Relation between functional and radiographic outcome after total knee arthroplasty

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ABSTRACT

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Background:
The successful clinical outcome of a total knee replacement (TKR) is contingent upon the precise alignment of components and the reproduction of the joint line.
Objective: In this study, we aim to evaluate the relationship between postoperative functional outcome and radiographic outcome after total knee arthroplasty according to the knee society scoring system.
Patients and Methods:
This was A retrospective study of 40 patients who 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 standard Anteroposterior, lateral, and view.
Results:
The mean age of the patients included in our study 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 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 Femur flexion angle was 5.758 ±2.4, while the mean Proximal tibial slope angle was 77.665±20.4. The mean angle deviation from neutral was 5.81 ±3.35the mean scores of knee score was 75.18 ±6.1. The mean 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. The aMDFA angle was markedly higher in patients with neutral alignment of the Tibiofemoral angle (p <0.001) and (p =0.002). Patients with the neutral alignment of the Tibiofemoral angle had significantly lower aMPTA angle deviation from neutral (p <0.001) association between the classification of Tibiofemoral angle and KSSS/Range of motion. Patients with neutral alignment of the 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 a 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 significantly strong negative correlation between angel deviation from neutral in the Varus group and range of motion in flexion or knee society score within the Varus group, we divided the patients into two groups according to angel of deviation. Table 8 illustrates that patients with an angle of deviation of less than 10 exhibited significantly more KSsS and range of motion than those with an angle of deviation of more than 10.
Conclusion:
Accurate coronal alignment of total knee prostheses leads to improved function and quality of life following TKR. 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- between- Functional - Radiographic -Outcome -after Total Knee Arthroplasty.

INTRODUCTION

Osteoarthritis (OA) is a chronic degenerative joint disease that impacts the quality of life in a significant way. It causes pain, joint rigidity, functional disability, and limited activity in approximately 10% of individuals over the age of 60.

(1,2).
One of the most frequently performed elective surgical procedures today, total joint arthroplasty (TJA) is the most effective treatment option for end-stage knee OA (3).
Patients who undergo TJA procedures are

becoming more physically active, and it is anticipated that the number of TJA procedures for knee OA will increase significantly in the future (4).

By 2030, it is anticipated that the percentage of patients under the age of 65 will rise to 50% of all arthroplasties (5).

In light of the increasing number of younger patients undergoing TJA and the growing and more active elderly population, patient demands for TJA are expanding beyond pain relief (4).

Additionally, Numerous studies have shown that TKR can result in functional improvements and favorable outcomes for a diverse array of patient populations (6)

Orthopedic surgeons prioritize the feasibility of quantifying clinical outcomes after knee procedures (7).

It is imperative to assess the clinical outcome not only in terms of objective findings but also by taking into account the patient's perspective and their evaluation of the functional trajectory of the treated joint, as the primary goal of all orthopedic interventions is to reestablish functional status (8). This objective has been accomplished through the development of a variety of evaluation instruments over the years: Some of them are more general, while others are more closely associated with specific diseases (9).

Our objective in this investigation is to assess the correlation between the postoperative functional outcome and the radiographic outcome of total knee arthroplasty following the knee society scoring system.

PATIENTS AND METHODS
Study Design and Population
A retrospective study was carried out 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 standard Anteroposterior, lateral, and skyline view

The inclusion criteria were:
• All osteoarthritic patients admitted for primary total knee arthroplasty including secondary or inflammatory O.A.e.g Rheumatoid patients
• Total knee of more than one year

The exclusion criteria were:
• Total knee arthroplasty revision
• Total knee arthroplasty of less than one year

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

Physical examination
The patient was examined clinically according to items of knee society score. Patient age, sex, body mass index, and operated limb were recorded.

A. The first item of the knee society score is an assessment of pain during walking and climbing stairs. If a patient felt pain during walking, he or she was scored from 0 to 35 points according to the degree of pain if it was severe to moderate to mild to none during walking. Pain during climbing stairs from 0 to 15 if it was severe to moderate to mild to none during climbing stairs.

B- Assessment of range of motion
- The active range of motion is assessed, and each eight degrees of range of motion attained by the prosthetic knee is equivalent to one point of score.

C- assessment of the stability of the prosthetic knee
- medial and lateral stability assessed by valgus and varus stress test at maximally extended knee.
- Medial gaping by valgus stress test assessed the degree of medial stability of prosthetic knee .gapping from 0 to 5mm was considered stable and scored 15 points and in the same way, varus stress test was used to assess lateral gapping and stability of the knee. If gapping from 5-10mm the knee scored by 10 points. If gapping more than 10 mm, the knee scored by 5 points
- anterior and posterior stability assessed by anterior and posterior drawer test at 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- Extension, lag, flexion contracture, malalignment, and discomfort at rest were the items that reduced the score.
- If the lag of the extension of the knee was more than 11 degrees, the score was reduced by 10 points. If the lag of extension was from

5-10, the score was reduced by 5 points. If the extension lag was less than 4 degrees, the score was reduced by 2 points. If there was no extension lag, there was no reduction in the score.

- The second item that reduced the score was flexion contracture. If flexion contracture is more than 20 degrees, the score is reduced by 10 points. If an angle of contracture was from 11- 20 degrees, the reduction of the score was 5 points and if flexion contracture was from 6-10 degrees, the score was reduced by 3 points. If the contracture was less than 5 degrees, there was no reduction in the score.
- The third item that reduced the score was the malalignment of the limb of the prosthetic knee. This was evaluated during the standing position which was rotated by the patella facing forward. If malalignment was from 5-10 degrees, there was no reduction of the score, and every 5 degrees more than 10 of malalignment reduced of score by 2 points.
- The fourth item that reduced the score was pain at rest. If there was no pain at rest there was no reduction of the score. If mild pain at rest, the reduction of the score was by 5 points. If moderate pain at rest, the reduction of the score was by 10 points, and severe pain at rest made 15 15-point reduction of the score.

The maximum knee score is one hundred points.

Radiographic evaluation

Component alignment was measured from conventional radiographs. The 18 by 43 cm film was used to capture the weight-bearing anteroposterior (AP) and supine lateral (LAT) views of the knee, which was in full extension. The following angles were used to assess the coronal plane alignment in the AP view.

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

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

Coronal alignment of the knee (CAK) is the angle between the anatomical axes of the tibia and femur. The indirect calculation of CAK is the sum of (cTCA–90) and (cFCA–90) (11).

The line that connects the midpoint of the endosteal cortices of the femoral isthmus to the midpoint of the femur 10 cm proximal to the joint line was defined as the anatomical femoral axis. Similarly, the anatomical tibial axis was defined as the line that connects 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 a short film, a neutral value between 4° and 1°, a valgus value greater than 1°, and an FTA-short value of less than 4° were all considered varus (12-15).

Sagittal plane alignment

The lateral view was used to gather the measurement. The posterior angle between the midline axis of the tibia and a line drawn across the tibial tray is known as the sagittal tibial component angle (sTCA; a). The angle formed between the midline axis of the femur and a line that is perpendicular to the distal part of the femoral component is known as 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). The metric for femoral component flexion is the angle (FF) between the axis of the femoral shaft and the line that runs across the bottom of the femoral implant. Flexion of the femoral component is indicated by an FF value greater than 6, which falls within the range of 0 to 6. (16). Tibial slope* is quantified as the angle (TS) between the tibial shaft axis and the line that spans the underside of the tibial plate. TS = 90 corresponds to neutral placement, TS > 90 corresponds to anterior tibial slope, and TS < 90 corresponds to posterior tibial slope.

Statistical analysis

To simplify data input, an Excel spreadsheet was implemented. To reduce the likelihood of errors, we implemented validation tests for numerical variables and a data entry procedure based on options for categorical variables. The statistical data was analyzed using SPSS software (Statistical Package for the Social Sciences, version 24, SSPS Inc, Chicago, IL, USA). The Shapiro-Wilk Test was employed to evaluate the normality of the data. The mean±SD was used to characterize numerical data that were normally distributed. If they were not normally distributed, they were described as a median and interquartile range [IQR]. Categorical variables were analyzed using frequency tables that included percentages. Wilcoxon matched pairs tests and Mann-Whitney tests were implemented to assess non-parametric quantitative variables. A p-value of less than 0.05 is considered statistically significant.

RESULTS

The present study was a retrospective study that was carried out 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	4 (10%)
• Female	36 (90%)
BM I (Kg/m^2)	
• Mean± SD	29.13± 6.75
Disease	
• Osteoarthritis	36 (90%)
• Rheumatoid arthritis	4 (10%)
Side	
• Left side	18 (45%)
• Right side	20 (50%)

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

The average age of the patients who were included was 57.95±9.29 years. The majority of patients were females 36 (90%). The mean BMI was 29.13± 6.75 kg/m^2. 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 flexion 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 shows that the mean of the 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 **Femur flexion angle** was 5.758 ±2.4, while the mean **Proximal tibial slope angle** was 77.665 ±20.4. The mean angle 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 shows the mean scores of knee score domains. The mean objective score was 75.18 ±6.1. The mean Range of motion flexion was 122.4 ±19.6.

Table 4: Classification of Tibiofemoral angle

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

Data presented as number (%)

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

Table 5: Association between the 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 flexion 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 the 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 the Tibiofemoral angle had significantly lower aMPTA angle deviation from neutral (p <0.001).

Table 6: Association between the 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 6 shows the association between the classification of Tibiofemoral angle and KSS/Range of motion. Patients with neutral alignment of the 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 a 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 7 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 the 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 the angle of deviation. Patients with an angle of deviation of less than 10 exhibited significantly greater KSS and range of motion than those with an angle of deviation of more than 10. This is illustrated in Table 8.

DISCUSSION

Osteoarthritis (OA) is a progressive condition that affects millions of Americans, with the knee being the most commonly affected joint. The continuous degeneration and loss of articular cartilage are the defining characteristics of this condition. Total knee arthroplasty (TKR) is a surgical procedure that is consistently successful and cost-effective in the field of orthopedics. Patient-reported outcomes indicate significant improvement in terms of pain alleviation, functional restoration, and improved quality of life. TKR guarantees consistent results for patients with end-stage, tri-compartmental, degenerative OA. (10).

The number of TKR operations has consistently increased due to the high efficacy rates and the growing demand. Consequently, a significant amount of research has been conducted to improve our comprehension of the patient-related factors that influence patient-reported outcomes, whether they are favorable or unfavorable. A significant proportion of patients experience postoperative dysfunction. A decline in overall knee function may occur in these patients, and symptoms may not resolve following TKR.

Similarly, it has been demonstrated that up to 20% of patients may experience dissatisfaction with their TKR operation (11).

There is significant interest in identifying the patients who will experience unsatisfactory outcomes following TKR, although there will always be some unfavorable outcomes associated with any operation. Numerous recent studies have endeavored to predict patient outcomes by examining radiographic findings, knee function scores, mental health, and socioeconomic status. Although each of these variables has exhibited some predictive value, they are all subject to significant limitations (12).

Premature mechanical displacement of components and patellofemoral complications may be the consequence of improper positioning or orientation of the prosthesis. Recent reports have demonstrated that accelerated implant degradation and poor function are associated with malalignment of the mechanical axis of more than 3°. Consequently, it was suggested that the functional ratings of the patients are significantly correlated with the postoperative radiographic findings (12).

Nevertheless, there is a lack in the published literature that evaluates the relationship between postoperative functional outcomes and radiographic outcomes. Therefore, the purpose of the present study was to assess the correlation between the functional and radiological outcomes of patients following TKR.

The present study was a retrospective study that was carried out 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.

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

In line with our findings, **Souza and colleagues**. Evaluated the socio-demographic characteristics of patients undergoing TKR at a public university hospital in 2016, a retrospective study was conducted. A total of 78 patients who underwent TKR from 2013 to 2014 were enrolled. In terms of gender, 64 individuals (79.1%) identified as female. Only 71 patients (87.65%) were afflicted by OA in terms of etiology. The mean age was 64 years, with a range of 29 to 84 years (17).

Similarly, **Hylkema and colleagues**, in 2017, intended to provide a comprehensive account of the demographic, physical, psychological, and social characteristics of patients who have

undergone total knee arthroscopy TKA. A cross-sectional analysis was conducted on 152 patients who underwent TKA and were able to function. Almost 70% of the patients were females with a mean age of 55 years old (13).

Despite the introduction of numerous methods to evaluate the coronal alignment of the knee, assessments that are based on plane radiographs have become the standard. The anatomical tibiofemoral angle (anatomical TFA) can be measured on standard (14 × 17 inch) knee radiographs, and the mechanical tibiofemoral angle (mechanical TFA) can be measured on full-limb radiographs. These are the two methodologies for evaluating the coronal alignment of the knee using plane radiographs (14).

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

In concordance with our findings, **Manjunath and colleagues** The prospective investigation was conducted at Lady Curzon, Bowring, and Victoria hospitals, and involved 120 knees from 80 patients who underwent TKA. Tibiofemoral angle was significantly correlated with improved knee score postoperatively (p = 0.026). The knee score (p = 0.0001) and functional score (p = 0.0082) were significantly improved for inliers in the tibiofemoral axis alignment parameter (13).

Similarly, **Huang and colleagues'** Research has demonstrated that a total knee prosthesis that is accurately aligned coronally (to within 3° of neutral) leads to improved quality of life and function for a period of up to 5 years following surgery. For two years following surgery, prostheses that are precisely aligned result in increased pain scores (18).

Similarly, **Youm and colleagues** assessed the clinical and radiological outcomes of TKA at a minimum of five years. Retrospective evaluations were conducted on one hundred twenty knees in 80 patients who were able to be monitored for a period exceeding five years following TKA. The preoperative tibiofemoral angle was 4.6° varus, while the postoperative angle was 5.8° valgus. This change was significantly correlated with the Knee Society Clinical Rating System and function scores (14).

Longstaff, and colleagues Between May 2003 and July 2004, authors' institution performed precisely one hundred fifty-nine total knee arthroplasties. Each patient underwent an objective and independent clinical and radiological evaluation both before and after surgery. Sagittal femoral, coronal femoral, sagittal tibial, coronal tibial, and femorotibial mismatch were the alignment parameters that were tested. The sum of the individual errors was calculated to produce a cumulative error score. The Knee Society Score was employed to assess the functional outcome. Better function was associated with good coronal femoral alignment at one year (P =.013). In conjunction with appropriate sagittal and coronal tibial alignment, trends were identified that suggest enhanced function. Patients with a low cumulative error score had a superior functional outcome (P =.015). These patients experienced a faster recovery and a two-day reduction in their hospital stay (19)

On the contrary, **Kim and colleagues** the clinical outcomes and failure of patients who underwent KA were evaluated with the impact of postoperative tibiofemoral alignment. The authors analyzed 246 cases of medial UKA that were monitored for a minimum of five years. After the operation. During the follow-up, which lasted an average of 7 years and 5 months, the knee score and function score were significantly enhanced in all groups, irrespective of the tibiofemoral angle (p<0.01). The clinical results did not indicate any significant difference between the groups (p>0.05) (16).

The precise reasons for the heterogeneity between our findings and the aforementioned study remain uncertain. Nevertheless, these discrepancies may be attributed to variations in the design of the study, the duration of the follow-up, or the size of the sample.

Postoperative knee range of motion (ROM) is one of the most critical factors that influences patient satisfaction following total knee replacement (TKR). Patients report low levels of satisfaction when their activity levels are below the preoperative level or when they are unable to engage in activities, they expect to appreciate due to a restricted flexion angle that impedes activities of daily living (17).

In the current investigation, we found that the mean Range of motion flexion was 56.81 ±16.59. There was a significant strong positive correlation between the range of motion in flexion with objective and satisfaction scores. In agreement with our findings, **Matsuda and colleagues** A retrospective evaluation was conducted on 375 patients who had undergone 500 TKR between 2000 and 2009. Functional

scores were linked to the ROM. The expectation was negatively correlated with varus alignment and restricted range of motion (18).

Similarly, **Promish and colleagues** A review was conducted to evaluate the clinical outcome with the safety and coronal alignment of the limb, as determined by the Knee Society Score. The Knee Society Score was found to have a significant correlation with coronal alignment and range of motion, according to the authors (19).

Study's Limitations

We recognize that the current investigation has certain constraints. The number of patients included in the sample was relatively modest. Furthermore, the limited duration of the study precluded us from evaluating the correlation between radiographic findings and long-term functional scores.

Conclusion

In conclusion, the precise coronal alignment of a total knee prosthesis following TKR leads to improved function and a higher 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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