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1 **Title:** Early outcomes of patella resurfacing in total knee arthroplasty.

2

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15 **Keywords**

16 Total Knee Arthroplasty, Patella, Resurfacing, Revision.

17

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28

29 **Abstract**

30

31 Background

32 Patella resurfacing in total knee arthroplasty is a contentious issue. Literature suggests  
33 resurfacing the patella is based on surgeon preference and little is known about the role and  
34 timing of resurfacing of the patella and how this affects outcomes.

35

36 Methods

37 We analysed 134,799 total knee arthroplasties using data from the Australian Orthopaedic  
38 Association National Joint Replacement Registry. Hazard ratios were used to compare rates of  
39 early revision between patella resurfacing at primary procedure (patella resurfacing group, or  
40 PRG) and primary arthroplasty without resurfacing (no patella resurfacing group, or NPRG). We  
41 also analysed the outcomes of NPRG that were revised for isolated patella addition.

42

43 Results

44 At five years, PRG showed a lower revision rate than NPRG, cumulative percent revision (CPR)  
45 3.1% and 4.0% respectively (HR=0.75,  $p<0.001$ ). Revisions for patello-femoral pain were more  
46 common in the NPRG (17%) than PRG (1%), and “patella only” revisions more common in NPRG  
47 (29%) than PRG (6%). Non-resurfaced knees revised for isolated patella addition had a higher  
48 revision rate than patella resurfacing at the primary, with the four year CPR 15.1% and 2.8%  
49 respectively (HR=4.11,  $p<0.001$ ).

50

51 Discussion

52 Rates of early revision of primary total knees were higher when the patella was not resurfaced  
53 and suggest that surgeons may be inclined to resurface later if there is patello-femoral pain.  
54 However, 15% of non-resurfaced knees revised for patella addition are re-revised by four years.  
55 Our results suggest an early beneficial outcome for patella resurfacing at primary arthroplasty  
56 based on revision rates up to five years.

**57 Introduction**

58

59 Patella resurfacing in total knee arthroplasty involves the replacement of the patella surface of the  
60 patello-femoral joint with a prosthesis. Early knee arthroplasty designs without patella resurfacing  
61 were associated with higher rates of patello-femoral problems including anterior knee pain,  
62 patella subluxation, and patella erosion (Insall et al. 1976). Aglietti et al. described the design of a  
63 patella component based on the area of articulation and loading in the cadaveric patello-femoral  
64 joint (Aglietti et al. 1975).

65

66 Resurfacing of the patella at primary surgery has always been a contentious issue and recent  
67 studies remain conflicting. Boyd suggested that replacement of the patella in patients with  
68 osteoarthritis and rheumatoid arthritis prevents early revision (Boyd et al. 1993). This was  
69 supported by Burnett (Burnett and Bourne, 2003) who analysed results from five randomised  
70 controlled trials (Schroeder-Boersch et al. 1988; Bourne et al. 1995; Feller et al. 1996; Barrack et  
71 al. 2001; Wood et al. 2002), and showed that of 451 knees having total arthroplasty, 11% without  
72 patella resurfacing required revision compared with 5% of knees with patella resurfacing. Anterior  
73 knee pain was the most common complication in the non-resurfaced groups (Burnett and Bourne,  
74 2003). These results have been supported by other literature suggesting resurfacing the patella  
75 leads to lower rates of revision (Forster 2004; Pakos et al. 2005; O Shea et al. 2006; Garneti et  
76 al. 2008), or increased patient satisfaction (Schroeder-Boersch et al. 1998; Mayman et al. 2003;  
77 Waters and Bentley 2003; Burnett et al. 2004; Gildone et al. 2005; Parvizi et al. 2005; Berti et al.  
78 2006; van Hemert et al. 2008). Despite promising results, other studies suggest that resurfacing  
79 the patella does not change rates of revision, patient satisfaction, or clinical outcomes (Grace and  
80 Sim 1988; Healy et al. 1995; Robertsson et al. 2000; Wood et al. 2002; Burnett et al. 2004; Wood  
81 et al. 2005; Campbell et al. 2006; Myles et al. 2006; Oztürk et al. 2006; Smith et al. 2006; Burnett  
82 et al. 2007; Epinette and Manley 2008; Smith et al. 2008). Most studies to date have been  
83 underpowered and the role of patella resurfacing in total knee arthroplasty is not clearly defined.

84

85 Whether to resurface the patella at primary surgery or as a subsequent reoperation is also  
86 unclear. Surgeons commonly believe that resurfacing as a secondary procedure is as beneficial  
87 as resurfacing at the initial operation. Surgeons who choose not to resurface the patella in the  
88 primary arthroplasty may consider it easy to resurface the patella later if the patient experiences  
89 complications such as patello-femoral pain. However, Khatod reports that only 52% of these  
90 patients will receive satisfactory results (Khatod et al. 2004), while Muoneke suggests only 45%  
91 of patients report improvement in knee pain with the addition of a patella button (Muoneke et al.  
92 2003). To date, there is no literature suggesting the revision rate is the same when resurfacing at  
93 primary or at revision, in the context of total knee arthroplasty.

94

95 Much of the literature concerning patella resurfacing in total knee arthroplasty report outcomes for  
96 osteoarthritis alone (Feller et al. 1996; Burnett et al. 2004; Campbell et al. 2006). Boyd suggests  
97 a beneficial outcome for resurfacing independent of the diagnosis (Boyd et al. 1993). Despite this,  
98 there has been no specific comparison of the outcomes of patella resurfacing by diagnosis and so  
99 the outcome of resurfacing the patella for different diagnoses remains uncertain.

100

101 Literature concerning patella resurfacing remains controversial. The purpose of our study was to  
102 use data from the Australian Orthopaedic Association (AOA) National Joint Replacement Registry  
103 (NJRR) to investigate the use of patella resurfacing in total knee arthroplasty. Registry data  
104 reflect current practice and includes a substantial number of total knee arthroplasties with and  
105 without the use of patella resurfacing.

106

## 107 **Materials and Methods**

108

109 Ethics approval was obtained from The Prince Charles Hospital Human Research and Ethics  
110 Committee prior to requesting data.

111

112 The purpose of the Commonwealth Government funded AOA NJRR is to improve the quality of  
113 care for patients undergoing joint replacement surgery. Similar registries exist in other countries,  
114 including the Swedish Knee Arthroplasty Register which has been in operation since 1976  
115 (Knutson et al. 1994). The AOA NJRR commenced data collection in 1999 and has collected full  
116 national data since mid 2002 with a greater than 97% capture rate. All 289 hospitals (public and  
117 private) currently undertaking joint replacement surgery in Australia provide information to the  
118 Registry. The 2007 Annual Report analysed 172,349 knee procedures performed between 1<sup>st</sup>  
119 September 1999 and 31<sup>st</sup> December 2006 of which 134,799 were total knee arthroplasties. Data  
120 obtained at the time of surgery include patient details, hospital, type of procedure, joint replaced,  
121 side (left or right), diagnosis and details of all components used. Although some identifying  
122 information including names are collected, no patient, surgeon, or hospital is identified in any data  
123 released by the AOA NJRR (Graves et al. 2004).

124

125 The main outcome reported by the Registry is time to first revision. As the Registry is still in its  
126 infancy, data reflect early rates of revision, although the very substantial number of procedures  
127 collected make the Registry a valuable source of information to compare outcomes (Graves et al.  
128 2004; Robertsson 2007).

129

### 130 **Statistical Methods**

131

132 The cumulative percent revision (CPR) of primary total knee arthroplasty at each of the first five  
133 years following implant was estimated using the Kaplan-Meier method. Primary interest was  
134 comparing revision rates between resurfaced patella at primary arthroplasty (patella resurfaced  
135 group, or PRG) and non-resurfaced patella at primary arthroplasty (no patella resurfacing group,  
136 or NPRG). Of secondary interest was the outcome of revision procedures after the primary  
137 arthroplasty (PRG and NPRG) where the components inserted at the time of revision surgery  
138 were the "patella only" or the "patella and insert" (and excluded "insert only"). Finally, revision  
139 rates for PRG and NPRG were compared between primary diagnosis of osteoarthritis and all

140 other diagnoses. Here “other diagnosis” refers to rheumatoid arthritis, other inflammatory arthritis,  
141 avascular necrosis, tumours, chondrocalcinosis, and other.

142

143 Unadjusted CPR are reported with 95% confidence intervals. Adjustment for age and sex was  
144 made, where appropriate, when comparing revisions over the entire period, using either log-rank  
145 tests or hazard ratios from proportional hazard models as appropriate. All tests are two-tailed at  
146 the 5% level of significance.

147

148 Descriptive analyses including primary diagnosis, reasons for revision and type of revision are  
149 also reported. Type of revision was categorised into major (involving femoral and/or tibial  
150 components) or minor (not involving femoral and/or tibial components).

151

152 Analysis was performed using SAS version 9.1 (SAS Institute Inc., Cary, NC, USA).

153

## 154 **Results**

155

156 Of the 134,799 primary total knee arthroplasties reported in the 2007 Annual Report, 57,359  
157 (42.6%) involved patella resurfacing. Of the PRG, 93.3% were cemented.

158

159 Primary total knee arthroplasty in PRG had a significantly lower revision rate than in the NPRG  
160 (adj HR=0.75, 95% CI: 0.69 to 0.80;  $p < 0.001$ ) (Figure 1). At five years the CPR of total knee  
161 procedures for PRG was 3.1% compared to 4.0% for NPRG (Table 1).

162

163 The most common reasons for revision in both groups were loosening and infection. However, in  
164 PRG, loosening (36.0%) and infection (26.7%) were more common than in NPRG (28.9%  
165 loosening, 18.6% infection) (Table 2). Conversely, in NPRG, patello-femoral pain (17.2%) and  
166 knee pain (12.9%) were more common reasons for revision than for PRG (1.1% patello-femoral  
167 pain, 7.0% knee pain) (Table 2).

168

169 Type of revision is shown in Table 3. There were 1,092 revisions of knees in PRG, of which 65  
170 were for isolated patella revision (6.0%) while 626 were for tibia and/or femoral components  
171 (57.3%). Major revisions in PRG constitute 1.2% of all procedures with patella resurfacing. There  
172 were 1,979 revisions of knees in NPRG, of which 566 were for isolated patella addition (28.6%)  
173 and 762 for tibia and/or femoral components (38.5%). Major revisions in the NPRG constitute  
174 1.1% of all procedures without patella resurfacing. Patients in PRG show a higher proportion of  
175 major revisions ( $p<0.001$ ), while NPRG show a higher proportion of minor revisions ( $p<0.001$ ).

176

177 There was a higher CPR in revisions for patella addition of NPRG than for PRG (adj HR=4.11,  
178 95% CI: 3.14 to 5.38,  $p<0.001$ ). At four years the CPR for PRG was 2.8% compared with 15.1%  
179 for NPRG revised for patella addition (Figure 2), the majority (74.2%) of these being for patello-  
180 femoral pain.

181

182 Diagnosis at primary arthroplasty was similar between groups, with 96.2% of PRG having  
183 osteoarthritis compared with 97.1% of NPRG. For NPRG, the five year CPR for the diagnosis of  
184 osteoarthritis was 4.9% and for other diagnoses was 4.0% (adj HR=1.1, 95% CI: 0.8 to 1.2;  
185  $p=0.690$ ). For PRG, the five year CPR for the diagnosis of osteoarthritis was 3.1% and for other  
186 diagnoses was 2.6% (adj HR=1.7, 95% CI: 1.2 to 2.4;  $p=0.003$ ) (Table 4). Other covariates  
187 including age at primary procedure, sex, and mean time to revision had no influence on revision  
188 rate between the diagnosis groups (Data not shown).

189

## 190 **Discussion**

191

192 The decision to resurface the patella has been a controversial topic in recent literature. We used  
193 Registry data obtained from the AOA NJRR to compare rates of early revision in patients with and  
194 without patella resurfacing. We have addressed the pitfall of many previous studies which have  
195 been underpowered to show any difference between rates of revision. The strengths of this study



196 include a large sample size, data reflecting current practice and incorporation of data from many  
197 centres including public and private. The limitations of this study are that the only outcome is the  
198 rate of revision, while other measures such as Knee Society scores, patient satisfaction, and  
199 extensor function are not available. There are also many implant types with different individual  
200 variations in design, and as such any discrepancy in outcomes of patella resurfacing from each  
201 individual design is not adjusted for. Data from the Registry reflect early revisions up to  
202 approximately five years.

203

204 Recent literature has proposed that revision rates are lower in patients who received patella  
205 resurfacing in total knee arthroplasty (Lindstrand et al. 2001; Forster 2004; Pakos et al. 2005; O  
206 Shea et al. 2006; Garneti et al. 2008). This has been confirmed in our study as we show PRG  
207 had a significantly lower revision rate than NPRG, with a hazard ratio of 0.75 ( $p < 0.001$ ).

208

209 Our results show patients in the NPRG are more likely to be revised for patello-femoral pain, and  
210 more likely to be revised with isolated patella addition. Surgeons may be more inclined to revise a  
211 non-resurfaced knee by secondary patella addition if the patient presents later with knee pain  
212 given that option is still available. While the aetiology of anterior knee pain following total knee  
213 arthroplasty is not proven, the interplay of forces on the patello-femoral joint is thought to be the  
214 culprit (Mochizuki and Schurman 1979). However, in patients where there are other causes for  
215 anterior knee pain (eg sub-clinical infection, component rotation, anatomical abnormality, patella  
216 maltracking), a tendency to offer patella addition may not correct the cause of pain or could lead  
217 to incorrect treatment and the need for further major re-revision. Sharkey discussed the concept  
218 of failing total knee arthroplasties and highlights that early failure can be due to a number of  
219 mechanisms (Sharkey et al. 2002). In approximately 8% of patients who are generally dissatisfied  
220 with their knee arthroplasty (Robertsson et al. 2000), the ability to offer a minor revision in the  
221 absence of a diagnosis may further increase the rate of early revision.

222

223 We show higher re-revision rates in NPRG with isolated patella addition, compared with revision  
224 rates of PRG. The four year cumulative percent revision for NPRG with patella addition was  
225 15.1%, with most revisions for loosening and infection requiring major re-revision. These results  
226 suggest patella resurfacing is more effective in terms of early revision when performed at the  
227 primary arthroplasty, rather than at the first revision. We support literature suggesting isolated  
228 patella addition in the non-resurfaced knee is associated with poor clinical outcomes and high  
229 rates of re-revision (Berry and Rand 1993 ; Leopold et al. 2003; Muoneke et al. 2003; Khatod et  
230 al. 2004), although this is the first study to compare primary and revision outcomes of patella  
231 resurfacing.

232

233 We identified a significantly higher proportion of major revisions compared to minor in PRG, and  
234 minor revisions compared to major in NPRG, with a higher proportion of revisions for loosening  
235 and infection in PRG compared to NPRG. These rates support early data from the Swedish Knee  
236 Arthroplasty Register (Robertsson et al. 2001). Major revisions tend to occur later in PRG  
237 compared with revisions in the NPRG. Although these results were significant, the difference is  
238 likely related to a tendency to offer minor revisions to NPRG as mentioned previously, particularly  
239 in the generally dissatisfied patient. A relatively simple patella addition is not available for PRG  
240 and as such surgeons may be inclined to wait and operate later with a major revision. This could  
241 account for both the lower proportion of major revisions and the lower proportion of loosening and  
242 infection (rather than patello-femoral pain) in the NPRG. As the Registry does not collect data on  
243 operation time or the use of other infection control measures, we are unable to report on whether  
244 there is a the link between operation time and infection rates when resurfacing the patella, at the  
245 primary procedure however this presents a direction for further research.

246

247 It remains to be seen whether early outcomes will be analogous with long term outcomes. Current  
248 data is only available up to approximately five years, and the possibility of patella resurfacing  
249 having an adverse long-term effect on major components cannot be excluded without ongoing  
250 data collection and further analysis. In addition, the integrity of the patella and its implanted button

251 is also a long-term issue that remains to present itself, and patella-related outcomes should be  
252 explored when further data becomes available. Given the close relationship between patella-  
253 related outcomes from the Australian and Swedish Registries, it is possible that Australian long  
254 term outcomes could mirror that of Swedish outcomes. Current data up to ten years from the  
255 Swedish Knee Arthroplasty Register 2007 Annual Report show that for patella implants  
256 performed since 1996, non-resurfacing is associated with a 1.3 times higher cumulative revision  
257 rate than for resurfacing in the setting of osteoarthritis, and 1.9 times higher for rheumatoid  
258 arthritis. The authors suggest this is directly related to the need for secondary patella resurfacing  
259 because of patello-femoral pain.(Robertsson and Lidgren 2007) These promising results suggest  
260 that the mechanical forces of the patella prosthesis may not affect tibial or femoral components in  
261 the mid-to-long term and present an ideal opportunity for follow-up in the future.

262

263 Osteoarthritis is currently the major reason for total knee arthroplasty performed in Australia,  
264 making up 96.7% of initial diagnoses. We show that the five year CPR is lower in PRG in the  
265 setting of both osteoarthritis and other diagnoses. These figures in the setting of other diagnoses  
266 (such as rheumatoid arthritis) support data from the Swedish Knee Arthroplasty Register  
267 (Robertsson and Lidgren 2007), however much of the published literature has yet to show a  
268 difference in outcomes for resurfaced patella in terms of revision rates (Shoji et al. 1989; Kajino et  
269 al. 1997; Moran and Horton 2000; Gioe et al. 2007). Potentially confounding factors such as age,  
270 gender, and mean time to revision did not affect our results.

271

272 Our study defines both “patella only” and “insert and patella” as patella additions, and this  
273 accounts for surgeons who may routinely change the insert at revision. Revision procedures for  
274 “insert only” do not fall under our analysis. Our data suggest that there is no difference in the  
275 revision rate of “insert and patella” compared to “patella only” revisions, and both “insert and  
276 patella” and “patella only” revisions in the NPRG have a higher revision rate compared to PRG  
277 ( $p<0.001$  and  $p<0.001$  respectively) (data not shown).

278

279 **Conclusions**

280

281 Our study uses data from the AOA NJRR to compare the rate of early revision in total knee  
282 arthroplasty with and without patella resurfacing at primary surgery. This allowed for evaluation of  
283 134,799 primary total knee arthroplasties performed since 1999.

284

285 We show patella resurfacing in total knee arthroplasty leads to lower rates of early revision. We  
286 also show non-resurfaced knees revised for patella addition have a higher revision rate than  
287 when resurfacing at primary. We suggest secondary patella addition is not a trivial procedure in  
288 terms of early outcomes, as 15% are re-revised by four years. Our results suggest a beneficial  
289 outcome for primary patella resurfacing independent of traditional indications and initial diagnosis.

290

291 These results support recent literature, however further evaluation of long term rates of revision  
292 and functional outcomes (Knee Society scores and patient satisfaction) will help to clarify the  
293 topic. Promising correlations between national registries' warrant further investigation and  
294 comparison.

295

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297

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420 total knee arthroplasty with and without patellar resurfacing: A prospective randomised  
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- 424

425 **Table 1: Yearly Cumulative Percent Revision of Primary Total Knee Arthroplasty by Patella**426 **Resurfacing**

<b>Patella Resurfacing at Primary</b>	<b>CPR 1yr</b>	<b>CPR 2yrs</b>	<b>CPR 3yrs</b>	<b>CPR 4yrs</b>	<b>CPR 5yrs</b>
Non Resurfaced Patella	1.2 (1.1, 1.2)	2.5 (2.3, 2.6)	3.1 (3.0, 3.3)	3.6 (3.5, 3.8)	4.0 (3.9, 4.3)
Resurfaced Patella	0.9 (0.8, 1.0)	1.7 (1.6, 1.9)	2.3 (2.1, 2.4)	2.8 (2.6, 3.0)	3.1 (2.9, 3.3)

427

428 **Table 2: Reason for Revision of Primary Total Knee Arthroplasty by Patella Resurfacing**

<b>Reason for Revision</b>	<b>Non Resurfaced Patella</b>		<b>Resurfaced Patella</b>		<b>Total</b>	
	<b>N</b>	<b>Col%</b>	<b>N</b>	<b>Col%</b>	<b>N</b>	<b>Col%</b>
Loosening	606	28.9	421	36.0	1027	31.4
Infection	389	18.6	323	27.6	712	21.8
Patello-femoral pain	361	17.2	13	1.1	374	11.4
Pain	270	12.9	82	7.0	352	10.8
Instability	97	4.6	59	5.0	156	4.8
Arthrofibrosis	78	3.7	55	4.7	133	4.1
Fracture	37	1.8	45	3.8	82	2.5
Malalignment	38	1.8	27	2.3	65	2.0
Dislocation	14	0.7	10	0.9	24	0.7
Patella maltracking	15	0.7	7	0.6	22	0.7
Wear patella	19	0.9	1	0.1	20	0.6
Bearing/dislocation	10	0.5	9	0.8	19	0.6
Other	163	7.8	119	10.2	282	8.6
<b>Total</b>	<b>2097</b>	<b>100</b>	<b>1171</b>	<b>100</b>	<b>3268</b>	<b>100</b>

429 **Note:** some patients have multiple diagnoses

430

431 **Table 3: Type of Revision for Primary Total Knee Arthroplasty comparing the use of**  
 432 **Patella Resurfacing**

433

Type of revision	Non Resurfaced Patella		Resurfaced Patella		Total	
	N	Col%	N	Col%	N	Col%
Tibial and Femoral	336	17.0	340	31.1	676	22.0
Patella Only	566	28.6	65	6.0	631	20.5
Insert Only	323	16.3	277	25.4	600	19.5
Tibial Only	184	9.3	172	15.8	356	11.6
Femoral Only	242	12.2	114	10.4	356	11.6
Insert and Patella	214	10.8	19	1.7	233	7.6
Cement spacer	73	3.7	71	6.5	144	4.7
Other minor components	20	1.0	15	1.4	35	1.1
Removal of Prostheses	19	1.0	15	1.4	34	1.1
Fusion Nail	1	0.1	2	0.2	3	0.1
Reinsertion of components	1	0.1	2	0.2	3	0.1
<b>Total</b>	<b>1979</b>	<b>100</b>	<b>1092</b>	<b>100</b>	<b>3071</b>	<b>100</b>

434

435 **Table 4: Yearly Cumulative Percent Revision of Primary Total Knee Arthroplasty by**  
 436 **Patella Resurfacing and Primary Diagnosis**

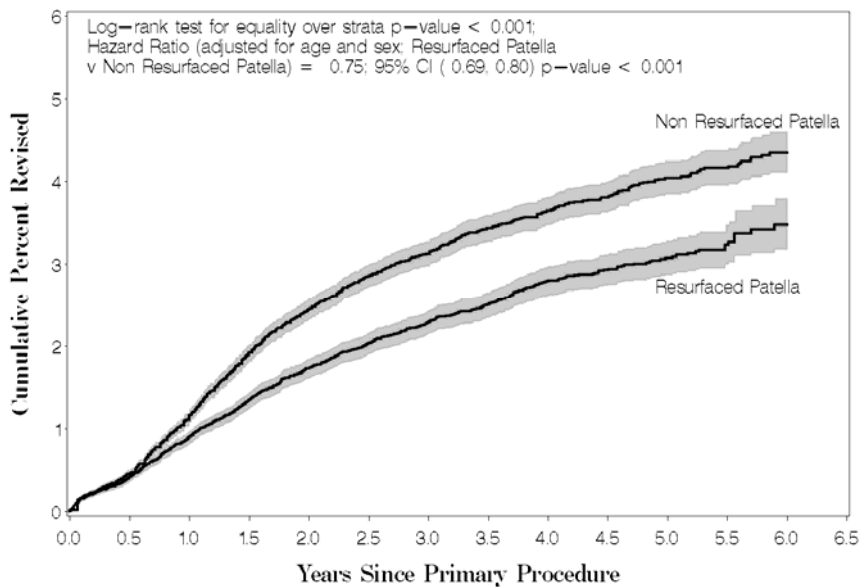
Patella Usage	Primary Diagnosis	CPR 1yr	CPR 2yrs	CPR 3yrs	CPR 4yrs	CPR 5yrs
Non Resurfaced Patella	Osteoarthritis	1.2 (1.1, 1.2)	2.4 (2.3, 2.6)	3.1 (3.0, 3.3)	3.6 (3.4, 3.8)	4.0 (3.8, 4.2)
Non Resurfaced Patella	Other Diagnosis	1.2 (0.8, 1.8)	2.9 (2.2, 3.8)	3.5 (2.7, 4.5)	4.5 (3.5, 5.7)	4.9 (3.8, 6.3)
Resurfaced Patella	Osteoarthritis	0.9 (0.8, 1.0)	1.8 (1.6, 1.9)	2.3 (2.2, 2.5)	2.8 (2.6, 3.0)	3.1 (2.9, 3.3)
Resurfaced Patella	Other Diagnosis	0.5 (0.3, 0.9)	1.1 (0.7, 1.7)	1.7 (1.2, 2.5)	2.2 (1.5, 3.2)	2.6 (1.8, 3.9)

437

438

439 **Figure 1: Cumulative Percent Revision of Primary Total Knee Arthroplasty by Patella**

440 **Resurfacing**

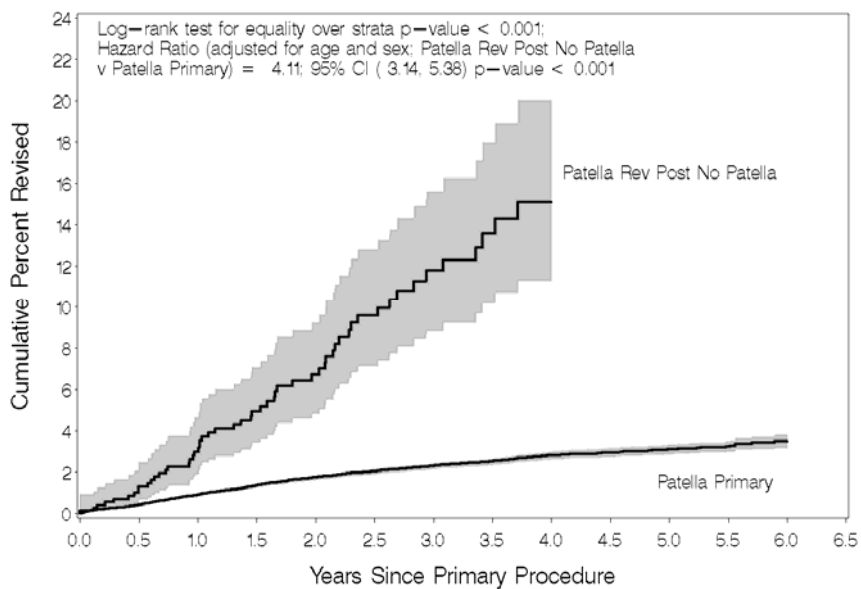


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442

443 **Figure 2: Cumulative Percent Revision comparing Patella Resurfacing at Primary with**

444 **Non-resurfacing at Primary revised for Patella Resurfacing**



445

446

447 **Ethics approval**

448 Ethics approval was obtained from The Prince Charles Hospital Human Research and Ethics  
449 Committee prior to requesting data from the AOA NJRR.

450

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454

455 **Contributions of authors**

456 Warren Clements conceived the study and drafted the manuscript

457 Lisa Miller performed statistical analysis and drafted the manuscript

458 Sarah Whitehouse conceived the study, performed statistical analysis and drafted the manuscript

459 Stephen Graves drafted the manuscript

460 Philip Ryan drafted the manuscript

461 Ross Crawford conceived the study and drafted the manuscript

462

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466

467 **Conflicts of interest**

468 There were no financial or other conflicts of interest in this study.