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Published in:
CiOS Clinics in Orthopedic Surgery

DOI:
10.4055/cios20207

Original Article Clinics in Orthopedic Surgery 2022;14:213-219 • https://doi.org/10.4055/cios20207

A Reliable Surgical Approach to Revision Total Knee Arthroplasty

Jonathan Quinn, MBBS, Peter Jones, PhD, Ray Randle, MBBS*

Faculty of Health Sciences and Medicine, Bond University, Robina,
**Gold Coast Centre for Bone and Joint Surgery, Gold Coast, Australia*

Background: The surgical exposure obtained in revision total knee arthroplasty should facilitate the utilisation of instrumentation and implants, including adjuncts such as stemmed prostheses, bone allograft, and artificial augments. We have previously identified within this cohort of revision total knee arthroplasty patients a high satisfaction rate of 93.5% at a mean 6.5 years of follow-up and a high level of postoperative function. We, therefore, seek to describe in detail the operative technique and perioperative care and report the early postoperative complications.

Methods: We report on the surgical approach, closure technique, and postoperative care used by the senior author for revision total knee arthroplasty procedures. The patient demographics, intraoperative details, and postoperative outcomes are also reported. We aim to provide a clear description of the intraoperative technique and postoperative outcome, facilitating adoption or comparison with other surgeons or techniques. Patient inclusion criteria were revision total knee arthroplasty performed by the senior author using the PFC (Depuy) prosthesis at John Flynn Private Hospital with a minimum of 2-year postoperative follow-up. A retrospective chart review was combined with a structured telephone assessment questionnaire to assess outcomes.

Results: A total of 202 revision total knee arthroplasties were available for follow-up in 185 patients. The mean 1-year postoperative range of motion was 110°. Key features of surgical approach include incision planning, soft-tissue plane development, parapatellar scar debridement, safe removal of implants, management of bone defects, and closure technique. The overall 90-day complication rate was 9%, including 4.4% requiring manipulation under anaesthesia and 3% superficial surgical site infections (1 patient requiring intravenous antibiotics).

Conclusions: We suggest that the described technique is reproducible and reliable. It rarely requires modification and facilitates successful postoperative outcomes with a low complication rate. The adoption of this surgical technique allows surgeons to approach complex knee arthroplasty with confidence in the appropriate exposure of anatomy, facilitating subsequent steps in their arthroplasty procedures.

Keywords: *Total knee arthroplasty, Revision total knee arthroplasty, Revision, Approach, Outcomes*

Revision total knee arthroplasty (RTKA) is widely accepted as a challenging operative procedure.[1-3] The reasons for increased difficulty of surgery and poorer postoperative outcome have been attributed to difficult surgical exposure, stiffness, adhesion of tissues, and instability due to ligamentous laxity and poor bone stock.[2,3] Surgical exposure required in RTKA should facilitate the utilisation of instrumentation and implants, including adjuncts such as stemmed prostheses, bone allograft, and artificial augments. Appropriate surgical exposure in RTKA is integral to obtaining a satisfactory outcome.[4] We have previously identified within this cohort of RTKA patients a high sat-

Received August 19, 2020; Revised January 27, 2021;
Accepted January 27, 2021
Correspondence to: Jonathan Quinn, MBBS
Faculty of Health Sciences and Medicine, Bond University, PO Box 809, Burleigh Heads, Robina 4220, Australia
Tel: +61-4-0247-6484, Fax: +61-7-5598-0294
E-mail: jonathan.quinn@student.bond.edu.au

isfaction rate of 93.5% at a mean 6.5 years of follow-up and a high level of postoperative function. We, therefore, seek to describe in detail the operative technique, perioperative care, and postoperative complications, thereby facilitating adoption or comparison with other surgeons or techniques.

METHODS

This study obtained ethical approval through the local Human Research Ethics Counsel (BUHREC approval No. 0000015604). Informed consent was obtained from every patient.

We report on the surgical approach and operative technique used by the senior author (RR) for RTKA procedures. Patient inclusion criteria were RTKA performed by the senior author using the PFC (Depuy Synthes, Warsaw, IN, USA) prosthesis at John Flynn Private Hospital with a minimum of 2 years since RTKA. A retrospective chart review was combined with a structured telephone assessment questionnaire to assess outcomes. The telephone assessment included Oxford Knee Score (OKS) and Mahomed Satisfaction Scale, evaluated as per the original recommendations. A total of 202 consecutive major RKTA procedures were performed in 185 patients from 2004 through 2015. Orthopaedic and medical records were retrospectively reviewed.

We considered important clinical outcomes as follows: need for tibial tubercle osteotomy (TTO) intraoperatively, postoperative range of motion (ROM), complication rate, and requirement for manipulation under anaesthesia (MUA).

Description of Technique

Tranexamic acid is administered preoperatively (1 g orally 2 hours prior to surgery) unless contraindicated. The patient is positioned supine after spinal or general anaesthesia. The limb is positioned with thigh and foot bolsters. No tourniquet is applied to avoid known adverse effects of tourniquet use including thigh pain,[5] postoperative quadriceps inhibition,[5,6] deep vein thrombosis,[7] or patella tracking/soft-tissue balancing difficulties.[8,9] We consider tourniquet use has no advantage in overall blood loss.[7,10] The previous incision is used whenever possible. If use of the previous incision is not appropriate, an adequate skin bridge between the new and the previous incision is maintained. Meticulous soft-tissue handling and avoidance of undermining skin and subcutaneous layers are ensured. Haemostasis with diathermy is performed.

A paramedian longitudinal incision through the retinaculum and capsule is performed. No quadriceps snip is routinely performed. The incision is typically 20–25 cm in length, depending on the patient body habitus and localised adiposity. It extends distally to approximately 3 cm below the tibial implant-bone interface. Adequate exposure is considered of greater importance than a short incision (Fig. 1). To obtain adequate exposure and mobility of the extensor mechanism, the medial gutter must be cleared of adhesions. Scar tissue can be divided using finger dissection or curved heavy scissors. Care must be taken to ensure appropriate plane of dissection. This dissection should be carried beyond the femoral epicondyle. The lateral gutter should be released in a similar fashion to ensure scar tissue does not impact soft-tissue balance or ROM intraoperatively or postoperatively (Figs. 2-4). Parapatellar scar is then identified and debrided. Excision should be performed, whilst preserving a layer of fat on the tendon surface. The lateral side of the patella should be cleared of scar tissue for a distance of approximately 10 mm (Figs. 5 and 6). This exposure and debridement of scar tissue should then allow for the removal of the tibial polyethylene liner. This is performed utilising prosthesis-specific instrumentation or an appropriate surgical instrument.

Removal of implants is then performed, with attention focused on safe removal and avoidance of periprosthetic fracture. A small interface is developed at the implant-cement or implant-bone junction. This is usually begun with a small offset osteotome, and then developed with a microsagittal saw. A reciprocating saw for this purpose should be used with great care and only in experienced hands. When complete, the implants can then be

Fig. 1. Skin incision and superficial dissection.

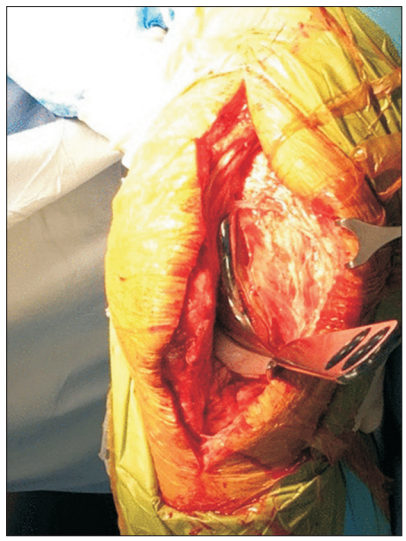

Fig. 2. Scar adhesions within medial gutter.

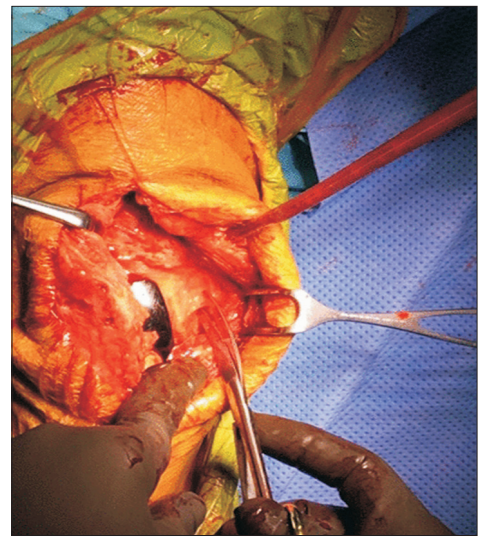

Fig. 4. Further removal of adhesions with heavy curved scissors.

Fig. 3. Removal of adhesions in medial gutter with heavy curved scissors.

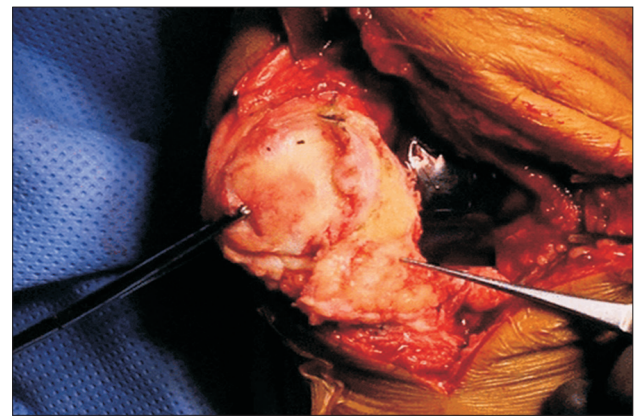

Fig. 5. Debridement of parapatellar scar.

tapped loose using specific prosthesis removal devices or a small punch and mallet. The femoral component is usually removed first, allowing greater access for removal of the tibial prosthesis. Care should be taken to ensure that the direction of force when tapping out the implant is parallel to any intramedullary stem and other longitudinal implant surfaces to minimise risk of fracture.

Removal of the tibial tray is facilitated by anterior subluxation of the tibia and deep flexion of the knee. This enables the tibial tray and stem to pass distal to the distal femoral surface. The use of retractors to lever the proximal tibia should be performed with caution given the often poor bone stock and risk of fracture. Further removal of cement and debridement of bone and soft-tissue surfaces

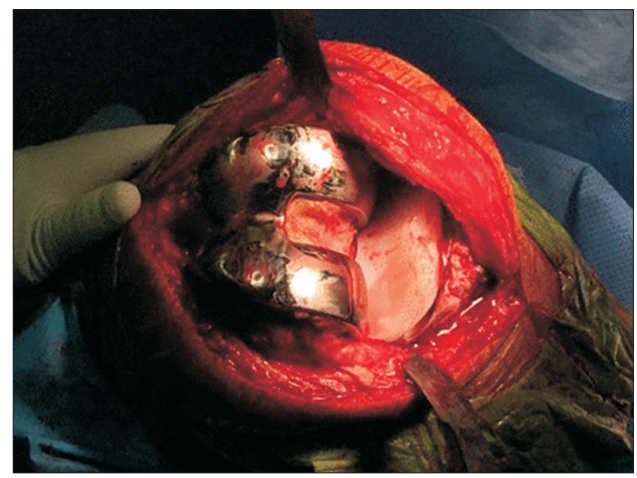

Fig. 6. Adequate exposure achieved to allow removal of implants.

can then be performed with increased exposure and access to all aspects of the knee joint. Multiple specimens are taken for frozen section analysis and assessment of white cell count per high-powered field. Leukocyte-esterase testing of synovial fluid is also performed intraoperatively.

The PFC prosthesis (Depuy Synthes) was inserted in all patients. This implant was used based on the preference and standard practice of the senior surgeon. A combination of adjuncts was used intraoperatively based on need at the time of surgery, such as stemmed implants, sleeves, bone augments, and artificial augments. Intraoperative details are presented in Table 1.

Closure

Following definitive implant insertion and final check of stability, soft-tissue balance, patella tracking, and ROM, an iodine lavage of the joint for 5 minutes is performed. Further wash and check of haemostasis is then performed. A drain is placed prior to closure of deep layers, exiting from the superolateral aspect of the suprapatellar pouch. Retinaculum is then closed with a size 2 polydioxanone (monofilament, synthetic, absorbable) suture using a combination of interrupted and running suture technique. This is followed by closure of fat and fascia with 2-0 Vicryl (braided, synthetic, absorbable). Iodine lavage of fat, fascia and skin is performed. Subcuticular closure with 3-0 monocryl (monofilament, synthetic, absorbable) suture is followed by a topical skin adhesive and surgical dressing. A compression bandage is applied over the sterile dressings.

One gram oral tranexamic acid is administered at 2 hours and 6 hours postoperatively. The surgical drain and compression bandage are removed 8 hours postoperatively.

Table 1. Intraoperative Details

Variable	Value
Medial parapatellar approach used	202
Tibial tubercle osteotomy required	5
Implant constraint	CR, 57; PS, 101; TC3, 32; Hinge, 12
Stemmed implant	170 (134 femur and tibia, 7 femur alone, 29 tibia alone)
Bone augment	82
Artificial augment	117
Cemented implant	202
Antibiotic cement	202
Surgical time (min), mean ± SD	143 ± 36

CR: cruciate-retaining, PS: posterior-stabilised, SD: standard deviation.

Apixaban oral anticoagulation is commenced 8 hours postoperatively, 2.5 mg twice daily for 14 days. Suitability of chemical venous thromboembolism prevention is considered based on patient-specific risks and comorbidities.

Postoperative Rehabilitation

Patients are encouraged to mobilise with physiotherapy assistance on the day of surgery. Most patients will be allowed to full weight bear as tolerated, with exception of patients with significant structural bone graft used intraoperatively. These patients should undertake protected weight bearing with crutches until adequate structural stability is obtained. The operative limb is elevated whilst in bed, with bed tilt or a limb elevation pillow. Patients are encouraged to sit out of bed as soon as comfortable, with the operative leg placed on a small skateboard to encourage gentle ROM. Passive extension exercises are performed for 10 minutes, 3 times per day.

Patients are progressed onto an exercise bike on day 2 postoperatively. The knee flexion required for exercise bike riding is approximately 105°, with variation depending on the seat height and leg length.[11] Patients are required to mobilise on stairs prior to discharge. Patients are discharged once safe, mobile, and comfortable.

RESULTS

Demographic data are detailed in Table 2. This cohort demonstrated heterogeneity in gender, age, weight, body mass index, American Society of Anaesthesiologists (ASA) score, diabetes status, and reason for RTKA. Summary of intraoperative details are described in Table 1. Of this patient cohort, only 5 RTKAs required TTO to allow adequate surgical exposure. All patients received a PFC (Depuy Synthes) prosthesis. A variety of implant levels of constraint were used, and use of stemmed implants, bone allograft, or artificial augments was common. Antibiotic cement was used in all cases. Mean surgical time was 143 minutes.

Postoperative outcomes are described in Table 3. A clinically significant improvement in mean ROM was recorded from 98° preoperatively to 110.9° at 1 year postoperatively. The mean OKS was 39.25 (range, 14–48). The Mahomed Satisfaction Scale outcomes demonstrated a mean score of 87.7 (range, 31.25–100). Complications within 90 days of operation were found in 19 cases. Six late complications of infection requiring subsequent revision were identified. There was no evidence of this complication within 90 days of RTKA. Three of these cases were following two-stage revision for infection.

Nine patients required MUA to enable good postoperative ROM. Preoperative mean total ROM for these patients was 67°, markedly lower than the cohort mean of 98°. At 1 year postoperatively, the mean total ROM for these patients was 98°, demonstrating a clinically significant improvement for these patients. One patient developed a hemarthrosis secondary to warfarin anticoagulation, necessary due to medical comorbidities. This was managed conservatively and obtained a total ROM of 135° at 1 year postoperatively.

One patient developed a pulmonary embolism despite receiving standard anticoagulation postoperatively. This was managed with appropriate anticoagulation following involvement of specialist physicians. Six patients developed a superficial surgical site infection, managed with a short course of oral antibiotics in 5 cases, and intravenous antibiotics in 1 case. This postoperative complication did not affect postoperative satisfaction or outcomes. The mean ROM for this group was 115° (range, 95°–135°), and mean OKS was 44 (range, 37–48). One patient required a return to theatre for repeat closure of the superficial wound after falling from bed whilst on the ward. No breach of the arthrotomy closure was evident intraoperatively. Six patients (3%) developed a deep infection after at least 6 months following RTKA (mean, 3.6 years) and required further operative intervention.

Table 2. Patient Demographics

Variable	Value
No. of patients	185
Sex (male : female)	97 : 88
Age at time of RTKA (yr)	70.5 ± 9.7 (45–90)
Patient with prior RTKA	37
Weight (kg)	83.4 ± 16.1 (49–130)
Body mass index (kg/m^2)	29.5 ± 4.8 (19–46)
ASA score	2.5 (1–4)
Diabetes	26 (2 type 1, 24 type 2, 22 patients diabetic status unknown)
Smoking status	Current smokers, 8; past smokers, 56; smoking status unknown, 19
Reason for revision, % (n)	Loosening, 36 (71); infection, 23 (47); UKA failure, 9 (17); instability, 7 (15); pain, 6 (12); polyethylene wear, 5 (11); stiffness, 3 (7); implant failure, 3 (7); periprosthetic fracture, 3 (7); component malposition, 2 (5); patellofemoral joint pain, 1 (2); avascular necrosis of tibia, 1 (1)
Mean preoperative range of motion (°)	98 ± 24.5 (15–140)

Values are presented as mean ± standard deviation (range) or mean (range) unless otherwise indicated.
RTKA: revision total knee arthroplasty, ASA: American Society of Anaesthesiologists, UKA: unicompartmental knee arthroplasty.

Table 3. Postoperative Outcomes

Variable	Value
Mean 3 month postoperative ROM (°)	103.3 ± 17.3
Mean 1 year postoperative ROM (°)	110.9 ± 16.6
Complication within 90 days of RTKA	Total: 19 (9) MUA required, 9 (4.4) Surgical site infection, 6 (3) (1 requiring intravenous antibiotics, 5 requiring oral antibiotics) Wound dehiscence post fall, 1 (0.5) Hemarthrosis, 1 (0.5) Postoperative pain requiring readmission, 1 (0.5) Pulmonary embolism, 1 (0.5)

Values are presented as mean ± standard deviation or number (%).
ROM: range of motion, RTKA: revision total knee arthroplasty, MUA: manipulation under anaesthesia.

DISCUSSION

We believe that there are a number of factors that have contributed to the high-quality outcomes and low postoperative complication rate for patients within our cohort. Firstly, all operations were performed by an experienced arthroplasty surgeon, familiar with the prosthesis and intraoperative insertion technique. While the operative approach and exposure are an important part of overall RTKA procedure, other aspects of RTKA must also be performed adequately to obtain a successful outcome. Secondly, the prosthesis used has demonstrated high-quality long-term outcomes, with a low revision rate over 15 years.[12] Thirdly, these patients underwent a well-structured postoperative physiotherapy and rehabilitation program within a private healthcare setting.

This surgical approach required modification in only 5 of 202 RTKAs. Della Valle et al.[4] reported a similar series of RTKA procedures using a medial capsular approach. Fifteen of 126 patients required modification of surgical approach to obtain adequate exposure. TTO has been well described in the literature, with variable outcomes and complication rates between authors. It is widely accepted as an option to allow for adequate exposure during knee arthroplasty procedures, with the goal of avoiding detachment of the patella ligament from the tibial tubercle.[13-15] Complications are reported by most authors with published series of TTO during arthroplasty, including fracture, fragment displacement, malunion, skin necrosis, difficulty in kneeling, and lower patient satisfaction.[3,14,16,17]

Reported complication rates of 5%–10% by most authors dictate TTO use only when necessary, and its use requires considerable surgical expertise to obtain good outcomes.[15,17-19] We suggest that avoidance of TTO when possible through alternate surgical exposure techniques is desirable. TTO was considered when mobilization of the extensor mechanism was not achievable after scar-tissue division, thereby placing the extensor mechanism at unacceptable risk of avulsion distally. Careful attention to extensor mechanism tension during attempts at patella eversion is crucial to avoid inadvertent avulsion. A prophylactic TTO is deemed appropriate to avoid avulsion of the patella ligament from the tibial tubercle. A quadriceps snip can be a valuable intermediate measure allowing greater mobility of the extensor mechanism, and potentially avoiding the need for TTO. If performed, the quadriceps snip is repaired during closure, and postoperative rehabilitation is unchanged.

Comparison of the described technique and postoperative outcomes with other techniques or patient cohorts is not possible at this time, due to the absence of such outcomes within the literature. Although surgical techniques for RTKA have been described in isolation, these descriptions have not been combined with postoperative outcomes. Similarly, while RTKA outcomes have been described, we were unable to identify any publications with accompanying specifics of surgical techniques. We would encourage the orthopaedic community to pursue a critical comparison with other RTKA cohorts, in efforts to further develop understanding of surgical approach and optimising patient outcomes.

The technique described above is similar in many ways to previously described techniques for RTKA.[20] Fundamental details of our technique include preoperative oral tranexamic acid administration, the absence of tourniquet use, focused release of scar tissue within the medial and lateral gutters using finger dissection or curved scissors, closure technique, and postoperative care. Our detailed description of the surgical technique and resultant outcomes allows other surgeons to make informed decisions regarding surgical techniques and to better inform patients of their expected outcomes postoperatively.

We acknowledge that other surgeons may have different surgical approaches for RTKA and obtain successful patient outcomes. We would encourage the description and sharing of these operative techniques and outcomes to enable a greater understanding of varied methods to obtain a successful outcome, thereby enabling surgeons to be better equipped intraoperatively.

The surgical approach in RTKA facilitates the subsequent stages of the operation; however, in itself it is likely only a small contributor to overall outcome. We do not suggest that the use of this approach directly results in better patient outcomes postoperatively, but we do suggest that the proficient use of this approach enables subsequent stages of the RTKA to be performed effectively. This surgical technique for RTKA has been reproduced in over 200 patients, with very few requiring modifications intraoperatively. This surgical exposure has facilitated subsequent aspects of RTKA surgery and has resulted in low complication rates postoperatively. The adoption of this surgical technique allows surgeons to approach complex knee arthroplasty with confidence in the appropriate exposure of anatomy, facilitating subsequent steps in their arthroplasty procedure. We suggest that this technique is reproducible and reliable, rarely requires modification, and facilitates successful postoperative outcomes with a low complication rate.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGEMENTS

This research was supported by an Australian Government Research Training Program Scholarship.

ORCID

Jonathan Quinn https://orcid.org/0000-0003-0374-2205
Peter Jones https://orcid.org/0000-0003-2932-6971
Ray Randle https://orcid.org/0000-0003-3524-9001

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