Lateral subvastus approach with osteotomy of the tibial tubercle for total knee replacement

A TWO-YEAR PROSPECTIVE, RANDOMISED, BLINDED CONTROLLED TRIAL

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The lateral subvastus approach combined with an osteotomy of the tibial tubercle is a recognised, but rarely used approach for total knee replacement (TKR). A total of 32 patients undergoing primary TKR was randomised into two groups, in one of which the lateral subvastus approach combined with a tibial tubercle osteotomy and in the other the medial parapatellar approach were used. The patients were assessed radiologically and clinically using measurement of the range of movement, a visual analogue patient satisfaction score, the Western Ontario McMasters University Osteoarthritis Index and the American Knee Society score. Four patients were lost to the complete follow-up at two years.

At two years there were no significant differences between the groups in any of the parameters for clinical outcome. In the lateral approach group there was one complication due to displacement of the tibial tubercle osteotomy and two osteotomies took more than six months to unite. In the medial approach group, one patient had a partial tear of the quadriceps. There was a significantly greater incidence of lateral patellar subluxation in the medial approach group (3 of 12) compared with the lateral approach group (0 of 16) (p = 0.034), but without any apparent clinical detriment.

We conclude that the lateral approach with tibial tubercle osteotomy is a safe technique with an outcome comparable with that of the medial parapatellar approach for TKR, but the increased surgical time and its specific complications do not support its routine use. It would seem to be more appropriate to reserve this technique for patients in whom problems with patellar tracking are anticipated.

The medial parapatellar approach with lateral eversion of the patella is widely accepted as being the standard for total knee replacement (TKR). Keblish recommended the lateral approach, without a tibial tubercle osteotomy, as the optimum method for fixed valgus deformity in TKR. A lateral release is performed as part of the approach, which optimises patellofemoral tracking and stability, and preserves the medial blood supply of the patella. He described the results in 53 patients with a follow-up exceeding two years, with good or excellent results in 94.3%.

Subsequently, Arnold et al described the lateral subvastus approach combined with an osteotomy of the tibial tubercle as a standard approach for all TKRs. They advocated the theoretical benefits of improved exposure, improved positioning of the femoral component, preservation of the patellar blood supply and sensation in the distribution of the saphenous nerve with retention of an intact extensor mechanism. In a series of 702 TKRs inserted through this approach the outcome was good at five years and only seven complications were reported in relation to the osteotomy of the tibial tubercle.

Our aim was to determine whether these theoretical benefits led to a better clinical outcome justifying the increased surgical time, a longer incision and the risks associated with producing an osteotomy of the tibial tubercle. We present the results of a prospective, randomised, blinded controlled trial comparing the lateral subvastus approach and osteotomy of the tibial tubercle with the medial parapatellar approach for TKR.

Patients and Methods
After obtaining approval from our ethics committee, 32 patients requiring TKR were enrolled in the study. Those with an inflammatory arthropathy, age > 85 years, a mechanical axis of the knee > 15° of varus or valgus, and a history of previous knee surgery, with the exception of arthroscopy, were excluded from the study. Patients were randomised using sealed envelopes to either a lateral subvastus...
approach with a tibial tubercle osteotomy (n = 16) or a medial parapatellar approach (n = 16).

There were 11 women and five men in the lateral group and nine women and seven men in the medial group. The mean age was 75.9 years (66 to 84) in the lateral and 72.4 years (59 to 83) in the medial group. The mean body mass index was 30.38 kg/m² (21.88 to 38.28) in the lateral and 31.03 kg/m² (22.65 to 45.67) in the medial group. Pre-operatively the mean passive flexion in the lateral group was 110.7° (70° to 135°) and 98.3° (60° to 120°) in the medial group which was significantly different (Mann-Whitney U test, p = 0.03). Also, pre-operatively four patients in the lateral group had valgus alignment and four varus alignment > 5° from neutral. In the medial group three patients had valgus alignment and four had varus alignment, > 5° from neutral. The mean alignment in the lateral group was 3.2° (17° to 8°) varus and in the medial group 5.1° varus (17° to 4°).

The patients were assessed clinically by a blinded research assistant pre-operatively and post-operatively at six weeks, three and six months, and at one and two years for range of movement (using a goniometer), patient satisfaction using a visual analogue scale (VAS) ranging from 0 to 10 (where 0 = no pain and 10 = excruciating pain), and the measurement of the American Knee Society (AKS) score. The Western Ontario McMasters University (WOMAC) index was determined pre-operatively and at one year. Radiological assessment was undertaken pre-operatively and post-operatively at six weeks, three and six months, and at one and two years by one author (GCH). Pre-operatively, all patients had Maquet views taken to determine alignment of the knee as well as routine anteroposterior, lateral and skyline views. Subsequent radiographs consisted of routine knee views only. Patellar subluxation, the lateral and skyline views. Subsequent radiographs consisted of routine knee views only. Patellar subluxation, the placement laterally by > 4 mm was considered to represent lateral subluxation. On reviewing the radiographs the assessor was able to determine the approach used and hence was not blinded to the randomisation of the patients. During admission a record was made of any surgical complications and the length of hospital stay. On day five post-operatively the range of movement and the VAS for knee pain were recorded.

Of the 32 patients, four were lost to follow-up, two each from the medial approach group at one year and two years respectively leaving 28 with complete results at two years. One patient refused to participate in the study after the six-month data had been collected. Three patients died between the six-month and two-year reviews. The data from all of these patients were included in the results until they were lost from the study.

Operative technique. All operations were performed by the senior author (MSK) using a cemented Low Contact Stress (LCS; De Puy, Warsaw, Indiana) rotating platform TKR. All the patients received peri-operative antibiotics for 24 hours commencing on induction. A laterally based paramedian longitudinal incision 2 cm to 3 cm from the midline was used in both groups. This was the surgeon’s preference since he believed that this produced less discomfort from the scar when kneeling and decreased the area of numbness over the anterolateral aspect of the knee post-operatively. Additionally, this approach aided in blinding both the patient and research assistant to the approach used.

The posterior cruciate ligament was resected in all the patients. An extramedullary alignment jig was used for the tibial osteotomy and an intramedullary jig for the femur. The patella was not resurfaced in any patient.

Thromboprophylaxis with low-molecular-weight heparin was begun post-operatively and continued for the length of the hospital stay. Drains were inserted intra-operatively and removed at day one. The post-operative rehabilitation programme was identical in both groups with no restrictions placed on the patients in terms of the range of movement or weight-bearing status.

The medial parapatellar approach included a midline longitudinal division of the quadriceps tendon and lateral version of the patella. The need for a lateral release was determined after implantation following the rule of ‘no thumb’ where before closure of the arthrotomy, good patella tracking had to occur without pressure of the thumb on the patella. If medial pressure was necessary to provide good patellar tracking, a lateral release was performed. This resulted in three lateral releases being undertaken.

The lateral subvastus approach involved a muscle-sparing elevation of vastus lateralis (Fig. 1). Care was taken at this stage to identify and cauterise the superior lateral geniculate vessels. The approach was extended inferiorly in two layers in a double-breasted waistcoat fashion. The superficial capsule was incised medially alongside the patella and patellar tendon, the deeper dissection through the synovial layer completing the arthrotomy, more laterally. This allowed any lateral opening which might follow when correcting a varus deformity to be closed by soft tissue.

The insertion of the patellar tendon was identified and a 10 mm osteotome was used to form a transverse step cut at its superior border which is important to prevent superior translation of the tibial tubercle post-operatively. The intention was to produce a step 6 mm to 10 mm deep and at right angles to the longitudinal axis of the tibia (Fig. 2). Then using an oscillating saw the tibial tubercle osteotomy was developed breaching only the lateral cortex. It was important that the osteotomy was at least 70 mm long and approximately 30 mm wide and 10 mm thick. Smaller osteotomies have been associated with failure of fixation. Broad-blade osteotomes were used to...
extend the osteotomy through the medial cortex (Fig. 3). Care was taken to avoid disruption of the medial periosteum. The tibial tubercle osteotomy was then everted on its periosteal hinge and the patella subluxed medially allowing flexion and full exposure of the knee (Fig. 4).

After insertion of the component the osteotomy was lagged in situ using two 3.5 mm cortical screws angled as necessary to bypass the stem of the prosthesis. The arthrotomy and skin were then closed in layers (Fig. 5).

**Statistical analysis.** For statistical analysis non-parametric chi-squared, Mann-Whitney and the Wilcoxon test were performed using the SPSS software package (SPSS Inc., Chicago, Illinois). A p-value ≤ 0.05 was considered to be statistically significant. A post hoc power calculation showed a power of 75% for both the AKS and the WOMAC scores. The knee flexion power calculation was only 55%.

**Results**

There was no significant difference (all p > 0.7) between the two groups in regard to the length of stay in hospital (lateral, 8.5 days (5 to 14); medial, 7.5 days (5 to 12)), the range of movement at day five (lateral, 60.9° (40° to 80°); medial, 60.6° (35° to 85°) and the VAS for pain at day five (lateral, 2.8 (0 to 5); medial, 2.9 (0 to 5)).

There was no significant difference in any of the clinical outcome scores at any review period in the two groups (Figs 6 and 7). At two years the mean AKS knee and function scores had improved significantly compared with the pre-operative scores in both groups (lateral, p < 0.001; medial, p < 0.001). The mean range of flexion improved in both groups from the pre-operative value in the lateral approach group from 110.7° (70° to 135°) to 121.9° (105° to 140°) (Wilcoxon test, p = 0.03) and in the medial approach
group from 98.3° (60° to 120°) to 112.1° (90° to 130°) (Wilcoxon test, p = 0.02). Patient satisfaction at two years reported on the VAS was a mean of 9.6 (7 to 10, 16 of 16 patients) in the lateral group and a mean of 8.8 (6 to 10, 12 of 16 patients) in the medial group. The mean WOMAC scores improved significantly from a pre-operative value of 47.2 (35 to 54, 16 of 16 patients) (lateral) and 46.2 (25 to 65, 16 of 16 patients) (medial) to 3.9 (0 to 16, 16 of 16 patients) (lateral) and 8.1 (0 to 20, 14 of 16 patients) (medial) at one year (p < 0.001, p < 0.001, respectively). This represented 16 of 16 good or excellent WOMAC scores in the lateral approach group, compared with 13 of 14 good or excellent WOMAC scores and one fair score in the medial approach group.

Two of the tibial tubercle osteotomies had not progressed to radiological union by six months, but united in a satisfactory position by one year. One patient had proximal migration of the tibial tubercle of 5 mm between the six-week and three-month reviews. The tibial tubercle united by six months and the patient had no extension lag, active flexion to 115° and WOMAC and AKS functional scores at one year of four and 100, respectively. In the medial group at six months four of 16 patients and at two years three of 12 patients had lateral subluxation of the patella. No patient in the lateral group had patellar subluxation or patellar tilt. Lateral release had not been performed in any of these three patients at the time of surgery. Although the difference in the incidence of patellar subluxation at two years was statistically significant (chi-squared test p = 0.04), lateral subluxation was not associated with poorer WOMAC, satisfaction or AKS scores or a decreased range of movement.

One patient had a complication related to the tibial tubercle osteotomy after having a fall one week after the operation causing proximal displacement of the osteotomy. This required operative re-fixation of the tubercle. She had no further problems and her osteotomy went on to unite by six months without an extension lag, with flexion to 110° and WOMAC and AKS scores of 96 and 80, respectively. One patient in the medial group developed pain and a haematoma near the proximal extent of the incision during strenuous knee flexion 14 days after surgery. The wound was explored in theatre and an acute tear of vastus...
intermedius of 5 cm was found and subsequently repaired. The patient recovered quickly and at one year had no extension lag, flexion to 125°, and WOMAC and AKS scores of 3 and 100, respectively. There were no cases of infection or wound dehiscence.

Discussion

The results identified no difference in outcome for both groups at all stages with the exception of patellar subluxation at two years. Three patients in the medial approach group only had lateral patellar subluxation. Nevertheless, even this had no influence on outcome, although the effect on the long-term function and longevity of the implant is unclear. None of these three patients had a lateral release at the time of surgery, but three other patients in the medial group did require a release. This incidence of ‘lateral release’ is consistent with that reported in the literature,8,9 but perhaps more liberal use of this procedure would lower the incidence of patellar subluxation. However, this would not have been without potential adverse sequelae. It has been reported that lateral release combined with a medial approach can significantly disrupt the patellar blood supply.10-12 This has been thought to be a cause of patellar necrosis and fracture after TKR.13 The lateral subvarus approach with tibial tubercle osteotomy, which incorporates a lateral release during the exposure avoids this problem.

The development and subsequent securing of the osteotomy as part of the lateral subvarus approach extends the operative time by ten to 15 minutes, requires a longer skin incision and carries the risk of complications related to the osteotomy. In our study we had one such complication in a patient with displacement of the tubercle osteotomy after a fall and in two patients the time to radiological union was more than six months. This compared favourably with the findings of other studies.6,13-15

The lateral subvarus approach with tibial tubercle osteotomy is a safe, reproducible technique, but it does not result in a better clinical outcome for TKR. Hence we do not advocate it as the standard approach for all TKRs. The benefits of this approach are best realised in cases in which problems with patellar tracking are anticipated or when there is a risk of intra-operative avulsion of the patellar tendon. Currently, we use it for primary TKRs in patients with a history of patellar instability, valgus deformity, after closing-wedge high tibial osteotomy or if patella baja is present pre-operatively. We also utilise it for revision TKRs.

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References