The role of patella resurfacing in total knee arthroplasty

INTRODUCTION

For decades, the role of patella resurfacing in total knee arthroplasty (TKA) has been extensively debated and investigated, with randomized control trials (RCTs), meta-analyses, and registry-based studies being conducted.[1-9] Despite this, there is still no consensus on whether the patella should itself be resurfaced. It is clear that surgeons remain divided into three broad camps, with some surgeons always resurfacing, others never resurfacing, and the third group only selectively resurfacing on a case-by-case basis. This review article will summarize the factors that influence the decision to resurface the patella, the indications for resurfacing, the potential complications, and the outcomes after resurfacing the patella.

GEOGRAPHICAL VARIATION

There is great variety in surgical practice between Europe, the United States, and Asia, with the average rate of resurfacing between 2004 and 2014 ranging from 4% in Norway to 82% in the United States.[10] The vast majority of American surgeons routinely resurface the patella, whereas in Europe, there is a mixture of practice.[11] Using national joint registry data, in Denmark, over 70% of TKAs have a patella button compared with only 2% in Norway; in England and Wales, the figure is around 30%.[12] A survey of 619 UK surgeons showed that 28% always resurfaced, 24% never resurfaced, and 48% sometimes resurfaced.[13] The reasons why surgeons would routinely choose to resurface the patella in TKA are varied. There is a lower rate of anterior knee pain after patella resurfacing. Second, patella resurfacing intuitively makes sense in patients who present with primarily anterior knee pain secondary to patella-femoral arthritis and who are having a TKA, or who have inflammatory arthritis as the primary diagnosis. In Asia, the practice of routinely resurfacing the patella is uncommon, although the exact percentage of TKAs that have a patella resurfacing is unclear. There are a range of possible explanations for this observed discrepancy; however, this lower likelihood of patella resurfacing in Asia is most likely due to differences in patella anatomy in Asian patients, who tend to be smaller in stature with thinner patella thickness.[14] Furthermore, there is the introduction of added costs with patella resurfacing, and in certain Asian health economies, patients have to pay for their implants.[11] Finally, the education and training of surgeons in Asia greatly influences the decision to resurface the patella or not, although this is equally applicable to surgeons elsewhere in the world.

AGE OF PATIENT

Some surgeons selectively resurface the patella in the older patient group and leave the patella in younger patients. The rationale behind this relates to the fact that younger patients who have a TKA may need a revision TKA in the future and, unless otherwise indicated, it is probably better to leave the patella unresurfaced at the time of the primary operation. The evidence regarding the influence of age on the outcome of patella resurfacing is very limited. The Knee Arthroplasty Trial (KAT), in a subgroup analysis, showed no clinical difference in Oxford Knee Scores between patients who underwent resurfacing and were aged over 70 years compared with patients who were younger.[3]

INFLAMMATORY ARTHRITIS

Traditional, accepted orthopaedic teaching would suggest that in patients with inflammatory arthritis, the patella should be resurfaced in order to remove a potential antigenic source for recurrent inflammatory synovial hypertrophy originating from the retained articular cartilage of the native patella.[15,16] In addition, inflammatory arthritis patients often have poor patellar tracking and limited flexion preoperatively, often with significant valgus knee deformities.[15] However, the evidence base for resurfacing in this circumstance is limited. Other studies have shown that in patients with rheumatoid arthritis, preserving the native patella has shown

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similarly good outcome in terms of anterior knee pain compared with cases where the patella has been resurfaced.[15,17] It should be remembered that RA patients often have severely osteoporotic bone with a very thin patella, and the surgeon needs to be mindful of the greater risk of fracture when choosing to resurface the patella. The decision to resurface the patella in RA patients may be more related to the use of a posterior-stabilized TKA because of the poor quality of the soft tissues, ligaments, and bone rather than the presence of an inflammatory arthritis itself.

COMPONENT SIZING AND ORIENTATION

The significance of appropriate component positioning and sizing cannot be overstated. The most important consideration is that of femoral and tibial component rotation. In a landmark study using CT axial imaging to determine component rotation after TKA, Berger et al[18] demonstrated that combined internal rotation of the components had a direct negative effect on patellar tracking. In the most severe cases (internal rotation 7° to 17°), this led to patella dislocation and implant loosening. Internal rotation of the tibial component causes the tibia to be externally rotated in relation to the femur, which, in turn, causes the tibial tubercle to be lateralized, increasing the Q-angle and leading to patella mal-tracking and instability.[18] Other considerations include the component sizing, position, and alignment. Component sizing in the anteroposterior and mediolateral planes is important to avoid overhang of the component or overstuffing of the patellofemoral joint. This can lead to patella mal-tracking and persistent pain. Malalignment of the femoral component (>7° valgus) or overall limb alignment (>10° valgus) can lead to patella mal-tracking as a result of the increased Q-angle.[5,6]

IMPLANT DESIGN

The design of the implant itself is critical in the decision as to whether or not the surgeon should resurface the patella as routine.[16,17] There are 'patella-friendly' femoral component designs that accommodate the native patella well and 'patella-unfriendly' designs that necessitate patella resurfacing.[19] Patella-friendly implant designs tend to incorporate an asymmetrical, deeper trochlea groove with proximal extension of the femoral flange, providing better congruency with the native patella.[19,20] In contrast, patella unfriendly designs tend to have flatter femoral condyles and narrow, angular trochlea grooves.[1,21] Use of a patella-friendly implant design has been shown to reduce the incidence of reoperation for patellofemoral joint complications, from 12% to 1.2%, when the patella is not resurfaced.[19] In a study from Belfast, O'Brien et al[22] showed that patella resurfacing using the Low Contact Stress (LCS) mobile-bearing TKA (DePuy Synthes, Warsaw, Indiana) was not required and only nine knees (1.5%) out of 600 needed secondary patella resurfacing for anterior knee pain. The LCS has a deep sulcus designed to articulate well with the native patella and is a patella-friendly design. Interestingly, taking this concept a little further, a meta-analysis of 7075 cases by Pavlou et al[5] did not find any difference in reoperation rates between patella-friendly and patella-unfriendly TKA designs. However, the definition of a patella-friendly implant used in their study was quite broad and therefore may have included implants that were not necessarily as suited to articulating with the native patella as some other implant designs. Attention must also be given to ensuring that the anterior space of the patellofemoral joint is sufficient to avoid overstuffing the joint. If the design of the femoral component trochlea is flat and the proximal extension of the femoral flange is thick and bulky, thereby reducing the anterior space, then patella resurfacing should be considered. Resurfacing the patella to restore the native amount of anterior space, by using the appropriate patella button thickness, will help avoid adverse biomechanical and functional problems.[23] The use of a posterior-stabilized (PS) TKA is another indication for resurfacing the patella in order to reduce the risk of patellar clunk syndrome, a complication associated with the use of PS designs.[24]. Anterior knee pain and patella femoral crepitus may also be an issue if the patella is not resurfaced when using a PS design TKA.[25] The soft tissues or proximal pole of the non-resurfaced patella may become caught in the more proximally positioned box of a PS design during extension of the knee, leading to impingement-type symptoms.[26] Finally, the influence of single-radius (SR) designed femoral components *versus* multi-radius (MR) components and the need to resurface the patella is unknown. The single-radius design exhibits the same femoral radius from extension through to flexion (a single radius of curvature). A multi-radius design incorporates multiple discrete points of radii with a distal broader radius in knee extension transitioning to a smaller posterior radius with the knee in flexion. The theoretical advantages of the SR design include less patella loading and improved quadriceps efficiency as a result of having a more posteriorly located centre of rotation, thereby increasing the moment arm of the patella tendon. In a prospective RCT, a SR-designed TKA (Triathlon, Stryker, Kalamazoo, Michigan) was compared with a MR-designed TKA (PFC, DePuy Synthes) but there were no measurable differences in quadriceps function and recovery at one year postoperatively.[27] The authors were unable to comment on the need to resurface the patella based on component design as selective patella resurfacing was undertaken based on age of the patient (over 60 years), degree of patella arthritis (grade 3 or higher), anterior knee pain, and native patella thickness (>20 mm) but not SR *versus* MR designs.[27]

DESIGN OF PATELLA BUTTONS

There is a huge variety of different patella button shapes available, ranging from a simple dome design to the anatomical design. Patella buttons can be cemented or uncemented, metal-backed or purely polyethylene, and centralized or lateralized. Some of the commercially available patella buttons are shown in Figure 1. The commonest patella button designs, together with their corresponding femoral components, are shown in Figure 2. In this photograph, the

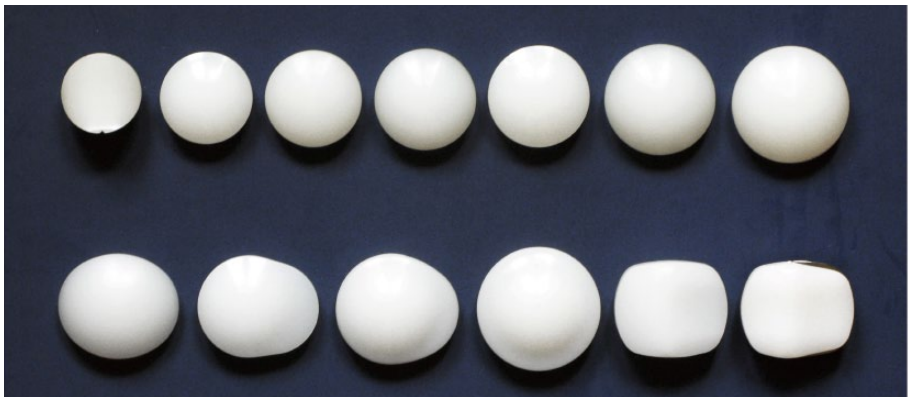

Fig. 1a

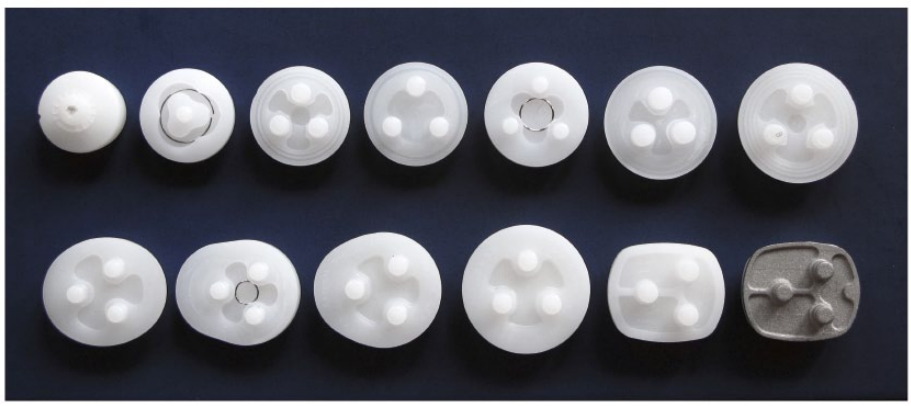

Fig. 1b

Fig. 1 A selection of commercially available patellar components. a) Articulating surface and b) retropatellar surface. Top row of a) and b), from left to right: Medial Rotation Knee (MRK; Finsbury Orthopaedics, Leatherhead, Surrey, United Kingdom); Genesis II (biconvex; Smith & Nephew, London, United Kingdom); Vanguard (Zimmer Biomet, Warsaw, Indiana); Optetrak (Exactech, Gainesville, Florida); Genesis II dome (Smith & Nephew); Advance Medial-Pivot (Wright Medical Group, Staines-upon-Thames, United Kingdom); Anatomical Graduated Component, (AGC; Zimmer Biomet). Bottom row of a) and b), from left to right: PFC-Sigma (DePuy Synthes, Warsaw, Indiana); Journey (offset dome; Smith & Nephew); Triathlon (offset dome; Stryker); Triathlon (sombrero; Stryker); Low Contact Stress (LCS) all polyethylene (DePuy Synthes); LCS rotating platform (DePuy Synthes). Figure reproduced with the kind permission of Mr Oliver Schindler, FRCS(Orth), Bristol Hip & Knee Clinic, Chesterfield Hospital, Bristol, United Kingdom. **Schindler OS.** Basic kinematics and biomechanics of the patello-femoral joint. Part 2: The patella in total knee arthroplasty. *Acta Orthop Belg* **2012;78:11-29.**

Fig. 2 Different patella buttons and femoral trochlea component designs. From left to right: Anatomical Graduated Component, (AGC; Zimmer Biomet, Warsaw, Indiana); PFC (Zimmer Biomet); Triathlon (Stryker, Kalamazoo, Michigan); Low Contact Stress (LCS; DePuy Synthes, Warsaw, Indiana). Figure reproduced with the kind permission of Mr Oliver Schindler, FRCS(Orth), Bristol Hip & Knee Clinic, Chesterfield Hospital, Bristol, United Kingdom. **Schindler OS.** The controversy of patellar resurfacing: Ibisne in medio tutissimus? *Knee Surg Sports Traumatol Arthrosc* **2012;20:1227-1244.**

Anatomical Graduated Component (AGC; Zimmer Biomet, Warsaw, Indiana) and PFC knee arthroplasties have a domed shaped patella, the Triathlon has an asymmetrical domed patella, and the LCS has a fixed-bearing anatomical patella. It is important that the surgeon appreciates and understands that the design of the patella button itself is implant-specific. Data from the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) suggests revision rates are higher when a patella button is used with an unmatched femoral component.[28] The Knee Arthroplasty Trial (KAT), a multicentre RCT by Murray et al[3] showed no difference in clinical outcome when an anatomical design was compared with a dome-shaped design, in which the femoral component trochlea was designed to fit either an anatomical button or dome-shaped button. Patella button designs have evolved over time. The original patella buttons were metal-backed and associated with significant failure rates, including early wear and loosening.[29,30] Modern patella buttons are made from polyethylene, usually with three pegs, and the outcomes have improved significantly as a result with patellofemoral complication rates of less than 5%, compared with almost 50% in the 1980s and 1990s.[31] The size of the patella button to be used is also a factor in determining whether or not to resurface. Larger size buttons (>41 mm diameter) provide better surface area coverage of the patella and may reduce the incidence of quadriceps tendon irritation and patella crepitus, but are also thicker and carry the risk of overstuffing the joint and patella fracture, as more native patella has to be resected.[32] It is our practice to use a smaller patella button in a medialized position and undertake a lateral patella facetectomy if required, rather than risk overstuffing the patellofemoral joint with a larger patella button.

INSTRUMENTATION FOR PATELLA RESURFACING

Another reason why some surgeons may be reluctant to resurface the patella routinely is that, traditionally, the instrumentation for patella resurfacing was quite basic and challenging to use in order to achieve an accurate and reproducible patella resurfacing osteotomy. However, modern knee arthroplasties have invested significant time and effort in order to improve the instrumentation for patella resurfacing, providing flexibility in resurfacing even

Fig. 3a

Fig. 3b

Fig. 3 a) Zimmer universal patella saw guide. b) Attune Intuition patella saw guide.

the thin patella (less than 18 mm thickness) and helping minimize complications associated with patella resurfacing. Figure 3 provides examples of a traditional patella saw guide compared with a more modern instrument design.

DECISION-MAKING IN PATELLA RESURFACING

The reasons cited for undertaking patella resurfacing include inflammatory arthritis, anterior knee pain, patellofemoral joint arthritis, patella mal-tracking, and subluxation.[11] The outcomes of patella resurfacing in patients with inflammatory arthritis have been shown to be superior.[33] However, Deehan et al[15] showed similar clinical outcome in patients with rheumatoid arthritis whether or not the patella was resurfaced, and question the contention that the patella needs to be resurfaced in such patients.

The arguments for not resurfacing the patella include the more anatomical and physiological shape of the native patella over the resurfaced patella, as well as, theoretically, avoiding the issues of overstuffing the patellofemoral joint and causing patella tilt.[34] The increased incidence of complications of patella resurfacing such as fracture, osteonecrosis, extensor mechanism disruption, patellar clunk syndrome, and patella dislocation/subluxation is the most widely used argument for avoiding the need to resurface the patella.

COMPLICATIONS OF PATELLA RESURFACING

The overall incidence of patellofemoral complications following patella resurfacing, including persistent anterior knee pain, is reported as around 7%.[35] Patella fractures following resurfacing is fortunately a relatively rare but devastating complication, with incidence rates of up to 5%.[36] Patella fractures after resurfacing are most often spontaneous, although risk factors such as technical errors (patella mal-tracking and button mal-positioning), patient factors (body mass index $\geqslant 30\,kg/m^2$, male gender, high activity levels), and implant factors (large patella button >38 mm diameter) may also play a role.[19] Osteonecrosis secondary to patella avascularity has been associated with the risk of patella fracture, although the evidence for this is limited.[19,37] Patella component loosening occurs in up to 5% of cases[36] and has been traditionally associated with metal-backed patella buttons. With the advent of all polyethylene buttons, the incidence of loosening has dropped significantly. Risk factors for loosening include obesity, lateral release, and an elevated joint line.[36] Patella component instability is a significant issue and is related to implant design (use of a patella-friendly design) and surgical errors in soft-tissue balancing, component mal-positioning, and overstuffing the patellofemoral joint.[38]

CLINICAL OUTCOME AFTER PATELLA RESURFACING

The role of patella resurfacing in TKA has been studied extensively and yet no consensus has been reached. In part, many of the studies looking at the outcome of resurfacing the patella in TKA have been small, outdated, retrospective case control studies,[34] supporting both resurfacing and non-resurfacing. The most recent systematic review and meta-analysis by Longo et al,[9] which looked at 5585 cases from 35 RCTs, showed significantly worse outcome scores for pain, increased incidence of anterior knee pain (15.9% *vs* 8%), and higher rate of reoperation for patellofemoral problems (5.9% *vs* 1%) in the non-resurfaced group compared with the patella resurfacing group. The meta-analysis by Parvizi et al[39] suggested that failure to resurface the patella led to higher incidence of anterior knee pain and secondary patella resurfacing operations and possibly less patient satisfaction. Of the 158 citations, only 14 studies met the inclusion criteria of being randomized trials and of these, several were flawed methodologically. In 2012, Pilling et al[6] undertook another meta-analysis, this time including 16 RCTs in their analysis. They concluded that, although there were no significant differences in clinical scores and patient satisfaction, the reoperation rate for secondary patella resurfacing was significantly higher in the non-resurfaced group. A meta-analysis on this subject by Nizard et al[40] in 2005 showed a significantly reduced incidence of anterior knee pain, reoperation rates, and pain on stair-climbing in the patella resurfacing group but overall similar function and patient satisfaction scores. A number of RCTs have also reported in favour of patella resurfacing. In a landmark study by Waters and Bentley,[2] 514 PFC TKAs were prospectively randomized to patella resurfacing or non-resurfacing. The results suggested that patients in the non-resurfaced group had a significantly higher incidence of anterior knee pain and the authors recommended patella resurfacing in all cases where this was technically possible. Another prospective RCT by Wood et al[1] also supported the finding that patients who had a patella

resurfacing had lower incidence of anterior knee pain and better functional outcome in terms of climbing down stairs. In 2016, Aunan et al[41] undertook a single-centre, double-blinded prospective RCT of 129 knees and showed minimal clinical difference between the patella resurfacing and non-resurfacing group. Registry data from the AOANJRR also suggest that patella resurfacing led to lower early revision rates and hence early beneficial outcome based on revision rates at up to five years.[7] An interesting retrospective study, which used accelerometers to provide quantitative data on function comparing patella resurfacing against retention, showed that patients who had the patella resurfacing had significantly better functional outcome from the accelerometer data that was not picked up by standard knee outcome scores, which may have a ceiling effect.[42]

In contrast, the large scale multicentre RCT by Murray et al[3] with 1715 participants showed no difference in clinical outcomes or secondary operations with or without patella resurfacing, although the study did find that patella resurfacing routinely was cost-effective. A much smaller, single-centre RCT with up to ten years' follow-up also reported no difference in outcomes between patella resurfacing and patella retention.[43] Finally, in terms of registry outcomes, a large study from the Norwegian arthroplasty register investigating the outcome of patella resurfacing in 972 patients showed no difference in clinical outcome at a minimum of two years follow-up.[8] The most relevant evidence synthesis is from a meta-analysis by Pavlou et al,[5] including 18 level 1 RCTs, which found no evidence that resurfacing influenced clinical outcome after TKA. A prospective, double-blinded RCT of selective patella resurfacing in 350 knees showed no significant difference in clinical scores or survivorship between the resurfaced and non-resurfaced patients, although the resurfaced group of patients had a higher satisfaction rate.[44]

CONCLUSION

In order to make a decision on whether to resurface the patella or not, a surgeon must have a thorough understanding of the design, kinematics, and philosophy of their implant of choice, based on whether the implant is patella-friendly or not, cruciate-retaining or posterior-stabilized, the quality of the patella resurfacing instrumentation, and type of patella button to be used. Based on the available evidence presented, we would recommend routinely resurfacing the patella in all posterior-stabilized TKAs, in patients presenting primarily with anterior knee pain with significant patellofemoral joint arthrosis, if using a TKA design that is patella-unfriendly, and in patients with inflammatory arthritis such as rheumatoid or psoriatic arthritis. In situations where there is patella mal-tracking, patella resurfacing should be considered first before performing lateral releases that can lead to wound-healing problems, avascular necrosis, or fracture. If there is reduced anterior space between the native patella and the femoral component (as an implant design feature), we would recommend patella resurfacing in order the restore the anterior space and avoid overstuffing the patellofemoral joint.

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