Factors that Influence the Range of Motion Following Primary Total Knee Arthroplasty

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ABSTRACT:

BACKGROUND:

Total knee arthroplasty is now practiced increasingly. Arthroplasty is considered successful if the knee is stable, painless with good range of motion.

OBJECTIVE:

To evaluate the importance of different factors that might affect the success rate of total arthroplasty in knee osteoarthritis

PATIENTS AND METHODS:

Patients with osteoarthritic knees admitted to Basrah center of joint replacement (Basrah Teaching Hospital) during the period from January 2017 to October 2018, for total knee replacement were enrolled in the study. Factors that can affect post-operative range of motion were studied. These involved factors related to patients (such as age, gender, body mass index, comorbidities, side of diseased knee, knee functional score, and range of motion), and those related to the operative procedure(duration of operation, use of tourniquet, size of femoral and tibial components, and the type of polyethylene spacer). The amount of postoperative blood in the drain was also recorded. The follow up period was for up to one year after the surgical operation.

RESULTS:

Seventy five patients were included in the study, 60 females and 15 males who constituted (80%, 20%) respectively. The mean age was (59.20±7.05 years), ranged between (45 - 71 years). The mean BMI of the patients was (26.52 ± 2.67). The tibial size ranged from 3 to 7 with mean (5.08±1.39).The mean pre and post-operative ROM (after one year follow up) was (110.20±20.25) and (116.46±6.76) respectively. The functional knee score (Lysholm score) increased from (50.40±14.67) to (79.48±9.75) post operatively. Fifty two percent of the patients were right sided knee and 48% of them were left sided. There was no significant statistical correlation between knee side and range of motion postoperatively. Correlation was also not significant between associated diseases, gender and post-operative range of motion. Patients with normal BMI had better postoperative ROM than over weight and obese patients with mean ROM (120.17±5.49, 115.0±10.28 and100.0±16.92) respectively. There was significant negative statistical correlation between the age and the post-operative range of motion. There was a significant negative correlation between post-operative range of motion, polyethylene spacer, and size of tibial and femoral components used. No correlation was found between the time of operation and postoperative range of motion; however, the latter was negatively correlated with the amount of blood in the drain.

CONCLUSION:

Postoperative range of motion after primary total knee arthroplasty in osteoarthritis of the knee joint seems to be mostly affected by preoperative range of motion and BMI**.** Younger patients tend to have a better postoperative range of motion, while larger size of the components of arthroplasty are associated lower post-operative range of motion.

KEYWORDS: Knee osteoarthritis, total knee arthroplasty, range of knee motion

INTRODUCTION:

Arthroplasty after knee osteoarthritis is increasingly performed. One important factor for patient satisfaction is the postoperative range of motion (ROM). Contracture of the knee flexion increases energy consumption of quadriceps muscle during walking. An extended and more powerful contraction is needed to prevent

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the flexion collapse. Energy consumption has been directly related to the severity of the contracture. Flexion contracture of 15 and 30 degrees, can cause increased energy consumption by 30% and 50% respectively.[1] The most important indication for TKA is debilitating pain, with the goal is to restore the mechanical alignment, joint line and ligament stability. [2]

The post-operative range of motion may be affected by different factors which include patient factors, and factors related to surgery and rehabilitation.

PATIENTS AND METHODS:

This study was conducted at Basrah Teaching Hospital starting from January 2017 and extending to October 2018.Seventy five patients who were admitted to Basrah center of joint replacement during that period for total knee replacement were enrolled in the study. All patients had severe isolated primary osteoarthritis of the knees without significant osteoarthritis elsewhere. Patients who ended up with post-operative infection were excluded from the study because they need special program for follow up and rehabilitation.

Preoperative preparation

A thorough history, including comorbidities, previous infections, knee surgery and social habits was taken. Patients underwent a comprehensive clinical examination, with further focus on the involved knee and BMI. Lysholme score was used to assess the function of the knee before operation.[3] Other diagnoses that may cause pain in the knees were excluded by examination of the hip and spine. Laboratory investigations were done in the form of complete blood count, renal function tests, random blood sugar, hepatitis markers and electrocardiography were done.

Preoperative radiographic study

The standard radiograph in standing weight-bearing position in form of AP view of full leg length, lateral view (slight bending) of the knee joint and sky line view were done to identify the mechanical, anatomical axis and any bony changes.

Operative day: At time of induction, all patients were given ceftriaxone(one gm) intravenously. According to patient condition, general anesthesia was used in only 10 patients. The remaining 65, surgeries were performed with spinal anesthesia. The same operative technique (medial para-patellar approach) was performed to all patients, by the same surgery team.

All patients had varus malalignment of the knee so we released the medial tight side in the following sequence until achieving coronal plane ligament balance : Osteophytes, deep medial collateral ligament including the medial knee capsule followed by posterior medial corner (Capsule, Semimembranosus) then superficial medial collateral ligament. Bones were prepared according to the standards of primary total knee arthroplasty.[4] Tourniquet was inflated during cement setting of the tibial and femoral components, and the drain was left insitu. The closure of the deep layer was done in 60 degree knee flexion, 2 ampules of tranexamic acid were infiltrated in the periarticular tissue. During surgical operation, parameters such as duration of surgery, size of tibial and femoral components, spacer size, and tourniquet time were recorded.

Post operation

Day zero (same day following surgery):

Antibiotic started: Ceftriaxone 1gm. vial twice per day intravenous Amikacin vial 500mg twice per day intravenous.

Good analgesic cover, cryotherapy and prophylactic enoxaparin started 10 hour after surgery and continued for 28 days after surgery. The drain was left closed for 6 hours for tamponed effect.

Day one (the day after the day of surgery)

Antibiotics, analgesia and enoxaparin were continued. 24 hours after surgery, the drain was removed and the amount of blood was calculated. Physiotherapy was started in the form of quadriceps muscle exercise (active straight leg rising), active and passive flexion, extension of the knee in supine and sitting position, and walking was started with crutches under the direct supervision of the physiotherapist

Day two

In addition to previous treatment and physiotherapy, imaging study was done included anterior posterior and lateral X ray view of the knee joint. The hospitalization ranged from three to five days according to patient's condition. The stitches were removed after 14 days of the surgery.

Follow up

All patients were followed by a special schedule; reassessed at 6 weeks, 6 months and 12 months following surgery during which examination of the knee was done. Examination involved stability of the knee and its degree of active motion (measured by goniometer), signs of infection, and knee function (using Lysholm score). Also, imaging studies for the patients with these visits (AP, lateral plain X-ray) looking for fitting of the prosthesis and any abnormality.

Statistical package for social sciences (SPSS), version 23 was used for data analysis. Significant P value <0.05.

RESULTS:

Seventy five patients were included in the study, 60 females and 15 males who constituted (80%, 20%) respectively. The mean age was (59.20±7.05 years), ranging between (45 - 71 years).

The mean BMI of the patients was(26.52 ± 2.67) , 45 patients(60%) were overweight (36 females and 9 males), 12 of them (16%) were obese (9 females and 3 males) , the remaining 18 patients (24%) were within normal range of BMI.

The tibial size ranged from 3 to 7 with mean (5.08±1.39). Other variables are shown in table (1).

Table (1) Variables in the study.

	Minimum	Maximum	Mean	Standard deviation
Age	45year	71year	59.20	7.05
BMI	22	32	26.52	2.67
Pre-operative ROM			110.20	20.25
Tibial size	3	7	5.08	1.39
Spacer	8mm	17mm	11.84	1.98
Operative time	75 minutes	105 minutes	92.73	7.45
Amount of blood in the drain	75 cc	250 cc	139.60	47.28
Lysholm score (preoperative)	17	81	50.40	14.67
Lysholm score (postoperative)	50	95	79.48	9.75

The preoperative and postoperative range of motion (ROM) were significantly and positively correlated(P value = 0.001). Functional knee score using Lysholme score was recorded pre-operative and postoperatively, the means were (50.40±14.67) and (79.48±9.75) respectively, as shown in Table (2).

Table (2) Pre and post-operative active ROM and functional knee score.

Pre-operative range of motion	110.20±20.25
ROM 6weeks post-operative	110.12±12.10
ROM 6months post-operative	114.61±9.45
ROM 1year post-operative	116.46±6.76
Pre-operative functional score (lysholm score)	50.40±14.67
Post-operative functional score (Lysholm score) 1 year post-operative	79.48±9.75

Postoperative range of motion showed no significant correlation with gender, co-morbidities and duration of surgical operation (Table 3). The present study found that 56% of the patients were hypertensive and 16% of them were diabetic.

Table (3):The association between the post-operative ROM and the gender, comorbidities, duration of surgery.

Variable		Number	ROM Mean±SD	P value
Gender	Male	15(20%)	111.0±10.85	**0.07**
	Female	60(80%)	117.50±15.71	
hypertension	Diseased	42(56%)	114.57±15.93	**0.28**
	None	33(44%)	119.27±13.75	
Diabetes mellitus	Diseased	12(16%)	116.00±13.31	**0.20**
	None	63(84%)	115.29±15.26	
Duration of surgery	< 90 minutes	24	116.00±11.22	**0.89**
	>=90 minutes	51	116.63±21.28	

The patients with normal body mass index had better post-operative ROM than over weight and obese patients with mean ROM (120.17±5.49, 115.0±10.28 and100.0±16.92) respectively, as shown in table (4).

Table (4) The correlation between the BMI and post-operative ROM.

Variable		Number	Mean ROM	P value
BMI	Normal(18.9 – 24.9)	18(24%)	120.17±5.49	**0.000**
	Over weight(25-29.9)	45(60%)	115.0±10.28	
	Obese (30-35)	12(16%)	100.0±16.92	

There was significant negative statistical correlation between age of the patients and the post-operative ROM (p= 0.009). As shown in table (5).

Table (5) Association between post-operative ROM and patient´s age.

Variable		Number	Mean ROM	P value
Age	Group 1	42	118.93±17.33	**0.009**
	Group 2	33	111.45±9.79	

Group 1: 45-60 years. Group 2 : 61-71 years

The post-operative ROM will decrease by 0.4 degrees (than the expected gain ROM) for each year above the minimal age which was decided as 45 years old in this study

The operations were performed on the right side in 52% of the patients and 48% of them were left sided.

There was a significant negative statistical correlation between the post-operative ROM and polyethylene spacer thickness as well as the femoral and tibial component size used, as shown in table (6).

Table (6) The correlation between polyethylene spacer size, femoral component size and post-operative ROM.

Variable		Number of patients	Mean ROM ± SD	P Value
Polyethylene spacer thickness	Group 1	57	117.84±16.21	**0.02**
	Group 2	18	111.00±8.91	
Size of femoral Component	D	18	115 ± 2.6	**0.000**
	E	14	111.07 ± 11.95	
	F	24	113.13 ± 9.89	
	G	19	103.95 ± 10.01	

Group 1: 8-12 mm polyethylene spacer. Group 2: 13-17 mm polyethylene spacer.

The present study found that the size of tibial component used negatively correlated with the post-operative ROM (P=0.009). As shown in table (7).

Table (7) Frequency of tibial component size.

Tibial component size		Frequency	P value
Val id	3	15	**P=0.009**
	4	6	
	5	30	
	6	6	
	7	18	
	Total	**75**	

The present study found that there was a negative significant statistical relation between the post-operative ROM and the amount of blood in the drain which was calculated post-operatively as shown in table (8).

Table (8) Amount of blood in the drain in relation with post-operative ROM.

Amount of blood in the drain	Mean ROM ± SD	P value
< 130 cc	118.50±17.37	**0.01**
130 cc – 190 cc	115.88±13.88	
> 190 cc	109.00±7.14	

In table (9), a multiple regression analysis was done to predict gain in ROM at one year post operatively. The dependent variable was the gain in ROM (post-operative ROM – pre operative ROM) for each patient. Predictors used were age, gender, BMI, pre-operative lysholm score, tibial component size, femoral component size, spacer size, operative time and amount of blood in the drain. The only significant predictors of better gain in ROM were the pre-operative ROM and BMI; these two predictors explained 72% of variability.

Table (9) Multiple regression analysis.

variables		B	T value	P value
Significant variables	ROM	0.823	15.17	**0.0001**
	BMI	-3.888	9.46	**0.0001**

DISCUSSION:

Total knee replacement is the proper procedure to treat severe knee dysfunction with the aim of obtaining patient satisfaction in having painless and well aligned knee with good range of motion.

The present study studied multiple factors (patient-related, surgical and post-operative factors) that we thought have the potential to influence post-operative ROM.

Patient factors

Gender: The present study found that there was no correlation between the gender and the post-operative ROM (P value =0.70). This result goes with the results of Insall et al. [5] Kotaniet al.[6], Ishii Y et al.[7] and Kawamura et al.[8]

Age: The correlation between the age of patients and range of motion post-operatively was highly significant. As patient´s age increased, the range of motion decreased.

This can be explained by the fact that younger patients are generally more physically active, whereas older patients tend to have more difficulty during the rehabilitation [9].This goes with Franklin et al. [10]. Schurman et al. [11] who reported that the post-operative ROM was higher for younger patients at three months post-operatively.

Body weight (Body mass index): Obesity adversely affects the post-operative range of motion, this is due to reduction of final knee flexion angle[10,12] because of soft tissue impingement between tibia and the femur. In one study,[13] half of patients undergoing total knee arthroplasty were obese. A meta-analysis by Kerkhoffs et al[14] found that obese patients (BMI of 30 or greater) were having more complications than non-obese patients.

It is believed that the excess adipose tissue requires longer incisions and tourniquet times, resulting in more tissue necrosis that may lead to wound complications. [15]

Pre-operative range of motion: There is a highly significant correlation between the pre-operative and post-operative range of motion, increased pre-operative ROM led to better post-operative ROM (p value = 0.001), this goes with Kawamura H et al.[8], Kurosaka M et al.[16]

Medical comorbidities: There was no correlation between medical comorbidities such as diabetes and hypertension with the post-operative

ROM (p value =0.20 and 0.28 respectively) and this goes with Gandhi R et al. [17], Meding JB et al. [18] results. Marchant MH Jr et al. [19] found a negative correlation between the diabetes and post-operative range of motion and explained that because patients with diabetes have higher risks of pulmonary embolism, postoperative hemorrhage, infection, wound complications, ileus, and even death compared with patients without diabetes [19].

Intra operative factors

Tibial component size and polyethylene spacer thickness**:** The tibial component size negatively correlates with the post-operative ROM (p = 0.009), also the polyethylene spacer affects the post-operative ROM negatively **(**P= 0.02), with lower mean ROM for those with polyethylene spacer thickness more than 12 mm. These results were inconsistent with Alrefaee et al, [20]who found no correlation between ROM and these variables.

Femoral component size: There was a negatively statistical correlation between the femoral component size and the post-operative range of motion(P = 0.000), this can be explained by decrease flexion gap and patella-femoral joint stiffness. This goes with Kurosaka M et al. [16], but inconsistence with Kotaniet al. [6], who found that the femoral component size did not affect the post-operative ROM.

Amount of blood in the drain: The present study found a significant negative correlation between the amount of blood in the drain and the post-operative ROM (P = 0.01)**,** which was higher for longer operative time (p = 0.00). This can be explained by promotion of soft tissue inflammation and fibrous tissue formation which lead to degenerative changes in the soft tissue around the knee.

CONCLUSIONS:

- The pre operative ROM and BMI of the patients are the most important factors that influence the post operative range of motion following primary total knee arthroplasty for osteoarthritis.
- The younger age groups tend to have a better post operative ROM.
- The larger size of the components of arthroplasty are associated with lower post-operative ROM.
- Gender and com-morbidities such as diabetes and hypertension do not correlate with the post-operative ROM.

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