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

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Abstract

Background

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

Methods

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

Results

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

Discussion

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

Introduction

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

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

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

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

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

Materials and Methods

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

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

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

Statistical Methods

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

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

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

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

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

Results

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

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

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

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

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

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

Discussion

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

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

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

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

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

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

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

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

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

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

Conclusions

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

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

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

References

Aglietti, P., J. N. Insall, P. S. Walker and P. Trent (1975). "A new patella prosthesis. Design and application." Clin Orthop Relat Res.(107): 175-187.

Barrack, R. L., A. J. Bertot, M. W. Wolfe, D. A. Waldman, M. Milicic and L. Myers (2001). "Patellar resurfacing in total knee arthroplasty. A prospective, randomized, double-blind study with five to seven years of follow-up." J Bone Joint Surg Am.(83): 1376-81.

Berry, D. J. and J. A. Rand (1993). "Isolated patellar component revision of total knee arthroplasty." Clin Orthop Relat Res. **286**: 110-5.

Berti, L., M. G. Benedetti, A. Ensini, F. Catani and S. Giannini (2006). "Clinical and biomechanical assessment of patella resurfacing in total knee arthroplasty." Clinical Biomechanics (Bristol, Avon) **21**(6): 610-616.

Bourne, R. B., C. H. Rorabeck, M. Vaz, J. Kramer, R. Hardie and D. Robertson (1995). "Resurfacing versus not resurfacing the patella during total knee replacement." Clin Orthop Relat Res.(321): 156-61.

Boyd, A. D., F. C. Ewald, W. H. Thomas, R. Poss and C. B. Sledge (1993). "Long-term complications after total knee arthroplasty with or without resurfacing of the patella." J Bone Joint Surg Am **75**(5): 674-681.

Burnett, R., K. P. McCarthy, J. L. Boone, R. Seth and L. B. Robert (2007). "A Prospective, Double-Blind, Randomized, Controlled Trial of Patellar Resurfacing in Bilateral Total Knee Arthroplasty: A Minimum 10-Year Follow-Up Study." J Arthroplasty **22**(2): 306.

Burnett, R. S. and R. B. Bourne (2003). "Indications for Patellar Resurfacing in Total Knee Arthroplasty." J Bone Joint Surg Am **85**(4): 728-745.

Burnett, R. S., C. M. Haydon, C. H. Rorabeck and R. B. Bourne (2004). "Patella resurfacing versus nonresurfacing in total knee arthroplasty: results of a randomized controlled clinical trial at a minimum of 10 years' followup." Clin Orthop Relat Res. **Nov**(428): 12-25.

322 Campbell, D. G., W. W. Duncan, M. Ashworth, A. Mintz, J. Stirling, L. Wakefield and T. M.
323 Stevenson (2006). "Patellar resurfacing in total knee replacement: A TEN-YEAR
324 RANDOMISED PROSPECTIVE TRIAL." J Bone Joint Surg Br **88-B**(6): 734-739.
325 Epinette, J. A. and M. T. Manley (2008). "Outcomes of Patellar Resurfacing Versus
326 Nonresurfacing in Total Knee Arthroplasty." J Knee Surg. **21**: 293-298.
327 Feller, J. A., R. J. Bartlett and D. M. Lang (1996). "Patellar resurfacing versus retention in total
328 knee arthroplasty." J Bone Joint Surg Br. (78): 226-8.
329 Forster, M. C. (2004). "Patellar resurfacing in total knee arthroplasty for osteoarthritis: a
330 systematic review." The Knee **11**(6): 427-30.
331 Garneti, N., D. Mahadeva, A. Khalil and C. A. McLaren (2008). "Patellar resurfacing versus no
332 resurfacing in Scorpio total knee arthroplasty." J Knee Surg. **Apr 21**(2): 97-100.
333 Gildone, G., M. Manfredini, R. Biscione and R. Faccini (2005). "Patella resurfacing in posterior
334 stabilised total knee arthroplasty: a follow-up study in 56 patients." Acta Orthop Belg.
335 **71**(4): 445-51.
336 Gioe, T. J., C. Novak, P. Sinner, W. Ma and S. Mehle (2007). "Knee arthroplasty in the young
337 patient: survival in a community registry." Clin Orthop Relat Res. **464**(Nov): 83-7.
338 Grace, J. N. and F. H. Sim (1988). "Fracture of the patella after total knee arthroplasty." Clin
339 Orthop Relat Res. **May**(230): 168-75.
340 Graves, S. E., D. Davidson, L. Ingerson, P. Ryan, E. C. Griffith, B. F. J. McDermott, H. J. McElroy
341 and N. L. Pratt (2004). "The Australian Orthopaedic Association National Joint
342 Replacement Registry." The Medical Journal of Australia **March**(180): 31-34.
343 Healy, W. L., S. A. Wasilewski, R. Takei and M. Oberlander (1995). "Patellofemoral complications
344 following total knee arthroplasty. Correlation with implant design and patient risk factors."
345 J Arthroplasty. **Apr, 10**(2): 197-201.
346 Insall, J. N., C. S. Ranawat, P. Aglietti and J. Shine (1976). "A comparison of four models of total
347 knee-replacement prostheses." J Bone Joint Surg Am **58**(6): 754-765.

348 Kajino, A., S. I. Yoshino, S. Kameyama, M. Kohda and S. Nagashima (1997). "Comparison of the
349 Results of Bilateral Total Knee Arthroplasty with and without Patellar Replacement for
350 Rheumatoid Arthritis. A Follow-up Note." J Bone Joint Surg Am **79**(4): 570-4.
351 Khatod, M., M. Codsi and B. Bierbaum (2004). "Results of resurfacing a native patella in patients
352 with a painful total knee arthroplasty." J Knee Surg. **17**(3): 151-5.
353 Knutson, K., S. Lewold, O. Robertsson and L. Lidgren (1994). "The Swedish knee arthroplasty
354 register. A nation-wide study of 30,003 knees 1976-1992." Acta Orthop Scand. **65**(4):
355 375-86.
356 Leopold, S. S., C. D. Silverton, R. M. Barden and A. G. Rosenberg (2003). "Isolated Revision of
357 the Patellar Component in Total Knee Arthroplasty." J Bone Joint Surg Am **85**(1): 41-47.
358 Lindstrand, A., O. Robertsson, S. Lewold and S. Toksvig-Larsen (2001). "The patella in total knee
359 arthroplasty: resurfacing or nonresurfacing of patella." Knee Surg Sports Traumatol
360 Arthrosc. **9**(Suppl 1): S21-3.
361 Mayman, D., R. B. Bourne, C. H. Rorabeck, M. Vaz and J. Kramer (2003). "Resurfacing versus
362 not resurfacing the patella in total knee arthroplasty: 8- to 10-year results1 1 No benefits
363 or funds were received in support of this study." The Journal of arthroplasty **18**(5): 541-
364 545.
365 Mochizuki, R. M. and D. J. Schurman (1979). "Patellar complications following total knee
366 arthroplasty." J Bone Joint Surg Am **61**(6): 879-883.
367 Moran, C. G. and T. C. Horton (2000). "Total knee replacement: the joint of the decade." BMJ
368 **March** (320): 820.
369 Muoneke, H. E., A. M. Khan, K. A. Giannikas, E. Hägglund and T. H. Dunningham (2003).
370 "Secondary resurfacing of the patella for persistent anterior knee pain after primary knee
371 arthroplasty." J Bone Joint Surg Br **85**(5): 675-8.
372 Myles, C. M., P. J. Rowe, R. W. Nutton and R. Burnett (2006). "The effect of patella resurfacing in
373 total knee arthroplasty on functional range of movement measured by flexible
374 electrogoniometry." Clinical biomechanics (Bristol, Avon) **21**(7): 733-739.

O Shea, K., E. Bale and P. Murray (2006). "Prospective randomised comparison of patellar resurfacing versus non-resurfacing in primary total knee replacement." J Bone Joint Surg Br **88-B**(SUPP_I): 28-b-.

Oztürk, A., S. Bilgen, T. Atici, O. Ozer and O. F. Bilgen (2006). "The evaluation of patients undergoing total knee arthroplasty with or without patellar resurfacing." Acta Orthop Traumatol Turc **40**(1): 29-37.

Pakos, E. E., E. E. Ntzani and T. A. Trikalinos (2005). "Patellar Resurfacing in Total Knee Arthroplasty. A Meta-Analysis." J Bone Joint Surg Am **87**(7): 1438-1445.

Parvizi, J., V. R. Rapuri, K. J. Saleh, M. A. Kuskowski, P. F. Sharkey and M. A. Mont (2005). "Failure to resurface the patella during total knee arthroplasty may result in more knee pain and secondary surgery." Clin Orthop Relat Res. **Sep**(438): 191-6.

Robertsson, O. (2007). "Knee arthroplasty registers." J Bone Joint Surg Br **89-B**(1): 1-4.

Robertsson, O., M. Dunbar, T. Pehrsson, K. Knutson and L. Lidgren (2000). "Patient satisfaction after knee arthroplasty: A report on 27,372 knees operated on between 1981 and 1995 in Sweden." Acta Orthopaedica Scandinavica **71**: 262-267.

Robertsson, O., K. Knutson, S. Lewold and L. Lidgren (2001). "The Swedish Knee Arthroplasty Register 1975-1997: An update with special emphasis on 41,223 knees operated on in 1988-1997." Acta Orthopaedica **72**(5): 503-13.

Robertsson, O. and L. Lidgren (2007). Annual Report 2007, The Swedish Knee Arthroplasty Register, Department of Orthopaedics, Lund University Hospital**:** 9-13.

Schroeder-Boersch, H., G. Scheller, J. Fischer and L. Jani (1998). "Advantages of patellar resurfacing in total knee arthroplasty. Two-year results of a prospective randomized study." Arch Orthop Trauma Surg.(117): 73-8.

Schroeder-Boersch, H., G. Scheller, M. Synnatschke, P. Arnold and L. Jani (1988). "Patellar resurfacing. Results of a prospective randomized study." Orthopadeics(27): 642-50.

Sharkey, P. F., W. J. Hozack, R. H. Rothman, S. Shastri and S. M. Jacoby (2002). "Why are total knee arthroplasties failing today?" Clin Orthop Relat Res. **Nov**(404): 7-13.

Shoji, H., S. Yoshino and A. Kajino (1989). "Patellar replacement in bilateral total knee arthroplasty. A study of patients who had rheumatoid arthritis and no gross deformity of the patella." J Bone Joint Surg Am **71**(6): 853-856.

Smith, A. J., D. G. Lloyd and D. J. Wood (2006). "A kinematic and kinetic analysis of walking after total knee arthroplasty with and without patellar resurfacing." Clinical biomechanics (Bristol, Avon) **21**(4): 379-386.

Smith, A. J., D. J. Wood and M. G. Li (2008). "Total knee replacement with and without patellar resurfacing: a prospective, randomised trial using the profix total knee system." J Bone Joint Surg Br. **90**(1): 43-9.

van Hemert, W. L., R. Senden, B. Grimm, A. D. Kester, M. J. van der Linde and I. C. Heyligers (2008). "Patella retention versus replacement in total knee arthroplasty; functional and clinimetric aspects." Arch Orthop Trauma Surg. **May**.

Waters, T. S. and G. Bentley (2003). "Patellar Resurfacing in Total Knee Arthroplasty: A Prospective, Randomized Study." J Bone Joint Surg Am **85**(2): 212-217.

Wood, D. J., A. J. Smith, D. Collopy, B. White, B. Brankov and M. K. Bulsara (2002). "Patellar Resurfacing in Total Knee Arthroplasty : A Prospective, Randomized Trial." J Bone Joint Surg Am **84**(2): 187-193.

Wood, D. J., A. J. Smith and D. G. Lloyd (2005). "Clinical outcomes and walking analysis after total knee arthroplasty with and without patellar resurfacing: A prospective randomised trial." J Bone Joint Surg Br **87-B**(SUPP_III): 338-e-339.

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

426 **Resurfacing**

Patella Resurfacing at Primary	CPR 1yr	CPR 2yrs	CPR 3yrs	CPR 4yrs	CPR 5yrs
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)

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

Reason for Revision	Non Resurfaced Patella		Resurfaced Patella		Total	
	N	Col%	N	Col%	N	Col%
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
Total	**2097**	**100**	**1171**	**100**	**3268**	**100**

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

430

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

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
Total	**1979**	**100**	**1092**	**100**	**3071**	**100**

Table 4: Yearly Cumulative Percent Revision of Primary Total Knee Arthroplasty by 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)

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

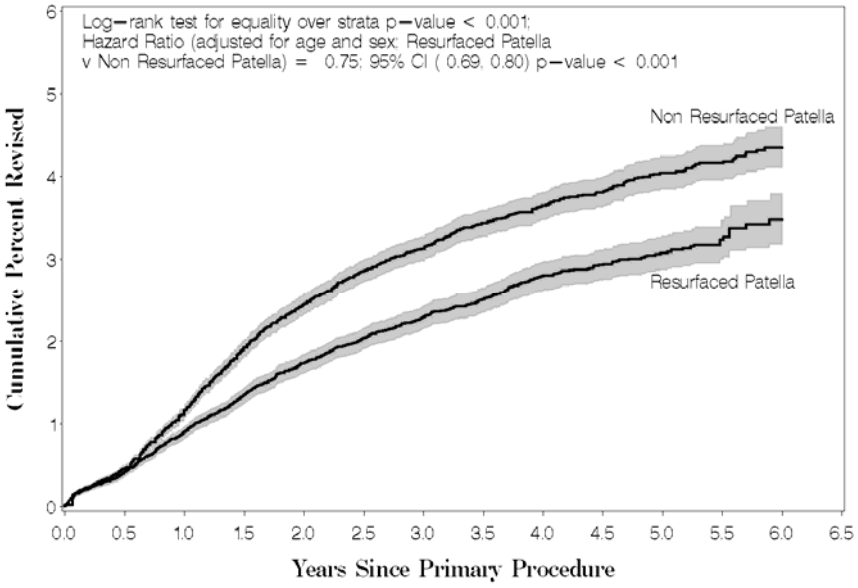
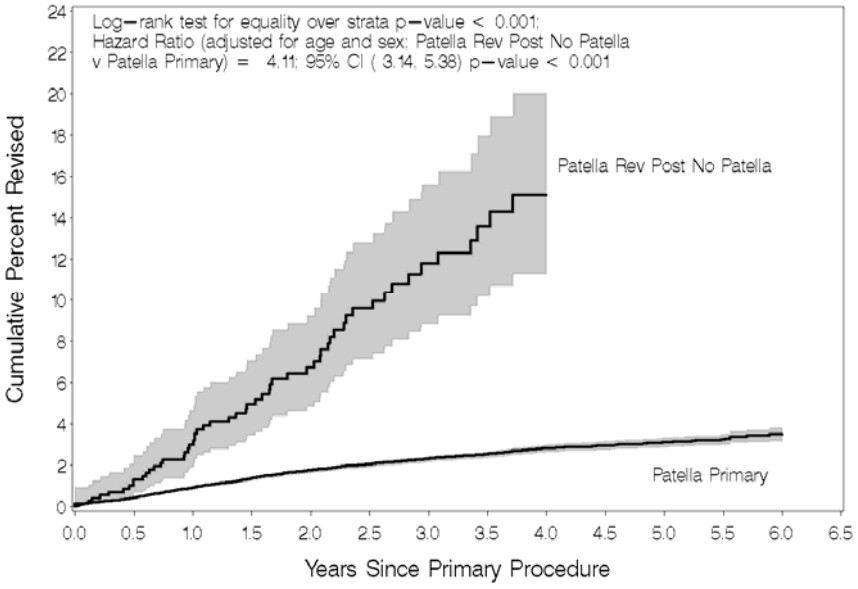


Figure 2: Cumulative Percent Revision comparing Patella Resurfacing at Primary with Non-resurfacing at Primary revised for Patella Resurfacing



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
451 Approval number: EC2799
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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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467 **Conflicts of interest**

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