Relation between functional and radiographic outcome after total knee arthroplasty

Elsayed Morsi[1], MD; Adel I. El Seedy[2], MD; Hany El-Sayed[3], MD and Abo El-Magd Sobhy Mostafa[4], MBBCh

Department of orthopedic Surgery Menofia university.
1- Professor , orthopedic Department of Surgery Menofia university.
2- Assistant Professor , orthopedic Department of Surgery Menofia university.
3- Lecturer , orthopedic Department of Surgery Menofia university.
4- Resident of orthopeadic surgery sidnawy health insurance hospital.

Corresponding Author: *Abo El Magd Sobhy Mostafa*
Addresskotour .tanta egypt.
Email: magdd87@yahoomail.com.
Mob: 01061687385

ABSTRACT

Background:
Accurate component alignment and joint line reproduction in total knee replacement(TKR) is crucial for successful clinical outcome

Objective:
In this study our aim is to evaluate relation between post operative functional outcome and radiographic outcome after total knee arthroplasty according to knee society scoring system.

Patients and Methods:
This was A retrospective study of 40 patients attended to orthopedic surgery department at Menoufia university hospital and Sidnawy health insurance hospital. These patients were Assessed postoperatively clinically by knee society score and radiologically by standered Antero posterior ,lateral and view.

Results:
Our results showed mean age of the included patients was 57.95±9.29 years. The majority of patients were females 36 (90%). The mean BMI was 29.13± 6.75 kg/m2. The majority of patients were presented with OA 36 (90%). Half of the patients showed right-sided diseasethe mean of Tibiofemoral angle was 4.75 ±0.30. The mean of aMDFA was 97.45 ±2.1, while the mean aMPTA was 87.73 ±2.6. The mean of Femur flextion angle was 5.758 ±2.4, while the mean Proximal tibial slope angle was 77.665 ±20.4. The mean angel deviation from neutral was 5.81 ±3.35the mean scores of knee score was 75.18 ±6.1. The mean of Range of motion flexion was 122.4 ±19.6

The majority of patients were presented with neutral Tibiofemoral angle (57.5%)the association between classification of Tibiofemoral angle and radiographic data. Patients with neutral alignment of Tibiofemoral angle had significantly higher aMDFA angle (p <0.001) and (p =0.002). Patients with neutral alignment of Tibiofemoral angle had significantly lower aMPTA angle deviation from neutral (p <0.001)association between classification of Tibiofemoral angle and KSSS/Range of motion. Patients with neutral alignment of Tibiofemoral angle had significantly higher KSS than patients with varus alignment (85.18 ±6.1 versus 77.18 ±7.3; p <0.001). Similarly, patients with neutral alignment of Tibiofemoral angle had significantly higher range of motion in flexion than patients with varus alignment 126.81 ±16.4 versus 119.65 ±10.4; p =0.002)there was a significant strong negative correlation between angel deviation from neutral in Varus group and range of motion in flexion or knee society scoreWithin the Varus group, we divided the patients into two groups according to angel of deviation. Table 8 shows that patients with angel of deviation of less than 10 had significantly higher KSsS and range of motion than patients with angel of deviation of more than 10.

Conclusion:
following TKR, accurate coronal alignment of total knee prosthesis results in better function and better quality of life. The present study shows that there are significant correlations between the Knee Society Knee Scoring System and radiographic findings. our results showed positive correlations between functional, scores and postoperative tibiofemoral angle and range of motion

Keywords:
Relation- Functional & Radiographic -Outcome - Total Knee Arthroplasty.

INTRODUCTION

Osteoarthritis (OA) is a chronic degenerative joint disease with a high impact on the quality of life. It disables approximately 10% of persons over the age of 60 years causing pain, joint stiffness, functional disability and limited activity(1, 2).

For end stage knee OA, total joint arthroplasty (TJA) is the most successful treatment option, and

it is one of the most performed elective surgical procedures nowadays (3).

The number of TJA for knee OA is expected to increase substantially in the future and patients undergoing TJA are becoming physically more active(4).

The proportion of patients younger than 65 years is expected to increase to 50% of all arthroplasties by 2030 (5).

With a growing and more active older population, and an increasing number of younger patients undergoing TJA, patient demands of TJA are increasing and go beyond just pain relief (4).

Furthermore, numerous studies have shown TKR to achieve favorable outcomes and functional gains for a great variety of patient groups (6) .

The possibility of measuring clinical outcome after a knee procedure is of fundamental importance for the Orthopaedic surgeons(7).

Since the goal of every Orthopedic treatment is to re-establish functional status, it is important to assess clinical outcome not only by objective findings but also by taking into account the patient's point of view and his own evaluation of the functional trend of the treated joint (8).

To this purpose several different evaluation tools have been developed over years: some of them are more general whereas others are more disease-linked (9) .

In this study our aim is to evaluate relation between post operative functional outcome and radiographic outcome after total knee arthroplasty according to knee society scoring system.

PATIENTS AND METHODS

Study Design and population

A retrospective study was carried on 40 patients attending to orthopedic surgery department at Menoufia university hospital and Sidnawy health insurance hospital. Assessed postoperatively clinically by knee society score and radiologically by standered Antero posterior ,lateral and sky line view

❖ *Inclusion criteria were:*
- All osteoarthritic patient admitted for primary total knee arthroplasty including secondary or inflammatory O.A.e.g Rheumatoid patients
- Total knee of more than one year
  Exclusion criteria were:
- Revision total knee arthroplasty
- Total knee arthroplasty of less than one year

Our study looked for three items :
1) the relationship between postoperative overall anatomical knee alignment and knee score.
2) the relationship between postoperative coronal alignment of the femoral and tibial component and knee score.
3) the relationship between postoperative sagittal alignment of the femoral and tibial components and knee score**.**

Physical examination

Patient examined clinically according to items of knee society score. Pateint age ,sex,body mass index and operated limb were recorded

A. First items of knee society score is assessment of pain during walking and climbing stairs .if patient felt pain during walking ,he or she was scored from 0 to 35 points according to the degree of pain if it was sever to moderate to mild to none during walking .pain during climbing stairs from 0 to 15 if it was sever to moderate to mild to none during climbing stairs.

B- Assessment of range of motion
- active range of motion assesd and every eight degrees range of motion achived by prosthetic knee equal one point of score .

C- assessment of stability of prosthetic knee
- medial and lateral stability assesd by valgus and varus stress test at maximally extended knee .
- medial gaping by valgus stress test assesd degree of medial stability of prosthetic knee .gapping from 0 to 5mm considered stable and scored 15 point and by same way varus stress test used to asses lateral gapping and stability of knee .if gapping from 5-10mm the knee scored by 10 points .if gapping more than 10 mm ,knee scored by 5 points
- anterior and posterior stability assesd by anterior and posterior drawer testat 90 degree flexed knee so if shifting of prosthetic knee from 5-10 ,the knee scored by 10 points , if shifting from 5-10,the knee scored by 8 points ,if shifting was more than 10 mm,the knee scored by 5 points .

D- the items which reduce the score were extension lag flexion contracture ,malalignment and pain at rest.
- if the lag of extension of knee was more than 11 degrees, the score reduced by 10 points .if the lag of extension was from 5-10,the score reduced by 5 points .if extension lag was less than 4 degrees ,the score reduced by 2 points .if there was no extension lag ,there was no reduction of the score .

- the second item which makes reduction of the score was flexion contracture .if flexion contracture more than 20 degrees ,the score reduced by 10 points .if an angle of contracture was from 11-20degrees ,the reduction of the score was 5points and if flexion contracture was from 6-10 degrees ,the score reduced by 3points .if contracture was less than 5 degrees ,there was no reduction of the score .
- the third item which makes reduction of the score was malalignment of the limb of the prosthetic knee .this was evaluated during standing posistion which were rotated by patella facing forward.if malalignment was from 5-10 degrees ,there were no reduction of the scoreand every 5 degree more than 10 of malalignment make reduction of score by 2 points .
- fourth item which make reduction of the score was pain at rest . if there was no pain at rest there was no reuction of the score. if mild pain at rest, the reduction of the score was by 5 points .if moderate pain at rest ,reduction of the score was by 10 points and sever pain at rest makes 15 points reduction of the score .

The maximum knee score is one hundrd points .

Radiographic evaluation

Component alignment was measured from standard radiographs. The weight-bearing anteroposterior (AP) and supine lateral (LAT) views were taken using an 18 by 43 cm film with the knee in full extension. Coronal plane alignment was measured on the AP view using the following angles.

The medial angle between the anatomical axis of the femur and the horizontal axis of the condyles is the coronal femoral component angle (cFCA)

The medial angle between the anatomical axis of the tibia and the horizontal axis of the tibial component is the coronal tibial component angle (cTCA) or the medial proximal tibial angle(10).

The angle between the anatomical axes of the tibia and femur is the coronal alignment of the knee (CAK). CAK is calculated indirectly as the sum of (cTCA–90) and (cFCA–90)(11).

The anatomical femoral axis was defined as the line connecting the midpoint of the endosteal cortices of the femoral isthmus to the midpoint of the femur 10 cm proximal to the joint line. Similarly, the anatomical tibial axis was determined as the line connecting the midpoint of the midshaft of the tibia to the midpoint of the tibia 10 cm distal to the joint line

When assessing coronal alignment on short films, an FTA-short value less than 4° was considered varus, neutral between 4° and1o°, and valgus greater than 1o°(12-15).

Sagittal plane alignment was measured on the lateral view .The posterior angle between the midline axis of the tibia and a line drawn across the tibial tray is the sagittal tibial component angle (sTCA; a).The angle between the midline axis of the femur and a line drawn perpendicular to the distal part of the femoral component is the sagittal femoral component angle (sFCA; g)(11). 2. according to Petersen and Engh (1988) and as used by e.g. Ritter et al. (2011). Flexion of the femoral component is measured as the angle (FF) between the line across the bottom of the femoral implant and the femoral shaft axis. FF range from (0-6)more than 6 indicate flexion of femoral componenet (16). Tibial slope* is measured as the angle (TS) between the line across the bottom of the tibial plate and the tibial shaft axis. TS = 90 correponds to neutral placement, TS > 90 corresponds to anterior tibial slope*, and TS < 90 corresponds to posterior tibial slope.

Statistical analysis

An Excel spreadsheet was established for the entry of data. We used validation checks on numerical variables and option-based data entry method for categorical variables to reduce potential errors. The analyses were carried with SPSS software (Statistical Package for the Social Sciences, version 24, SSPS Inc, Chicago, IL, USA). The normality of the data were assessed using Shapiro-Wilk Test. Numerical data were described as mean±SD if normally distributed; or median and interquartile range [IQR] if not normally distributed. Frequency tables with percentages were used for categorical variables. Mann-Whitney tests and Wilcoxon matched pairs test were used to compare non-parametric quantitative variables. A p-value < 0.05 is considered statistically significant.

RESULTS

The present study was a retrospective study that was carried on 40 patients attending to orthopedic surgery department at Menoufia university hospital and Sidnawy health insurance hospitals and completed one year of follow-up after primary TKR.

Table 1: The baseline demographic characteristics of the included patients

Parameters	Enrolled Patients (n=40)
Age in years • Mean ±SD	57.95 ± 9.29
Gender • Male • Female	4 (10%) 36 (90%)
BM I (Kg/m²) • Mean± SD	29.13± 6.75
Disease • Osteoarthritis • Rheumatoid arthritis	36 (90%) 4 (10%)
Side • Left side • Right side	18 (45%) 20 (50%)

Data are presented as mean ±SD or number (%).

The mean age of the included patients was 57.95±9.29 years. The majority of patients were females 36 (90%). The mean BMI was 29.13± 6.75 kg/m². The majority of patients were presented with OA 36 (90%). Half of the patients showed right-sided disease.

Table 2: Radiographic Data

Parameters	Enrolled Patients (n=40)
	Mean ±SD
Tibiofemoral angle	4.75 ±0.30
aMDFA	97.45 ±2.1
aMPTA	87.73 ±2.6
Femur flextion angle	5.758 ±2.4
Proximal tibial slope angle	77.665 ±20.4
Angle deviation from neutral	5.81 ±3.35

Data are presented as mean ±SD, median (Range)

Table 2 showed that the mean of Tibiofemoral angle was 4.75 ±0.30. The mean of **aMDFA** was 97.45 ±2.1, while the mean **aMPTA** was 87.73 ±2.6. The mean of **Femur flextion angle** was 5.758 ±2.4, while the mean **Proximal tibial slope angle** was 77.665 ±20.4. The mean angel deviation from neutral was 5.81 ±3.35.

Table 3: Knee Score Domains and Range of motion in flexion

Parameters	Enrolled Patients (n=40)
	Mean ±SD
Knee society score	84.18 ±12.1
Range of motion flexion	122.4 ±19.6

Data are presented as mean ±SD, median (Range)

Table 3 showed that the mean scores of knee score domains. The mean objective score was 75.18 ±6.1. The mean of Range of motion flexion was 122.4 ±19.6.

Table 4: Classification of Tibiofemoral angle

Variable	Enrolled Patients N=40
Tibiofemoral angle • Varus • Neutral	17 (42.5%) 23 (57.5)

Data presented as number (%)

The majority of patients were presented with neutral Tibiofemoral angle (57.5%).

Table 5: Association between classification of Tibiofemoral angle and radiographic data

Variable, mean ±SD	Neutral Alignment N=23	Varus Alignment N=17	P-value
aMDFA	97.45 ±2.1	91.3 ±7.3	<0.001*
aMPTA	87.73 ±2.6	85.2 ±10.4	0.002*
Femur flextion angle	5.758 ±2.4	5.23 ±1.98	0.07
Proximal tibial slope angle	77.665 ±20.4	77.1 ±18.4	0.37
Angle deviation from neutral	2.00±0.60	8.10 ±1.86	<0.001*

Data presented as number (%)

Table 5 shows the association between classification of Tibiofemoral angle and radiographic data. Patients with neutral alignment of Tibiofemoral angle had significantly higher aMDFA angle (p <0.001) and (p =0.002). Patients with neutral alignment of Tibiofemoral angle had significantly lower aMPTA angle deviation from neutral (p <0.001).

Table 6: Association between classification of Tibiofemoral angle and KSS/Range of motion

Variable, mean ±SD	Neutral Alignment N=23	Varus Alignment N=17	P-value
Knee society score	85.18 ±6.1	77.18 ±7.3	<0.001
Range of motion	126.81 ±16.4	119.2 ±10.4	0.002

Data presented as number (%)

Table 9 shows the association between classification of Tibiofemoral angle and KSS/Range of motion. Patients with neutral alignment of Tibiofemoral angle had significantly higher KSS than patients with varus alignment (85.18 ±6.1 versus 77.18 ±7.3; p <0.001). Similarly, patients with neutral alignment of Tibiofemoral angle had significantly higher range of motion in flexion than patients with varus alignment 126.81 ±16.4 versus 119.65 ±10.4; p =0.002).

Table 7: Correlation between angel deviation from neutral in Varus group and KSS/Range of motion

Variables	Angel deviation from neutral in Varus group	
	r	P-value
Range of motion flexion	-0.499	<0.001
Knee society score	-0.364	0.021

Table 10 showed that there was a significant strong negative correlation between angel deviation from neutral in Varus group and range of motion in flexion or knee society score.

Table 8: Association between classification of Tibiofemoral angle and KSS/Range of motion

Variable, mean ±SD	Angel deviation from neutral in Varus group		P-value
	< 10	> 10	
Knee society score	79.25 ±4.1	73.2 ±8.3	0.03
Range of motion	126.01 ±12.43	118.5 ±9.36	0.002

Data presented as number (%)

Within the Varus group, we divided the patients into two groups according to angel of deviation. Table 11 shows that patients with angel of deviation of less than 10 had significantly higher KSS and range of motion than patients with angel of deviation of more than 10.

DISCUSSION

While osteoarthritis (OA) affects millions of Americans, the knee is the most commonly affected joint plagued by this progressive condition which is hallmarked by a gradual degeneration and loss of articular cartilage. Total knee arthroplasty (TKR) is one of the most cost-effective and consistently successful surgeries performed in orthopedics. Patient-reported outcomes are shown to improve dramatically with respect to pain relief, functional restoration, and improved quality of life. TKR provides reliable outcomes for patients' suffering from end-stage, tri-compartmental, degenerative OA(10).

With such high rates of efficacy and increasing demand, TKR operations have steadily grown in number. Consequently, much research has been done to better understand the patient-related factors that contribute to either favorable or poor patient-reported outcomes. There are a substantial number of patients who have unfavorable postsurgical function. These patients may experience no improvement in symptoms after TKR and may even see a decline in overall knee function. Likewise, it has been shown that up to 20% of patients may be dissatisfied with their TKR operation(11).

Although there will always be some unfavorable outcomes with any operation, there is a great interest in being able to identify those patients who will have unsatisfactory outcomes after TKR. Many recent studies have sought to predict patient outcomes based on radiographic findings, knee function scores, mental health, and socioeconomic status. Each of these variables has shown to have some predictive value but each has significant limitations(12).

Mal-positioning/orientation of the prosthesis may result in premature mechanical loosening of components and patellofemoral problems. Recent reports have shown that malalignment of >3° of the mechanical axis is associated with accelerated implant wear and poor function. Thus, it was proposed that postoperative radiographic findings are well-correlated with the functional scores of the patients(12).

Nevertheless, there is a lack in the published literature that evaluated the relation between postoperative functional outcome and radiographic outcome. Therefore, we conducted the presnet study in order to evaluate the relation between functional and radiological outcome of patients after TKR.

The present study was a retrospective study that was carried on 40 patients attending to orthopedic surgery department at Menoufia university hospital and Sidnawy health insurance hospitals and completed one year of of follow-up after primary TKR.

In terms of demographic and clinical characteristics of the included patients, the mean age of the patients was 57.95±9.29 years and the majority of them were females (90%). The majority of patients were presented with OA (90%).

In line with our findings, **Souza and colleagues**, in 2016, conducted a retrospective study in order to assess socio-demographic characteristics of patients undergoing TKR in a public university hospital. A total of 78 patients undergoing TKR, from 2013 to 2014, were included. As to gender, 64 (79.1%) were females. Regarding etiology, only OA affected 71 (87.65%) patients. The age range was between 29-84 years old (mean 64 years) (17).

Similarly, **Hylkema and colleagues**, in 2017, aimed to to describe demographic, physical, psychological and social characteristics of working TKA patients. A cross-sectional analysis of 152 working TKA patients was used. Almost 70% of the patients were females with a mean age of 55 years old(13).

Although several methods have been introduced to assess coronal alignment of the knee, assessments based on plane radiographs have become established as standard methods. There are two ways of assessing coronal alignment of the knee using plane radiographs, namely, by measuring the anatomical tibiofemoral angle (anatomical TFA) on standard (14 × 17 inch) knee radiographs, and by measuring mechanical tibiofemoral angle (mechanical TFA) on full-limb radiographs(14).

In the present study, the mean of Tibiofemoral angle was 4.75 ±0.30. We found that there was a significant strong positive correlation between Tibiofemoral angle with objective and satisfaction scores of The Knee Society Clinical Rating System. In addition, there was a significant association between Knee score and Tibiofemoral angle categories; in which patients with neutral angle had better scores.

In concordance with our findings, **Manjunath and colleagues** conducted a prospective study of 120 knees in 80 patients that underwent TKA at Victoria and Bowring and Lady Curzon hospitals. Postoperatively, Tibiofemoral angle correlated significantly with better knee score (p = 0.026). Inliers in tibiofemoral axis alignment parameter had extremely significant better knee score (p = 0.0001) and also functional score (p = 0.0082)(13).

Similarly **huang and colleagues** shown that accurate coronal alignment of total knee prosthesis (to within 3° of neutral) results in better function and better quality of life up to 5 years postoperatively. Improved pain scores are seen in accurately aligned prostheses up to 2 years postoperatively(18).

Similarly, **Youm and colleagues** evaluated minimum 5-year follow-up clinical and radiological results of TKA. One hundred and twenty knees in 80 patients who could be followed up for more than 5 years after TKA were evaluated retrospectively. The tibiofemoral angle was changed from 4.6° varus preoperatively to 5.8° valgus postoperatively and correlated signifcantlky with the Knee Society Clinical Rating System and function scores(14).

Longstaff,and colleagues One hundred and fifty-nine total knee arthroplasties were performed at the authors' institution between May 2003 and July 2004. All patients underwent anobjective and independent clinical and radiological assessment before and after surgery. The alignment parameters that were measured included sagittal femoral, coronal femoral, agittal tibial, coronal tibial, and femorotibial mismatch. The cumulative error score, which represents the sum of the individual errors, was calculated. Functional outcome was measured using the Knee Society Score. Good coronal femoral alignment was associated with better function at 1 year (P = .013). Trends were identified for better function with good sagittal and good sagittal and coronal tibial alignment. Patients with a low cumulative error score had a better functional outcome (P = .015). These patients rehabilitated more quickly and their length of stay in hospital was 2 days shorter. (19)

In contrary, **Kim and colleagues** evaluated the influence of postoperative tibiofemoral alignment on the clinical results and failure in patients who underwent KA. The authors reviewed 246 cases of medial UKA which were followed up for at least 5 years after the operation. During the follow-up, which averaged 7 years and 5 months, the knee score and function score were improved significantly in all groups regardless of the tibiofemoral angle (p<0.01). There were no significant difference between the groups in the clinical results (p>0.05)(16).

The exact causes of such heterogenity between our findings and the abovementioned study are unclear. However, these differences cen be attributed to difference in study design, length of follow-up, or sample size.

Postoperative knee range of motion (ROM) is one of the most important factors influencing patient satisfaction after TKR. A limited flexion angle hinders activities of daily living, and patients experience low satisfaction levels when their activity is lower than the preoperative level or when they are unable to enjoy anticipated activities(17).

In the present study, we found that the mean of Range of motion flexion was 56.81 ±16.59. There was a significant strong positive correlation between range of motion in flexion with objective and satisfaction score.

In agreement with our findings, **Matsuda and colleagues** retrospectively evaluated 375 patients who had undergone 500 TKR between 2000 and 2009 The ROM correlated with functionl scores. Varus alignment and limited ROM negatively correlated with the expectation(18).

Similarly, **Promish and colleagues** performed a review is to evaluate clinical outcome with reference to the coronal alignment of the limb and safety based on Knee Society Score. The authors concluded that the Knee Society Score correlated signifcantly with coronal alignment and range of motion(19).

Study's Limitations

We acknowledge that the present study has some limitations. The sample size of the included patients was relatively small. In addition, the short time of the study did not allow us to assess the correlation between long-term functional scores and radiographic findings.

Conclusion

In conclusion, following TKR, accurate coronal alignment of total knee prosthesis results in better function and better quality of life. The present study shows that there are significant correlations between the Knee Society Knee Scoring System and radiographic findings. our results showed positive correlations between functional, scores and postoperative tibiofemoral angle and range of motion..

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