Cervical Ca.	5000	(–)	

**Table 2**  
THA Operation 2001 ~ 2010.

No (Hip)	Age/Sex	Site	Follow-up (months)	Original Diagnosis	Total Radiation dose(cGy)	THA to Failure (months)	Note
1	64/F	Right	68	Cervical Ca.	5000	(–)	
2	57/F	Right	48	Cervical Ca.	4500	(–)	
3	57/F	Left	48	Cervical Ca.	4500	(–)	
4	50/F	Left	108	Cervical Ca.	5400	(–)	
5	63/F	Left	72	Cervical Ca.	4600	36	
6	63/F	Right	60	Cervical Ca.	4600	(–)	
7	63/F	Left	60	Cervical Ca.	4600	(–)	
8	77/F	Left	46	Cervical Ca.	4800	Periprosthetic Infection (18)	
9	69/F	Left	88	Cervical Ca.	4600	24	
10	53/F	Left	32	Cervical Ca.	5000	(–)	
11	66/F	Right	26	Cervical Ca.	4000	(–)	
12	68/F	Left	48	Cervical Ca.	6100	Periprosthetic Infection (34)	Recurrent Cervical Ca.

(Tables 1 and 2). The 1999–2000 group was based on our medical records and previous research data.

There were nine cases of resection arthroplasty, including three cases of primary resection arthroplasty and six case of secondary resection arthroplasty after failure of total hip arthroplasty (Tables 3 and 4). The indications for THA included avascular necrosis of the femoral head ( $n = 16; 57\%$ ), symptomatic radiation osteitis causing incapacity ( $n = 8; 29\%$ ), and pathologic fracture of the femoral neck or acetabulum ( $n = 4; 14$ ). Primary resection arthroplasty was performed in patients who were treated with repeated pelvic abscesses and who could not walk without crutches. The indications for primary resection arthroplasty were avascular necrosis of the femoral head ( $n = 2; 33\%$ ) and pathologic fracture of the femoral neck or acetabulum ( $n = 2; 67$ ).

The procedures were performed by a senior surgeon. Serum tests (ESR, CRP, WBC) were performed in all patients to rule out the possibility of infection before the operation.

The acetabular components were of hemispherical design with an ingrowth surface of titanium fiber-metal (Harris-Galante II or

Trilogy, Zimmer, Warsaw, IN). The acetabulum was reamed to the size of the prosthesis and supplementary screw fixation was performed to secure the hemispherical cup.

Clinical symptoms, x-ray images, and magnetic resonance imaging (MRI) findings were used for preoperative diagnosis, and all patients were evaluated for stability after total hip arthroplasty based on clinical symptoms and radiological findings at follow-up. Radiologic findings were defined as radiographic transmission, dissociation of the acetabular cup, dissolution of acetabular osteolysis, and failure of an acetabular component during acetabular cup loosening or pelvic prolapse. Loosening of the acetabular component was defined as a vertical or horizontal change greater than 4 mm in any component's position when compared with the early postoperative radiographs.<sup>9</sup> Internal migration of the acetabular cup beyond the Kohler line was defined as protrusion of the acetabular cup into the pelvis.

Visual analogue scale (VAS) score and Harris hip score (HHS) at postoperative follow-up were evaluated in both the total hip

**Table 3**  
Details of the Patients in Resection Arthroplasty as the 2nd Operation.

No	Age/Sex	Site	Follow-up (Months)	Original Diagnosis	Total Radiation Dose(cGy)	1st Operation	Re OP indication	Pain (VAS)	Satisfaction	Walking aids
1	68/F	Left	94	Cervical Ca.	6100	THRA	Septic loosening	0	Satisfied	Zimmer Frame
2	67/F	Left	72	Cervical Ca.	6300	THRA	Aseptic loosening	2	Satisfied	Zimmer Frame
3	57/F	Left	146	Cervical Ca.	4500	THRA	Aseptic loosening	2	Satisfied	Chair bound
4	57/F	Right	146	Cervical Ca.	4500	THRA	Aseptic loosening	2	(–)	(–)
5	77/F	Left	46	Cervical Ca.	4800	THRA	Septic loosening	1	Satisfied	Zimmer Frame
6	60/F	Right	76	Cervical Ca.	5400	THRA	Septic loosening	3	Dissatisfied	Zimmer Frame

**Table 4**  
Details of the Patients in Resection Arthroplasty as the 1st Operation.

No	Age/Sex	Site	Follow-up (Months)	Original Diagnosis	Total Radiation Dose(cGy)	1st Operation	Re OP indication	Pain (VAS)	Satisfaction	Walking aids
1	72/F	Right	51	Cervical Ca.	6100	Rescetion Arthroplasty	(-)	2	Dissatisfied	Chair bound
2	72/F	Left	51	Cervical Ca.	6100	Rescetion Arthroplasty	(-)	2	(-)	(-)
3	74/F	Right	34	Cervical Ca.	5000	Rescetion Arthroplasty	(-)	3	Satisfied	Stick

arthroplasty group and the resection arthroplasty group to evaluate postoperative pain relief and function.

Statistical analysis was performed using SPSS 24.0. Chi-Square tests, and Fisher's exact tests, and Mann-Whitney *U* tests were used to analyze the significance of differences between the total hip arthroplasty group and the resection arthroplasty group. The Mann-Whitney *U* test was used to compare the VAS and HHS between the two groups, as these scores did not follow a normal distribution. We considered a *p*-value < 0.05 to indicate statistical significance.

This study was approved by the Institutional Review Board of Kosin University Gospel Hospital.

### 3. Results

Failure of an acetabular component occurred in 8 (50%) of the 16 cases of primary total hip arthroplasty from 1990 to 2000. The mean time to failure of the acetabular component was 30 months, with a range from 12 months to 61 months. Postoperative infection occurred in three cases (18.8%). One case (6.3%) required surgical treatment. One patient (6.3%) was treated only with antibiotics. One patient (6.3%) had a superficial infection, but treatment was stopped due to other causes of death. Six patients (37.5%) underwent a revision operation for failure of an acetabular component. Two patients died during the study period.

Failure of an acetabular component occurred in two (16.7%) of the 12 cases of primary total hip arthroplasty at 2001–2010. The mean time to failure of the acetabular component was 36 months. Postoperative infection occurred in two cases (16.7%) and required surgical treatment. Two patients (16.7%) underwent a revision total hip arthroplasty for failure of an acetabular component. One patient had a recurrence during the study period.

There were no complications in the three cases of primary resection arthroplasty and six cases of secondary resection arthroplasty. Of the nine patients who underwent resection arthroplasty, seven patients (77.7%) had pain relief and five of these seven patients (71.4%) were satisfied with the outcome after

surgery. However, all mobile patients required walking aids when ambulating independently.

The mean VAS score of the total hip arthroplasty group improved from 7.08 (range 4–9) preoperatively to 3.39 (range 0–8) at the time of the latest follow-up, while the mean VAS score of the resection arthroplasty group improved from 8.02 (range 6–9) preoperatively to 2.3 (range 0–5) at the time of the latest follow-up. VAS scores of the resection arthroplasty group were lower than those of the total hip arthroplasty group (*P* = 0.04).

The mean HHS score of the total hip arthroplasty group improved from 42 (range 8–78) preoperatively to 79 (range 36–100) at the time of the latest follow-up, while the mean HHS score of the resection arthroplasty group improved from 34 (range 6–58) preoperatively to 53 (range 43–66) at the time of the latest follow-up. HHS scores of the total hip arthroplasty group were significantly higher than those of the resection arthroplasty group (*P* = 0.001).

### 4. Discussion

Irradiation of the pelvis to treat cancer also affects the surrounding normal tissue and can result in histological changes to the bone tissue, which manifest as bone necrosis, microfractures, osteitis, bone marrow fibrosis, and osteoporosis.<sup>1,10,11</sup> This progression of osteonecrosis can result in postoperative complications such as acetabular fracture and acetabular component failure.<sup>2,12</sup>

In the present study, failure of an acetabular component occurred in 8 (50%) of the 16 cases of primary total hip arthroplasty from 1990 to 2000. Failure of an acetabular component occurred in two (16.7%) of the 12 cases of primary total hip arthroplasty from 2001 to 2010. In previous studies of total hip arthroplasty after irradiation, the failure rate of the acetabular component was reported to range from 0% to 52%. (Table 5)

These differences among studies are likely due to differences in the follow-up period, radiation dose, latency period, patient age, and acetabular components used.

**Table 5**  
Data from literature.

Study	Number of hips	Acetabular fixation	Mean radiation dose(cGy)	Mean follow-up (months) (range)	Acetabular loosening (%)	Revision Operation (%)	Mean final HHS (range)	Year of Operation
Massin et al. <sup>3</sup>	42/22	Cemented/Cemented into acetabular ring	5500	69(6–240)/40(6–132)	52/19	38/10	NR/NR	1970–1990
Jacobs et al. <sup>4</sup>	9	Non-cemented		37(17–78)	44	22	82(62–98)	–
Cho et al. <sup>5</sup>	14/4	Noncemented/Cemented into acetabular ring	5250	58(20–139)34(20–41)	50/50	42/25	NR/NR	1990–2000
Kim et al. <sup>14</sup>	58	Noncemented	7065	58(24–90)	0	5	90(42–100)	1997–2003
Joglekar et al. <sup>15</sup>	22	Noncemented	6300	78(57–116)	0	0	80(60–100)	1998–2005
Felden et al. <sup>16</sup>	49	Noncemented	5000	57(3–372)	2	8	NR	1995–2011
Current study	16	Noncemented	4611	64(7–139)	50	38	74	1990–2000
	12	Noncemented	5255	62(20–116)	17	25	88	2001–2010
	6	Rescetion Arthroplasty	5317	63(34–120)	–	–	53	1995–2005

HHS, Harris hip score; NR, not reported.

Interestingly, the THA failure rate is decreasing. This is likely due to the development of better surgical instruments, surgical techniques, and radiation methods. In particular, intensity-modulated radiation therapy (IMRT) is one of the most important advances in oncology in the past few decades. By conforming more precisely to the selected target, IMRT may allow more normal tissue to be spared compared to other techniques.<sup>13</sup>

Of the six patients who underwent secondary resection arthroplasty and the three patients who underwent primary resection arthroplasty, seven (77%) reported pain relief after surgery, and five of these patients (71.4%) reported satisfaction with the surgical outcome. The postoperative satisfaction rate of resection arthroplasty varies widely among studies, and appears to be low in young patients with functional needs and expectation.<sup>14,15,16,17</sup> The patients in this previous study had a history of malignant tumors and were 65.33 years old on average (SD, 9.00, Range 44–77). In this previous study, the group with low functional demands and expectations reported relatively high satisfaction after achieving pain relief.

In the current study, the mean VAS scores for the resection arthroplasty group were lower than those for the total hip arthroplasty group. For pain relief, resection arthroplasty is a better surgical option than THA. This is because pain worsened in the THA group when acetabular loosening and infection occurred.

Uncemented implants have shown a high success rate in primary THA and good outcomes on long-term follow-up. In comparison of the cement and uncemented types, superiority has yet to be determined. However, a choice based on surgical objective, the quality of the bone, and the surgeon's experience will likely result in a good outcome.<sup>18,19</sup> The cemented type is advantageous when strong fixation is needed at the beginning, and there is an advantage of reduced complications during the operation, such as the fracture around the implant. The disadvantages are damage to the bone tissue, problems such as aseptic loosening and osteolysis, and difficulty in removing cement for revision arthroplasty.<sup>18,19</sup> In this study, we performed uncemented acetabular fixation in all cases. We found no significant difference in cemented type and uncemented type in fixation for THA in radiation-induced hip issues. In particular, THA in radiation-induced AVN was more favorable for the uncemented type because of the avoidance of high rate of revision operation and postoperative infection. However, the comparison of cemented and uncemented type requires more research in the future.

Future studies should incorporate more cases to confirm our findings as the lack of statistical significance in our study may have been due to our small sample size.

## 5. Conclusions

The failure rate of total hip arthroplasty used for the treatment of radiation necrosis was high. We considered resection

arthroplasty as a treatment alternative. However, the failure rate of total hip arthroplasty has decreased due to the development of better surgical techniques, instrumentation, and irradiation methods. Therefore, total hip arthroplasty should be the primary surgical method in patients with radiation-induced osteonecrosis of the hip. Resection arthroplasty is limited as a first-line therapy due to functional problems. It should be done for pain control only in low-demand elderly patients.

## Conflict of interest

None.

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