

The Management of the Patella in Total Knee Arthroplasty

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Total knee arthroplasty (TKA) is a well-established procedure, and has proven to be durable and effective for the treatment of advanced arthritis of the knee joint. Early TKAs did not include patellar replacement and anterior knee pain was reported after the procedure had been carried out. The incorporation of patellar resurfacing during TKA reduces anterior knee pain, although new complications have emerged. These complications include component failure, instability, fracture, tendon rupture and soft tissue impingement. Such complications are attributed to inferior implant design and improper surgical techniques. Fear of sustaining these complications has prohibited surgeons from routine patellar resurfacing during TKA. Whether or not to resurface the patella during primary TKA is still a controversial topic. There are authors who recommend routine resurfacing, some who do not recommend resurfacing and some who suggest selective resurfacing. The rationale for and against patellar resurfacing during primary TKA has been individually justified and reported in the literature. The selection of suitable implants and adherence to proper surgical technique are the fundamental principles for the success of TKA. Patella resurfacing during TKA is recommended when inflammatory arthritis, an eburnated articular surface and patellofemoral maltracking are present; patella preservation is recommended when there is a small patella, normal articular surface and normal patellar tracking. In long-term follow-up, 60% of nonresurfaced patellas continued to have good tracking after TKA. The correct choice of patellar component size, as well as implant design, medial placement of the patellar component, rule of no thumb and lateral retinaculum release when needed, should be adhered to when performing patellar resurfacing during TKA. (*Chang Gung Med J* 2006;29:448-57)



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Total knee arthroplasty (TKA) is a conventional procedure that has been found to be durable and effective for treating advanced knee joint arthritis in long-term follow-up.⁽¹⁻³⁾ Early total knee prostheses do not facilitate patellofemoral replacement and up to 50% of patients without patellar resurfacing expe-

rienced anterior knee pain.⁽⁴⁻⁶⁾ This common morbidity has resulted in widespread patellar resurfacing.^(5,7-18) Although patellofemoral resurfacing has improved the functional outcome and reduced the incidence of anterior knee pain, new complications have emerged.^(13,19-37) Most of these complications have

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been attributed to inferior implant design and surgical techniques.^(19,20,27,29,35-40) Fear of such complications has limited the use of patella resurfacing during primary TKA.⁽⁴¹⁻⁴³⁾ The frequency of patellar resurfacing during a primary TKA increased from 30% in the 1970s to 68% in 1985.^(16,44) However, patella resurfacing during primary TKA remains controversial.⁽⁴⁵⁾ Some surgeons favor routine resurfacing,^(5,12,15,23) whereas others recommend routine no resurfacing^(46,47) and some favor patellar resurfacing on a case-by-case basis.^(14,43,44,48-51) This retrospective study addresses the rationale for and against patellar resurfacing in an effort to guide surgeons through the three basic options of routine resurfacing, no routine resurfacing and selectively resurfacing when managing the patella during primary TKA.

Anatomy, functions and biomechanics

The patella is triangular, asymmetrical, slightly wider than high, with an apex pointing distally that sits on the femoral trochlea.⁽⁵²⁾ The patella posterior surface has three facets: medial, lateral and odd.⁽⁵³⁾ The facets are covered by hyaline cartilage. The patellofemoral joint has rich vascular anastomoses. It receives arterial input from the medial and lateral superior genicular arteries superiorly, and medial and lateral inferior genicular arteries inferiorly. Further, the anterior tibial recurrent artery and medial tibial recurrent artery approach the inferolateral and inferomedial border of the patella separately. The fat pad is an important source of blood supply entry into the patella.⁽⁵⁴⁾ These arteries anastomose freely around the patella forming a peripatellar circle. The two principle drainage routes consist of the popliteal vein and the internal saphenous vein. Thus, the patella is a bone that is richly vascularized and well nourished, as well as drained by a rich anastomosis.⁽⁵⁵⁾ The patella does not fit perfectly with the femoral trochlea: the contact points between the patella and femur vary with knee flexion.^(56,57) The distal pole of the patella contacts the femoral trochlea at 20° of flexion.^(57,58) The contact area increases with knee flexion and the contact area shifts to the patella upper pole at 90° flexion. The principal patella function is to increase the moment arm of the quadriceps mechanisms.⁽⁵⁹⁾ The patella increases extension force as much as 50%.⁽⁶⁰⁾ Reilly and Martens identified that the patellofemoral joint reaction (PFJR) force can be 0.5 times body weight during level walking.⁽⁶¹⁾

Conversely, when climbing and descending stairs, the PFJR force reaches 6.5-7.6 times body weight. The patella lengthens the moment arm of the quadriceps. On average, patellectomy reduces quadriceps forces by 30-40%.⁽⁶²⁾ PFJR can be reduced to only 21% after TKA.⁽⁶³⁾ The prosthetic patella shifts medially during flexion, rather than laterally like the normal patella. The modified kinematics and reduced patellofemoral contact area following TKA likely contribute to patellofemoral complications. Successful TKA often increases knee flexion angle, thus enhancing the patellofemoral contact and pressing forces.⁽⁶⁴⁻⁶⁶⁾ Decreased bony thickness combined with osteopenia following patella resurfacing during TKA likely contributes to risk of patellar fracture. This risk increases when lateral retinaculum release is simultaneously performed.^(67,68)

Design of TKA implants

The design of TKA implants has substantial impact on a surgeon's decision to resurface or retain the patella. Early designs of the femoral component have a shallow, flat trochlear groove that frequently results in an unstable patella. A deep groove has been associated with relatively normal function.⁽¹³⁾ The early hinged prostheses (Guepar tape) have a narrow femoral flange, lack patellar rotation, and have a high rate of patellar subluxation and dislocation.⁽⁶⁹⁾ The design of the next generation of implants, even of total condylar implants, also have either no groove or an insufficient groove for the patella and can induce high patellofemoral stress. Recent designs have a smooth deep groove with a short, narrow notch that improves patellar tracking and stability.⁽⁷⁰⁾ Another study suggested that a trochlea with distal extension and anatomical curvature enhances patellar tracking regardless of whether the patella was replaced or retained.^(13,71-73) A lateral femoral trochlea closely resembles the natural knee.⁽⁷²⁾ Orientation and positioning of an implanted prosthesis is reported to be closely associated with patellofemoral tracking and contact stress. Medial placement of the patellar component, and external rotation implantation of the femoral component and tibial component appeared to enhance patellofemoral tracking after TKA.^(68,74) The combination of a normal patella with a prosthetic femoral component altered normal patellofemoral kinematics and mechanical properties. The design of TKA components must be

considered when determining whether to resurface the patella during TKA.⁽⁷⁵⁾ The frequency of patellar complications increased following the use of metal-backed patellar components after TKA. The all-polyethylene patellar component was recommended for use when patellar resurfacing during TKA.

Complications after patellar resurfacing during TKA

Several complications can occur following patella resurfacing during TKA, including patellar instability and fracture, wearing of the patellar component, soft tissue impingement, patellar ligament rupture and loosening of the patellar component.

Patellar instability

Patellar subluxation or dislocation can develop following TKA. The incidence of symptomatic patella instability requiring revision surgery is roughly 0.5-0.8%. Several factors likely contribute to patellar instability, including malposition of components, soft tissue imbalance, excessive femoral component size and inadequate patellar resection.⁽⁷⁶⁻⁷⁹⁾ Component revision, proximal and distal realignment of soft tissue, and osteotomy of the tibial tubercle may resolve the complication.⁽⁷⁶⁻⁷⁹⁾ However, some complications, such as recurrent instability, skin necrosis and patellar fracture, can occur after reoperation.^(44,76-79)

Patellar fracture

Patellar fracture occurs in 0.05-8.5% of TKA cases.^(25,44,80-83) Avascularity, trauma, fatigue and stress can generate patellar fracture.⁽⁸⁰⁻⁹⁰⁾ Treatment is decided upon according to fractured fragment displacement: non-surgical or surgical treatment is based on the fracture pattern. Patellar fractures typically respond well to non-surgical treatment when an implant is not loose and the extensor mechanism is not disrupted. Surgical options include open reduction with internal fixation, excision of fracture fragments and patellectomy. Reoperation outcomes of different treatment modes vary.^(44,80,91,92)

Wear of the patellar component

The incidence of wear with all-polyethylene and metal-backed components is 5-11%.⁽⁹³⁻⁹⁵⁾ Congruity, maltracking and contact force are associated with polyethylene wear.⁽⁹⁶⁾ Decreased polyethylene thickness in metal-backed designs is the determining fac-

tor for mechanism failure.⁽⁹⁷⁾

Patellar component loosening

The incidence of patellar component loosening is 0.6-1.3% following TKA.^(23,44,98) Thin fixation pegs, maltracking and trauma frequently induce component loosening. Revision of a failed patellar component is typically associated with a relatively high complication rate.^(30,98)

Soft-tissue impingement

The so-called patellar clunk syndrome results from formation of a fibrous nodule over the patella proximal pole and reportedly occurs in TKA cases in which a posterior stabilized design is utilized.⁽³⁰⁾ Arthroscopic or open resection of the fibrous nodule can eliminate this syndrome.

Patellar ligament rupture

The incidence of patellar ligament rupture is roughly 0.22-0.55%.⁽⁹⁹⁻¹⁰²⁾ Contributing factors are excessive dissection and knee manipulation, and trauma.⁽⁹⁹⁻¹⁰²⁾ Staple fixation or autogenous semitendinosus graft can be utilized in treating acute ruptures, whereas allografts are indicated for chronic cases.⁽⁹⁹⁻¹⁰²⁾ Treatment outcomes for ruptured patellar ligaments are not good.

Management of the patella in TKA

Patella resurfacing during TKA remains controversial. Options vary from routine resurfacing, to no resurfacing^(18,46-48,103) or selective resurfacing.^(1,16,44)

Routine resurfacing

Resurfacing can relieve pain, improve a patient's ability to climb stairs and increase quadriceps strength.^(7,14,23,50,51) Numerous studies have demonstrated that substantial cartilage destruction in the patella occurred during secondary resurfacing due to anterior knee pain after TKA without patellar resurfacing.^(10,41,50,104-108) Revision rates for patellar resurfacing have improved as a result of enhanced implant design, refined surgical techniques, use of all-polyethylene patellas with three peg components, proper selection of patellar implant size and avoidance of over-resection of the patella.^(23,41,42,45,109,110) Indications for resurfacing are rheumatoid arthritis, inflammatory arthritis, severely destructive PFJ, maltracking of the patella, and incongruence of the patella and

femoral components.^(16,23,48) An extremely small patella is not suitable for resurfacing.

No resurfacing

Patellar resurfacing during TKA has a high complication rate.^(44,111-113) Such complications are component wear, dissociation, loosening, patellar fracture and soft tissue impingement syndrome. Retaining the patella can reduce the complication rate. Hsu et al., Keblish et al., Braakman et al., Ichinish et al. and Abraham et al. observed no difference in pain and functional outcomes between patients with and without patellar resurfacing.^(43,46,51,114,115)

Selective resurfacing

Scott and Reilly recommend applying a selective approach to patellar resurfacing.⁽⁴⁹⁾ They suggest employing patellar resurfacing for patients with osteoarthritis with an eburnated articular surface and patellar maltracking. They maintain that retaining the patella can eliminate complications following resurfacing procedures. Subsequent studies have suggested that selective resurfacing generates satisfactory outcomes.^(7,43,44,46-48,105,109)

Bilateral TKA studies

A number of studies have compared outcomes for bilateral TKAs in which one knee undergoes patellar resurfacing and the other knee retains the patella. Keblish et al. found no difference in clinical outcomes when comparing these two approaches.⁽⁴³⁾ Enis et al. identified a patient preference for resurfaced knees.⁽⁷⁾ Although Barrack et al. found no difference in knee score or patient satisfaction, 10% of TKA cases without resurfacing underwent secondary resurfacing.^(109,111) Bourne et al. reported that patients had reduced pain and increased flexion following TKA without resurfacing. However 4% of patients without resurfacing required secondary patellar resurfacing.⁽¹⁰⁵⁾ Feller et al. determined that patients' ability to climb stairs was superior when TKA without resurfacing was performed.⁽⁴²⁾

Randomized studies

Several prospective, randomized, double-blind studies have investigated patients who underwent patellar resurfacing in one knee and no patella resurfacing in the other knee. Burnett et al. described out-

comes for a 6.3-year follow-up of 100 TKAs with or without patellar resurfacing.⁽¹⁰⁸⁾ No difference existed for pain scores, knee scores and patient satisfaction between the two approaches. Patients preferred resurfaced patellas to nonresurfaced ones. Feller et al. analyzed a series of 38 TKA procedures for implantation of porous coated anatomical (PCA) knee prostheses with or without patellar resurfacing over a 3-year follow-up.⁽⁴²⁾ No difference in outcome was found between the two groups. Patients undergoing TKA with no patella resurfacing were better at climbing stairs than those with patella resurfacing. The authors did not recommend routine resurfacing of the patella during TKA for osteoarthritis patients. Schroeder-Boersch et al. conducted a 2-year follow-up study of 40 knees.^(106,107) Patients who underwent TKA and patella resurfacing experienced less patellar tilting than those who had TKA without patella resurfacing. No difference was identified for functional score and stair climbing ability between the two groups. Barrack et al. investigated 118 TKA procedures using the Miller-Galante (MG) knee prosthesis. Patients received follow-up for a minimum of two years.⁽¹⁰⁴⁾ No difference in pain, knee score and patient satisfaction existed between the group with patella resurfacing and those without resurfacing. Another study analyzed the outcome from 93 TKA procedures performed at the same institution; patients received follow-up for at least five years.⁽⁴¹⁾ Barrack et al. also determined that no difference existed for pain, knee scores and patient satisfaction between two groups whether patella resurfacing was performed or not. The authors concluded that anterior knee pain following TKA may not be related to whether the patella was resurfaced. They proposed that implant design and surgical technique were more critical to anterior knee pain than patella resurfacing. Wood et al. analyzed 198 osteoarthritic knees that underwent TKA with MG II knee prosthesis.⁽⁴⁵⁾ After follow-up for a minimum of three years, no significant difference was identified for knee scores and functional scores between patients with resurfaced and nonresurfaced patellas. However, more patients in the nonresurfaced group experienced anterior knee pain. The authors favored TKAs with patellar resurfacing. The results of randomized, prospective studies, therefore, are not in agreement. Thus, selective patellar resurfacing during TKA for osteoarthritic knees should be carefully evaluated. The patella can

be retained when its articular surface is intact, it has a normal shape, and there is good tracking before surgery and during TKA. The patella should be resurfaced in cases of rheumatoid arthritis, eburnated articular surface and poor patellar tracking.

Surgical principles

Surgical techniques are important factors in the development of patellar complications. When resurfacing a patella, the following characteristics are crucial to surgical outcomes and minimization of complications: reproducing the initial thickness after patellar resurfacing; protecting patellar blood supply; avoiding soft tissue impingement; maintaining joint line and balanced soft tissue.^(38,116) A minimum patellar thickness of 15-mm should be retained following resection.⁽¹¹⁷⁾ Medial placement of the patella with a minimal 4-mm trochlear groove generates good patellar tracking.⁽¹¹⁸⁾ External rotation of femoral and tibial components also reproduces normal patellar tracking.⁽¹¹⁹⁾ Lateral release should be 2-cm posterior to the patella periphery. "Rule of no thumb" should be adhered to when evaluating patellar tracking.

Long-term changes to nonresurfaced patellas after TKA

Long-term changes for nonresurfaced patellas have seldom been reported. Laughlin et al. indicated that the lateral tilt of patellar components increases over time.⁽¹²⁰⁾ Smith et al. demonstrated that patellofemoral symptoms existed in 8% of 112 TKAs without patellar resurfacing.⁽⁴⁷⁾ Patellar tracking was maintained with only a slight malposition of the patellar and this shift typically stabilized over time. Kawakubo et al. identified few patellar alterations and minimal peripatellar pain after 17 TKAs without patella resurfacing.⁽¹²¹⁾ A retrospective study by Shih et al. that included 227 TKAs without patellar resurfacing over an average 8.5-year follow-up found that patellar tracking and the PFJ remained normal in 60% of the TKAs, whereas progressive degenerative changes to nonresurfaced patellas, primarily on the lateral facet, and patellar maltracking were frequent abnormal radiographic findings.⁽¹²²⁾ Patients with preoperative patellar maltracking were at risk of developing these abnormalities and clinical symptoms. Patellar resurfacing during TKA may benefit such patients. Observations from Shih's study support those obtained by Laughlin et al. We propose that

temporal changes are comparable with degenerative changes to the natural PFJ due to abnormal stress; once such changes begin, the patella deteriorates slowly.⁽¹²⁰⁾

Conclusion

Determining whether a patella should be resurfaced rests with the surgeon. Surgical training and experience, preoperative analysis of patellofemoral tracking, and intraoperative analysis of the patellofemoral articular surface and articulation are critical to the final decision. With optimal implant design and appropriate surgical techniques, optimal outcomes can be obtained for TKA with and without patellar resurfacing.

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膕骨在全膝關節成形術的處理

許文蔚

全膝關節成形術是普遍被接受來處理晚期膝關節炎，耐久而且有效的方法。早期全膝人工關節不包含膕股骨置換，術後會發生前膝痛。因此後來加上膕骨置換後，的確有效降低膝痛的發生，而且提昇手術結果。然而新的併發症，如零件失敗、不穩定、膕骨骨折、膕骨韌帶斷裂及軟組織擠壓症候群接著被察覺到。這些併發症主要歸因於植入零件設計不良，及不恰當的開刀技術。懼怕產生膕骨置換後的併發症，因此限制人工膝關節之膕骨置換。因此膕骨置換在人工膝關節仍然沒有一致的定論。現在處理原則可分為常態性置換、常態性不置換，及選擇性置換。經過了人工關節零件設計的改良及改善開刀技術，我們認為選擇恰當的人工膝關節零件，遵循良好的開刀原則，膕骨置換與否，不會影響開刀的結果。(長庚醫誌 2006;29:448-57)

關鍵字：全膝關節成形術、膕骨置換、併發症。