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Total Knee Arthroplasty for Complex Osteoarthritic Varus Knee Deformities

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Introduction

Total knee arthroplasty (TKA) is a successful procedure for alleviating pain from advanced degenerative diseases. The chief indications are knee pain, deformity and sometimes instability, in a sedentary or active (but not athletic) subject [1]. Complex varus deformities typically are associated with contracture of soft tissue on the concave side of the deformity with severe laxity on the convex side, and substantial bone loss, in addition to a significant sagittal plane deformity, such as flexion contracture or internal tibial torsion, and sometimes diaphyseal tibial varus deformity [2,3]. The most important step in approaching such knees is preoperative planning that typically involves soft tissue release and bone cuts or additional procedures, such as epicondylar osteotomies or reconstruction procedures to re-establish the mechanical and rotational axes while optimizing ligamentous balance and maximizing range of motion which present difficult challenges in cases of severe varus deformity [1,2-5]. In cases of severe varus deformity, bone defects are commonly found and require management with prosthetic augmentation with or without bone grafting [3,4].

Patients and Methods

Clinico-Radiographic Assessment

The study included 41 patients with 45 knees with complex osteoarthritic varus knee deformities, in the period between February 2015 and March 2018, to whom primary total knee arthroplasty was conducted in Ain Shams University Hospitals. The group of patients included 5 males (12%) and 36 (88%) females with a mean age at the time of surgery of 60.31±4.24 years old (range from 55 to 73 years) with varus knee deformities associated with knee flexion deformities ≥ 15 degrees, internal tibial torsion, or lateral knee thrust. All patients were assessed clinically using the Knee Society Scoring System as regards the pain and functional activity. Standing X-ray long film monopedal AP radiographs to assess preoperative mechanical axes and bone defects together with lateral x-rays to assess tibial slope were ordered for all patients. Immediate post-operative X-ray films were done. Patients were asked to visit outpatient clinics 1 week, 2 weeks, 1 month, 3 months, every 3 months for 1 year, and every six months for 2 years after the operation and were assessed by the Knee Society Clinical and Radiological Evaluation System. Any systemic or local complication during the surgery or in the postoperative period was reported and analyzed.

Surgical Technique

The main approach performed in the present study was the medial para-patellar approach in thirty knees (66.7%). While fifteen knees (33.3%) were done by the subvastus approach. The distal femoral and proximal tibial bone was resected using the intramedullary alignment guide. The posterior cruciate ligament (PCL) was resected in all cases. Extension gap first technique was adopted for gap balancing. The sequential medial release was done. In case of severe varus deformity, semimembranosus tissue and the posterior oblique portions of the superficial MCL were released selectively with particular attention to overcorrection. Management of flexion deformities was done through posterior capsular release and removal of posterior osteophytes. Additional resection of distal femur was done along with increasing femoral component size for flexion and extension gaps balancing. Numerous treatment options have been proposed for dealing with bone defects. The alternatives include additional bone resection, reconstitution of the defect with polymethyl-meth-acrylate, reconstitution of the defect with autogenous or allograft bone, or metal augmentation. Stem extensions were employed considering the bone quality of the tibial cut surface. All implants were fixed using bone cement. Patelloplasty was performed on all patients without resurfacing of the patella.

Statistical Analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage. Paired sample t-test of significance was used when comparing quantitative parameters in the same group before and after the surgical procedure. Chi-square (x2) test of significance was used in order to compare proportions between two qualitative parameters. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the

p-value was considered significant if <0.05 and was considered insignificant if >0.05.

Results

The mean post-operative tibio-femoral valgus angle was 6.2 0 (range from 20 to 80 valgus), compared with average pre-operative tibio-femoral valgus angle of 12.4˚ (range from 50 to 400 varus). Postoperatively full correction of flexion deformity up to 00 was achieved in 36 cases (80%) while 8 cases (18%) had residual flexion deformity of 50 and only one case (2%) had residual deformity of 100 and this could be attributed to the severity of preoperative flexion deformity. The mean improvement of flexion deformity was 1.10 ± 20 postoperatively compared to 17.40 ± 70 preoperatively. Knee society score improved from 12.8 preoperatively to 91.5 postoperatively and the functional knee score improved from 36 preoperatively to 82 postoperatively.

Discussion

The most important step in approaching knees with complex osteoarthritic varus deformities is preoperative planning to re-establish the mechanical and rotational axes while optimizing ligamentous balance and maximizing range of motion [1,4,6,7]. These challenges are magnified in TKA patients with severe deformity, particularly if the aim is to correct the deformity while balancing the soft tissues so as to use the least amount of constraint [7]. The main approach performed in the present study was the medial para-patellar approach in thirty knees (66.7%). While fifteen knees (33.3%) were done by the subvastus approach. De Muylder et al. [7] also adopted the minimally invasive far medial subvastus approach [7]. The subvastus approach allows a rapid mobilization of the knee. Despite the parapatellar arthrotomy, straight leg raising is achievable earlier to allow useful daily activities [8].

In the present study, all the patients were planned to use a posterior stabilized prosthesis i.e. sacrificing the PCL as the study done by Lee et al. [9] The philosophy of De Muylder et al was adopted where the combination of a minimally invasive far medial subvastus approach, interchangeable PS implants and staged soft tissue release implied that the benefits of more conventional implant designs can be made available to patients [7]. Sequential release of the medial structures was done including stripping the superficial MCL and in every step of release the gaps were checked to avoid over release. None of the 45 knees developed medial laxity post operatively.

Lee et al. [9] performed sequential medial release with use of a thicker polyethylene inlay. In case of severe varus deformity, semimembranosus muscle and the posterior oblique portions of the superficial MCL along the medial tibial flare were released selectively with particular attention to overcorrection. Fixed flexion deformity is among the most challenging problems of total knee arthroplasty (TKA). According to Jain et al. [10] in case of grade I flexion contracture regular soft-tissue release, and removal of osteophytes are all that is necessary. In grade II fixed flexion deformity (>300), distal femoral over-resection of 2mm should be done to begin with, followed by release of the contracted soft-tissue structures. In grade III deformity, distal femoral over-resection by 4mm was done to start with, followed by complete release of the posterior capsule from both the tibia and femur as in cases of grade II [10]. These steps were utilized in the present study.

Cheng et al. [11] found that in cases with a preoperative FFD a statistically significant decrease in the mean fixed flexion was demonstrated between preoperative and year one follow-up (16.9±5.7 vs 4.1 ±6.0, respectively; p<0.001), years one and five (4.2 ± 6.0 vs 2.6 ±4.8, respectively; p<0.001) and between years five and ten (2.6±4.8 vs 1.1±3.1, respectively; p=0.009). (11) While in the present study after average follow up of 27 months flexion deformity improved significantly (p-value <0.001) where all cases had flexion deformity. Twenty-three knees (52%) had mild flexion deformity (less than 15˚) while Twenty-two knees (48%) had severe flexion deformity (15˚ - 40˚).

Numerous treatment options have been proposed for dealing with bone defects. The alternatives include additional bone resection, reconstruction of the defect with polymethyl-meth-acrylate, reconstruction of the defect with autogenous or allograft bone, or metal augmentation. In the same way which was done in the present study Lee et al. [9] managed bone defects more than 5 mm were with a rectangular metal block augmentation in 3 cases with mild varus deformity and 26 cases with severe varus deformity. Stem extensions were employed considering the bone quality of the tibial cut surface. They used bone grafts in managing bone defects in 10 knees in their study [9].

In the present study, tibial stems were used in 8 cases where tibial defects' reconstruction was done and in cases of osteoporosis of subchondral bone to prevent collapse of tibial components. In the present study, all the patients were planned to use a posterior stabilized prosthesis i.e. sacrificing the PCL as the study done by Lee et al. [9] All implants were cemented similar to what was done in most of the cases of the compared studies of De Muylder [7], Cheng et al. [11], Lee et al. [9], and Dixon et al. [12] who cemented all tibial components and 11 femoral components of 12 cases [7,9,11,12]. Patelloplasty was performed on all patients without resurfacing of the patella as what was done in the present study.

In the current study, the average post-operative tibio-femoral valgus angle was 6.2 0 (range from 20 to 80 valgus), compared with average pre-operative tibio-femoral valgus angle of 12.4˚ (range from 50 to 400 varus). The mean improvement of flexion deformity was 1.10 ± 20 postoperatively compared to 17.40 ± 70 preoperatively. Compared to the study of Lee et al. [9], the mean postoperative tibiofemoral angles at last follow-up were 7.10 ± 2.50 in the mild varus group and 6.40 ± 2.50 in the severe varus group [9]. According to Dixon et al. [12] the mean

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tibiofemoral angle was 4° of valgus (range, 2° to 7°). The mean anatomic alignment of the tibial component was 90° (range, 90° to 92°). (12)

Knee society score improved from 12.8 preoperatively to 91.5 postoperatively and the functional knee score improved from 36 preoperatively to 82 postoperatively. Lee et al. [9] reported in their series improvement of the mean knee society score from 21 preoperatively to 96 postoperatively and the function knee score from 39 to 77 in the mild varus group at 2 years follow up and improvement of the mean knee society score from 14 preoperatively to 97 postoperatively and the function knee score from 33 to 79 in the severe varus group at 2 years follow up [9]. In the study of Dixon et al. [12] the KSS increased from a mean of 24 (range, 0 to 43) to a mean of 94 (range, 78 to 100). The FS improved from a mean of 34 (range, 0 to 70) to a mean of 85 (range, 45 to 100). The arc of movement increased from a mean of 93° (range, 30° to 120°) to a mean of 112° (range, 80° to 125°) [12]. A regards Jain et al. [10] mean KSS improved from 41.5 to 92.5 (knee score) and from 48.3 to 81 (function score) in group 1. In group 2, patients scores improved from 18.1 to 75 (knee score) and from 34.7 to 80.7 (function score) [10]. Their results coincided with the present study results.

Conclusion

Success in management of complex knee deformities in osteoarthritic patients can be achieved by meticulous preoperative planning and proper surgical techniques. Subvastus approach provides earlier range of motion post-operatively than medial para-patellar approach. Subvastus approach can be done in obese patients and in cases of severe deformities in contrast to what was believed before. Measured resection technique provides balancing extension then flexion gaps before soft tissue release, cutting less tibial and femoral bone than gap balancing technique and preserving bone stock for future revisions. Flexion contractures can be fully corrected intraoperatively, yet post-operative range of motion is dictated by the pre-operative status. PCL retaining was not an option in dealing with deformed knees as PCL poses a strong force against deformity correction. Recent guidelines for deformity correction during total knee replacement showed excellent to good results in all cases of this study, yet longer studies with larger numbers are needed to rule out the occurrence of loosening or any other complications.

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