Proximal Femur Versus Acetabular Extra-articular Resection of the Hip Joint for Primary Malignant Bone Tumors : A Retrospective Comparative Review of 33 Cases

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Proximal femur versus acetabular extra-articular resection of the hip joint for primary malignant bone tumors : A retrospective comparative review of 33 cases

Subtitle: Extra-articular resection of the hip joint for malignant bone tumours

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27 **ABSTRACT**

28 *Introduction*

29 Extra-articular resection (EAR) of the hip joint is prone to significant complications and
30 morbidity. Thus, this study evaluates the cumulative incidences and main reasons of reoperation
31 following EAR of primary bone tumors of the hip to determine whether the outcomes are different
32 between EAR of the pelvis and that of the proximal femur.

33 *Patients and methods*

34 Thirty-three patients presented with a PMBT of the proximal femur or pelvis were included
35 in this study. Among all PMBTs, 58% originated from the pelvis and 42% were from the proximal
36 femur. Twenty patients had chondrosarcomas (61%), 10 had osteosarcomas (30%), and 3 had
37 sarcomas of another histological subtype (9%).

38 *Results*

39 The mean follow-up was of 76 months (range: 24–220 months). The cumulative probabilities
40 of revision for any reason was 52% (95% confidence interval [CI]: 30%–70%) five years after
41 surgery. The five-year cumulative probabilities of revision were 13% (95% CI: 4%–27%), 24% (95%
42 CI: 10%–42%) and 34% (95% CI: 14%–56%) for mechanical, infectious and tumoral reasons,
43 respectively. The five-year cumulative probabilities of revision for any reason were 78% (95% CI:
44 37%–94%) and 14% (95% CI: 2%–38%) for the pelvis and proximal femur, respectively ($p = 0.004$).
45 Posterior column preservation was significantly associated with more mechanical complications even
46 after adjusting for the resection site ($p = 0.043$).

47 *Conclusion*

48 Half of patients undergoing EAR of the hip joint for PMBT of the proximal femur or
49 acetabulum will require another operation. EAR of the pelvis is associated with significantly worse
50 outcome than EAR of the proximal femur.

51

52

53 INTRODUCTION

54 Bone sarcomas are rare cancers, accounting for less than 0.1% of all cancers (1). The proximal
55 distal femur, proximal tibia, proximal humerus and pelvis are the most common anatomical sites for
56 bone sarcomas. Osteosarcoma, chondrosarcoma and Ewing sarcoma are the most common
57 histologies. The surgical control of a bone sarcoma requires resection of the affected bone with only
58 an approximately 1–2-cm margin at the bony cuts (2) and may require an extensive soft-tissue
59 resection depending on the size and location of the tumour. Despite the development of imaging
60 techniques and increase in the effectiveness of chemotherapy, none of the many reconstructive
61 options described have been established nowadays as a *gold standard* procedure following resection
62 of periacetabular primary malignant bone tumours (PMBTs) due to the challenging aspect of these
63 procedures and the high rate of postoperative complications. However, when a bone sarcoma invades
64 a joint, an extra-articular resection (EAR) (viz. *en-bloc* resection) of the affected bone, joint and part
65 of the adjacent bone should be performed to obtain adequate margins (3).

66 EAR of the joint decreases the risk of local recurrence when joint contamination is suspected
67 (4). Before surgery, the necessary means must be employed to rule out joint contamination. A
68 significant joint effusion on clinical examination should be considered a potential joint contamination.
69 Imaging studies, including MRI, radiography and CT, are paramount to suspect an invasion of the
70 joint by the tumour, and eventually, biopsy should be performed through the joint.

71 EARs of the joint are technically challenging and prone to significant complications and
72 morbidity (5). The most commonly performed EAR of the joint is that of the knee joint with a bone
73 sarcoma affecting either the proximal tibia or the distal femur (6–8). When performed in an expert
74 centre, EAR of the joint is associated with adequate margins and little local recurrence. EAR and
75 wide resection of the hip joint have been reported in few series (4,5,9). without a significant difference
76 in outcomes between resections of PMBTs located in the pelvis and proximal femur. Deep infection,
77 mechanical failure and local recurrences seem to be the main reasons for revision and reoperation
78 following this surgically demanding procedure (4,5,9). Given the limited information available on

79 this difficult technique, we decided to report our experience to provide information on the technical
80 aspects and expected results of such a procedure.

81 Therefore, this study evaluates the cumulative incidences of reoperation following EAR of
82 the hip and determines the main reasons for reoperation to compare the different outcomes between
83 EAR of the pelvis and EAR of the proximal femur.

84

85 **PATIENTS AND METHODS**

86 *Study design, setting and participants*

87 This retrospective study involved patients treated between 2000 and 2016 at a tertiary care
88 centre specialising in treating musculoskeletal tumours. Patients who presented with a PMBT of the
89 proximal femur or pelvis and were treated with EAR of the hip joint for articular invasion were
90 included in this study. Those who were <15 years of age, those who presented with a local recurrence
91 after a previous operation and those who presented a non-malignant primitive bone tumour were
92 excluded from the study. All eligible patients, identified using our electronic hospital records, were
93 included. Treatment decisions were discussed at a multidisciplinary team meeting; four senior
94 surgeons with specific expertise in musculoskeletal orthopaedic oncology performed all surgeries.

95

96 *Surgical technique and postoperative care*

97 A prophylactic antibiotic therapy including metronidazole and cefazolin for 24 hours was
98 started at the time of anaesthetic induction. The patients were placed on the lateral recumbent position
99 to allow for the necessary surgical exposures, and the surgical approach varied depending on the
100 tumour location. Proximal femoral tumours were approached through a single posterolateral incision
101 (n = 7) or both posterolateral and inguinal incisions (n = 7). Pelvic tumours were approached through
102 a utilitarian incision (n = 7) or both posterolateral and ilio-inguinal incisions (n = 12). For both
103 femoral and pelvic tumours, the involved bone and soft tissue were dissected based on oncological
104 principles that a 1–2-cm margin should be retained when possible depending on the extent of the

105 tumour. For proximal femoral tumours, the posterior column, the superior part of the acetabulum and
106 the iliopubic ramus were freed from soft-tissue attachments, and osteotomies were performed the
107 same way as a periacetabular osteotomy; the acetabulum was then mobilised together with the
108 proximal femur, and the specimen was removed and sent to pathology. In one case, the posterior
109 column was not preserved (7%). For pelvic tumours, the proximal femur was exposed, and a vertical
110 osteotomy in the plane of the greater trochanter was performed, and a horizontal, or short oblique,
111 osteotomy was performed at the upper level of the lesser trochanter; the femoral neck and joint
112 capsule were mobilised together with the pelvic resection, and the specimen was removed and sent
113 to pathology. The posterior column was preserved in two cases (10.5%).

114 For every patient, reconstruction was performed simultaneous to the resection. Proximal
115 femoral resections were reconstructed using endoprotheses in five cases (Figure 1), using allograft–
116 prosthesis composites in six cases and using a standard stem in three cases. On the pelvic side, an ice-
117 cream cone reconstruction was performed in 10 cases (Figure 2), an acetabular cemented
118 reconstruction with an allograft and acetabular ring was performed in three cases, and an uncemented
119 reconstruction in one case. Pelvic resections were reconstructed using an ice-cream cone in eight
120 cases(10), a saddle prosthesis in four cases, an acetabular cemented reconstruction with an allograft
121 in one case, and no reconstruction (medialisation) in six cases. A standard stem was used in all cases
122 where a saddle prosthesis was not used (15 cases).

123 Postoperative care included prophylactic anticoagulation for six weeks, standard wound care
124 and removal of the suction drains between postoperative days 2 and 5. For 28 patients (85%), bed rest
125 was maintained for 7–15 days with a transtibial suspension, while wound care was performed in bed.
126 All but one patient had a fibreglass hip spica applied until the sixth postoperative week. Weight
127 bearing was resumed depending on the reconstruction performed. For five patients, (15%) bed rest
128 was continued until the patient was comfortable enough to mobilise, and weight bearing was resumed
129 immediately. The standardised postoperative follow-up includes clinical and imaging evaluation

130 (pelvic and hip radiography and pelvic CT or MRI and chest CT) six weeks after surgery, then every
131 four months during the first two years, every six months until the fifth year and every year after that.

132

133 *Variables, data sources and measurements*

134 Demographic information, clinical findings and treatment details were retrieved from the
135 patients' medical records. All operating notes and pathology reports were reviewed. Histology was
136 defined by one of two pathologists specialising in bone and soft-tissue tumours from the resection
137 specimen using the residual tumour (R) classification: R0, no residual tumour; R1, microscopic
138 residual tumour; and R2, macroscopic residual tumour. Radiographic contamination was suspected
139 based on the following criteria: an intra-articular fracture of the affected bone or direct visualisation
140 of the tumour in the joint. Histological articular contamination was then confirmed, or not, from the
141 resection specimen. The patients' status was that reported at the time of last review. A definite surgical
142 site infection was considered if a sinus tract communicating with the surgical site existed; if a
143 pathogen was isolated by culture from at least two separate tissue or fluid samples obtained from the
144 affected prosthetic joint/surgical site; or based on clinical, biological, and histopathological exams
145 under review by the multidisciplinary infectious board. Mechanical failure included aseptic loosening
146 and hip dislocation requiring open reduction. Local tumour recurrence was usually suspected on
147 imaging follow-up studies and confirmed using percutaneous biopsy. A reoperation was defined as
148 any surgical procedure performed under general anaesthesia of the previous surgical site and included
149 open hip reduction. No complication or revision surgeries were excluded in the final analysis even if
150 they occurred less than 1 year postoperatively. Investigations were conducted in accordance with the
151 ethical standards of the 1964 Declaration of Helsinki. Ethical approval was not required according to
152 the MR-004 reference methodology; the study was registered in the *Commission nationale de*
153 *l'informatique et des libertés* database register (n°2215812), and each patient was individually
154 informed and consented before any data collection (11).

155 *Statistical analysis and data collection*

156 Continuous data are presented as median with first and third quartile values (Q1–Q3);
157 categorical data are presented as counts and proportions. The cumulative incidence rates of
158 reoperation for infection, mechanical failure and any reason and the cumulative incidence rate of local
159 recurrence were presented as defined by Prentice et al. (12) The cumulative incidence rates of events
160 were estimated from the date of EAR of the hip to either the event, competing event (death) or last
161 news when neither event nor death was experienced (censored observation). Point estimates with 95%
162 exact confidence intervals (CIs) are reported. Patient survival was estimated according to the Kaplan–
163 Meier method (13) from the date of EAR of the hip to either death or last news for living patients
164 (censored observation). The log-rank test was used to test for differences between categories of a
165 variable in survival times.

166

167 **RESULTS**

168 The median follow-up period was 76 months with a minimum follow-up period of 24 months
169 and a maximum follow-up period of 220 months. In total, 33 patients (Table 1) were enrolled in this
170 study, including 14 women and 19 men, with a median age of 52 years (interquartile range (IQR),
171 44–61 years). Nineteen tumours originated from the pelvis (58%) and 14 tumours were from the
172 proximal femur (42%). For the 19 pelvic tumours, in three cases, the lesions were type I+II (16%); in
173 ten cases, the lesions were type II+III (52%); and in six cases, the lesions were type I+II+III (32%),
174 according to Enneking and Dunham (14). Among the 33 lesions, 20 were chondrosarcomas (61%),
175 10 were osteosarcomas (30%) and three were sarcomas of another histological subtype (9%). Thirteen
176 tumours were high grade (39%). The median size in the larger axis of the bone tumours was $83.7 \pm$
177 38.2 mm (IQR: 50–100 mm). Two patients (6%) presented with metastatic disease at the time of
178 surgery. Ten patients had preoperative chemotherapy (30%), and two had preoperative radiation
179 (6%). Nine patients presented with a pathological fracture (27%). Articular contamination was

180 suspected on imaging in 28 patients (85%), and among them, 13 (93%) presented with proximal femur
181 bone tumours (93%) and 15 (79%) presented with periacetabular localisation.

182 The cumulative probabilities of revision for any reason were 45% (95% CI: 26%–62%), 52%
183 (95% CI: 30%–70%) and 52% (95% CI: 30%–70%) one, two and five years after surgery,
184 respectively. The cumulative probabilities of revision for mechanical reasons were 13% (95% CI:
185 4%–27%), 13% (95% CI: 4%–27%) and 13% (95% CI: 4%–27%) one, two and five years after
186 surgery, respectively. The cumulative probabilities of revision for infection were 18% (95% CI: 7%–
187 33%), 24% (95% CI: 10%–42%) and 24% (95% CI: 10%–42%) one, two and five years
188 postoperatively, respectively. The cumulative probabilities of local recurrence were 15% (95% CI:
189 4%–31%), 27% (95% CI: 10%–48%) and 34% (95% CI: 14%–56%) one, two and five years
190 postoperatively, respectively. The cumulative incidences of the main reasons for reoperation after
191 EAR of the hip are represented in Figure 3.

192

193 Significant differences in outcomes were observed between EAR of the pelvis and EAR of
194 the proximal femur. The five-year cumulative probabilities of revision for any reason were 78% (95%
195 CI: 37%–94%) and 14% (95% CI: 2%–38%) for EAR of the pelvis and EAR of the proximal femur,
196 respectively ($p = 0.004$). The five-year cumulative probabilities of revision for mechanical reasons
197 were 12% (95% CI: 2%–32%) and 14% (95% CI: 2%–38%) for EAR of the pelvis and EAR of the
198 proximal femur, respectively ($p = 0.8$). The five-year cumulative probabilities of revision for infection
199 were 41% (95% CI: 16%–64%) and 0% for EAR of the pelvis and EAR of the proximal femur,
200 respectively ($p = 0.05$). The five-year cumulative probabilities of local recurrence were 54% (95%
201 CI: 20%–80%) and 29% (95% CI: 6%–58%) for tumours of the pelvis and proximal femur,
202 respectively ($p = 0.03$). Differences between EAR of the pelvis and EAR of the proximal femur are
203 shown in Figure 4. The preservation of the posterior column was significantly associated with more
204 mechanical complications, including dislocation and aseptic loosening, even after adjusting for the
205 resection site (pelvis or femur) (hazard ratio [HR] = 0.05; 95% CI = 0.003–0.91; $p = 0.043$); when

performing the analysis among patients who had a reconstruction (n=23), the effect remained similar but was not significant (hazard ratio [HR] = 0.13; 95% CI = 0.008–2.2; $p = 0.16$).

208

Other relevant findings

There was no correlation between the tumor grade, the surgical approaches and the method of reconstruction with the final outcomes for both techniques. The median surgery length was 300 min (Q1–Q3: 230–360). A mean number of four packed red blood cells were transfused (Q1–Q3: 3–5). Significant intraoperative complications including injuries to the internal iliac vein (n = 1), femoral vein (n = 1) and ureter (n = 1) were observed. All injuries were repaired during the procedure. Accidental intraoperative joint effraction occurred in eight patients: two (11%) during EAR of the pelvis (capsule dissection) and six (43%) during EAR of the proximal femur (bone osteotomies in two cases and capsule dissection in four cases); this difference was statistically significant ($p = 0.047$). Among them, only one (12.5%) has had a revision surgery for hindquarter amputation three months after the initial resection. Despite these patients, R0 resection was confirmed in 91% of the patients (30/33) after histological examination of the specimens. At the last follow-up, seven patients passed away, and the five-year survival probability was 76% (61%–95%). The table 2 summarizes the number and ratio of the encountered complications at the last follow up for pelvis and proximal femur tumours.

224

DISCUSSION

When a bone sarcoma invades a joint, EAR should be performed to obtain adequate margins to decrease the risk of local recurrence (4,6,7,15). EARs of the joint are technically challenging and prone to significant complications and morbidity (4,6–8,15). Although the technique is well known for the knee joint, fewer information exists with regard to its use in the hip joint (4,5,9).

Li and colleagues have reported their experience on 18 patients who presented with either pelvic sarcoma or proximal femur sarcoma and suspicion of joint invasion (4). They reported one

232 (6%) postoperative death. Wide margins were achieved in 72% of cases, and the proportion of local
233 recurrence was 24% after a mean follow-up period of 35 months. In their series, Li and colleagues
234 did not preserve the posterior column when the tumour originated from the proximal femur. However,
235 Rudiger and colleagues have reported two cases of EAR of the hip joint with preservation of the
236 posterior column (16). Interestingly, we showed that preserving the posterior column was associated
237 with significantly more mechanical failures. This could be because surgeons tended to use the
238 remaining, probably fragile, posterior column as a means of fixation when it is in fact
239 counterproductive.

240 A recent nationwide survey in 17 Japanese institutions on 80 prosthetic reconstructions using
241 constrained-type hip tumour prostheses following wide resection of periacetabular tumours with a
242 mean follow-up period of 65 months found a local recurrence rate of 26%, a deep infection rate of
243 39% and the occurrence of prosthesis-related complications requiring surgery in 9% of the case (9).
244 The rates of postoperative complications were still high, but comparable to those found in previous
245 studies. Meanwhile, Fujiwara and colleagues have conducted a retrospective study involving a
246 comparable number of patients ($n = 34$) and found a higher occurrence rate of complications in
247 patients who underwent EAR of the hip joint for bone sarcomas involving the pelvis than that in
248 patients who underwent EAR of proximal femur tumours with a shorter mean follow-up period of 38
249 months. No statistical differences were observed between pelvic EAR and proximal femur EAR ($p =$
250 0.116). Therefore, in this study, we described the outcomes of a large retrospective series of EAR of
251 the hip in a single centre specialising in this type of procedures and looked for differences between
252 pelvic EAR and proximal femur EAR with a longer follow-up.

253 The overall five-year cumulative probability of revision for any reason was 52% (95% CI:
254 30%–70%) with a significant difference between pelvic EAR and proximal femur EAR. The five-
255 year cumulative probabilities of revision for any reason were 78% following pelvic EAR and 14%
256 following proximal femur EAR. The reoperation rate is therefore high. Hoffmann et al. in a
257 retrospective series of 241 Ewing sarcomas of the pelvis have reported a 20% failure rate (17). Brown

258 and colleagues in a recent systematic review of the literature published between 1990 and 2017 have
259 analysed 1,700 periacetabular oncological lesions with a mean follow-up period of 3.4 years (18).
260 They found a 50% complication rate. Hillmann and colleagues in a retrospective review of 110 cases
261 have reported a 58% complication rate after pelvic reconstruction (15). Proximal femoral resection
262 and reconstruction are associated with significantly less complications. In a recent systematic review
263 of 41 studies, Janssen and colleagues have reported a 10% revision rate (ranging from 0% to 69%)
264 for endoprosthetic reconstruction (19). At their last follow-ups, Ogura et al. and Fujiwara et al. have
265 reported 59% and 69%, respectively, occurrence rates of complications requiring revision. Overall,
266 the revision rate in this study is similar to those found in the literature although the patients in this
267 study may have had more aggressive tumours and undergone more extensive surgeries following the
268 concept of EAR of the whole hip joint.

269 The local recurrence rate was 54% after pelvic EAR and 29% after proximal femur EAR,
270 which is high after resection of a bone sarcoma. Guo and colleagues in a retrospective study involving
271 a series of 30 patients with osteosarcoma have reported a 26% local recurrence rate (20). Although
272 their follow-up period was twice as short as ours, the local recurrence rate at the last follow-up in the
273 study by Fujiwara et al. (21%) was less significant for both pelvic (23%) and proximal femoral (13%)
274 locations(5). Li and colleagues in their retrospective study on a series of 18 patients have reported a
275 local recurrence rate of 18% ; however, they did not mention joint invasion (4). Bus and colleagues
276 in a multicentre retrospective review of 162 primary central chondrosarcomas of the pelvis have
277 reported a 38% local recurrence rate (21). Similarly, the recurrence rate in this study is higher than
278 that for EAR of the proximal femur. In our own experience of 32 proximal femur resections for bone
279 tumours, the local recurrence rate was 9% (22). Although the aggressiveness of the tumour could
280 explain these differences, the technical difficulties encountered during the procedure may also be an
281 explanation. Indeed, preoperative joint effraction occurred in eight patients (24%). Interestingly, this
282 complication was significantly more common after proximal femur EAR than after pelvic EAR; the
283 additional procedure for an EAR of the hip is technically more challenging for a femur than for a

284 pelvis. The use of navigation and robotics or the use of patient-specific cutting guides may improve
285 the resection by joint invasion at the bony cuts (23,24).

286 This study has several limitations. First, a limited number of patients were included. This is
287 due to the low incidence of bone sarcomas of the pelvis or proximal femur with joint contamination.
288 Li and colleagues have analysed 18 cases only among more than 1,500 pelvic and proximal femur
289 tumours (4). Ogura and colleagues had a larger number of patients but from different centres, which
290 may not ensure the reproducibility of the procedure, and the procedures were not performed in centres
291 specialising in treating primary bone tumours (9). We included 33 patients over 16 years' experience
292 at our reference centre, which is a similar number of patients as that in the study by Fujiwara et al.
293 but covering a shorter period. Second, the retrospective design of this study is a limitation to the type
294 of data that may be collected. However, this is a common limitation in such rare conditions. Third,
295 the heterogeneity in patients and the surgical techniques employed for resection or reconstruction are
296 a limitation to providing guidelines after EAR of the hip; however, most procedures included non-
297 constrained prostheses, which may have diminished the rate of mechanical failures of the
298 reconstructions.

299

300 **CONCLUSION**

301 Half of the patients undergoing EAR of the hip joint for PMBTs of the proximal femur or
302 acetabulum will require another operation. Pelvic EAR is associated with significantly worse
303 outcomes than proximal femur EAR. Surgeons should be aware that the procedure is technically
304 challenging and that joint invasion is common. Preserving the posterior column may be attempted,
305 but fixation should not rely on it.

306

307 **DECLARATIONS**

308 Ethics approval and consent to participate

309 Not applicable.

310 Consent for publication
311 Not applicable.

312 Availability of data and materials

313 The datasets used and/or analysed during the current study are available from the
314 corresponding author on reasonable request.

315 Competing interests

316 The authors declare that they have no competing interests.

317 Funding

318 None.

319 Authors' contributions

320 VH wrote the manuscript. VH and DB analyzed and interpreted the patient's data.
321 AB, PA and DB performed the surgeries. GA was a major contributor in writing the
322 manuscript. All authors read and approved the final manuscript.

323 Acknowledgements

324 None.

325

326 **FIGURES**

327

328
329 Fig. 1. On the left, proximal femur pathologic fracture on a chondrosarcoma. On the right,
330 extraarticular resection and reconstruction with an endoprosthesis reconstruction and ice-cream
331 cone prosthesis performed for the same patient. The posterior column was preserved.

332

333

334 Fig. 2. On the left, Zone 2 and 3 pelvis chondrosarcoma. On the right, extraarticular resection and
335 reconstruction with an ice-cream cone prosthesis and standard cemented femoral stem performed
336 for the same patient..

337

338

339

340 Fig. 3. Cumulative incidence of revision for any reason, for mechanical reason, for infection and
 341 local recurrence
 342

343
 344 Fig. 4. Cumulative incidences of revision for pelvis EAR and proximal femur EAR.

345
 346 **TABLES**

347
 348 Table 1: Characteristics of the population

Characteristics	Total (n=33)	Femur (n=14)	Pelvis (n=19)	p value
Median age (Q1-Q3)	52 (44 to 61)	52 (42 to 58)	52 (45 to 62)	0.99
ASA Physical status score	-	-	-	0.65
I	15 (46)	5 (36)	10 (52)	-
II	12 (36)	6 (43)	6 (32)	-
III	6 (18)	3 (21)	3 (16)	-
Localisation	-	-	-	-
Pelvis	19 (58)	-	19 (100)	-
Proximal femur	14 (42)	14 (100)	-	-
Enneking and Dunham	-	-	-	-

<u>I - II</u>	<u>3 (16)</u>	<u>-</u>	<u>-</u>	<u>-</u>
<u>I - II - III</u>	<u>6 (32)</u>	<u>-</u>	<u>-</u>	<u>-</u>
<u>II - III</u>	<u>10 (52)</u>	<u>-</u>	<u>-</u>	<u>-</u>
<u>Average size in mm (Q1-Q3)</u>	<u>80 (50 to 110)</u>	<u>85 (49 to 128)</u>	<u>79 (52 to 100)</u>	<u>0.37</u>
<u>Histology</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>0.11</u>
<u>Chondrosarcoma</u>	<u>20 (61)</u>	<u>6 (43)</u>	<u>14 (74)</u>	<u>-</u>
<u>Ewing sarcoma</u>	<u>1 (3)</u>	<u>-</u>	<u>1 (5)</u>	<u>-</u>
<u>Ostéosarcoma</u>	<u>10 (30)</u>	<u>7 (50)</u>	<u>3 (16)</u>	<u>-</u>
<u>Other sarcoma</u>	<u>2 (6)</u>	<u>1 (7)</u>	<u>1 (5)</u>	<u>-</u>
<u>Preoperative metastasis</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>0.17</u>
<u>No</u>	<u>31 (94)</u>	<u>12 (86)</u>	<u>19 (100)</u>	<u>-</u>
<u>Yes</u>	<u>2 (6)</u>	<u>2 (14)</u>	<u>0 (0)</u>	<u>-</u>
<u>Preoperative radiation</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>1</u>
<u>No</u>	<u>31 (94)</u>	<u>13 (93)</u>	<u>18 (95)</u>	<u>-</u>
<u>Yes</u>	<u>2 (6)</u>	<u>1 (7)</u>	<u>1 (5)</u>	<u>-</u>
<u>Preoperative chemotherapy</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>0.057</u>
<u>No</u>	<u>23 (70)</u>	<u>7 (50)</u>	<u>16 (84)</u>	<u>-</u>
<u>Yes</u>	<u>10 (30)</u>	<u>7 (50)</u>	<u>3 (16)</u>	<u>-</u>
<u>Articular contamination (imaging)</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>0.37</u>
<u>No</u>	<u>5 (15)</u>	<u>1 (7)</u>	<u>4 (21)</u>	<u>-</u>
<u>Yes</u>	<u>28 (85)</u>	<u>13 (93)</u>	<u>15 (79)</u>	<u>-</u>

350

351

352

ASA Physical status score : American Society of Anaesthesiologists physical status classification

Table 2: Total number and ratio for each complication encounter from the procedure to the last follow-up for total population, proximal femur and pelvis tumors respectively

Variable	Total (N = 33)			Pelvis (N= 19)			Femur (N= 14)		
	No. Complication	No. Patient	% (range)	No. Complication	No. Patient	% (range)	No. Complication	No. Patient	% (range)
Revision surgeries any causes	29	17	51,5 %	22	13	68,4 %	7	4	28,6%
Mechanical complication	6	5	15,1 %	2	2	10,5 %	4	3	21,4 %
Dislocation reduced under anesthesia	3	3	9 %	0	0	0	3	3	21,4 %
Total dislocation	13	9	27,3 %	3	3	15,8 %	10	6	42,9%
Other mechanical revision	3	2	6 %	2	2	10,5 %	1	1	7,1 %
Total infection	12	9	27,3 %	10	8	42,1 %	2	1	7,1%
Wound surgeries	3	2	6 %	3	2	10,5 %	0	0	0 %
Deep infection	9	7	21,2 %	7	6	31,6 %	2	1	7,1 %
Local recurrence	7	4	12,1 %	7	4	21 %	0	0	0 %
Other surgeries	4	4	3 %	1	1	5,3 %	0	0	0
Neurological complication	2	2	6 %	2	2	10,5 %	0	0	0%
Hematoma	1	1	3 %	1	1	5,3 %	0	0	0
Parietal complication	1	1	3 %	1	1	5,3 %	0	0	0
Oncologic surgery	7	4	15,1 %	7	4	21 %	0	0	0 %
Per-operative complication	8	5	15,1 %	7	4	21 %	1	1	7,1%
Capsular effraction	8	8	24,2 %	2	2	10,5 %	6	6	42,9 %
Non R0 margin	3	3	9%	3	3	15,8%	0	0	0 %

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