

## Fixed Bearing Versus Mobile Bearing Total Knee Replacement

MOLHAM M. MOHAMED, M.D.\*; YASSER M. SAQR, M.D.\*\* and HAITHAM A.A.I. DESOKY, M.D.\*

The Department of Orthopedic Surgery, Faculty of Medicine, Cairo\* Port Said\*\* Universities

### Abstract

**Background:** Total knee arthroplasty (TKA) is the preferred treatment for those with end stage osteoarthritis (OA) and functional limitations.

**Aim of Study:** The primary objective of this prospective RCT is to compare the functional outcomes of MB versus FB TKA.

**Patients and Methods:** In the period between May 2014 and May 2016 in the Hospitals of Cairo University and the ministry of health, a prospective RCT was conducted on 40 patients with advanced tricompartmental OA of the knee joint.

**Results:** Forty patients were followed-up for 12 months. Functional assessment using KSS (2011) was done to assess every patient pre-operatively, 2 weeks, 3 months and then every 3 months till 12 months post-operatively with nearly no difference between the two designs.

**Conclusion:** There is nearly no statistically significant difference between MB and FB TKA on active knee flexion and on functional outcomes at 1 year follow-up.

**Key Words:** Total knee replacement – Fixed bearing prosthesis – Mobile bearing prosthesis – Pre operative – Post operative – Knee Society Score (2011).

### Introduction

**TOTAL** knee arthroplasty (TKA) is the preferred treatment for those with end stage osteoarthritis (OA) and functional limitations [1]. Younger patients are generally more active requiring an increased range of motion as in the mobile-bearing (MB) TKA [2,3].

The MB design offers greater conformity and decreased contact stresses through a polyethylene liner that is mobile relative to the tibial tray resulting in a lower polyethylene wear rate [4].

The MB design imitates kinematics of the normal knee and potentially allowing for a greater range of motion (ROM) [5,6].

**Correspondence to:** Dr. Haitham A.A.I. Desoky,  
[E-Mail: Haitham6620133@gmail.com](mailto:Haitham6620133@gmail.com), 001225011020

The potential disadvantages of the MB TKA include higher implant cost and higher incidence of bearing dislocation [7,8].

The objective of this prospective randomized controlled trial (RCT) was to investigate functional outcomes in a single design posterior-stabilized (PS) TKA offering MB and FB variants (Zimmer Inc, Warsaw, IN).

### Patients and Methods

In the period between May 2014 and May 2016 in the hospitals of Cairo University and the ministry of health, a prospective RCT was conducted on 40 patients with advanced tricompartmental OA of the knee joint were managed by TKA using FB or MB Cemented PS Total knee Prosthesis according to the process of randomization via sealed opaque envelope method. The postoperative follow-up of these cases was 1 year. The patients were excluded from this study were those unfit for surgery, with active infection, with substantial angular deformity required an osteotomy or the use of a constrained device, which had Rheumatoid arthritis of the knee and also cases of Revision TKR.

**Patient demographics:**

**Pre-operative stage:**

Included clinical evaluation, radiological evaluation, Preoperative preparation of the patient and Patient counseling.

**Operative stage:**

Type of prosthesis used in our study were the NexGen Legacy posterior-stabilized LPS-FB and NexGen LPS-MB Knee Systems. These two implant designs were of a PCL substituting design.

**- Pre skin incision preparations:**

Under general or regional anesthesia, the patients were placed in a supine position and the stopper and the tourniquet were used and antibiotic

prophylaxis (ceftriaxone 1-2gm, according to body weight, intravenously) was given to the patients with induction of anesthesia.

General characteristics	Fixed prosthesis group		Mobile prosthesis group	
	No=20	%	No=20	%
<b>Age (year):</b>				
Mean $\pm$ SD	61.45 $\pm$ 6.67		60.9 $\pm$ 6.1	
Min - Max	50.0-75.0		53.0-77.0	
<b>BMI:</b>				
Mean $\pm$ SD	32.3 $\pm$ 2.34		31.7 $\pm$ 2.94	
Min - Max	28.0-37.0		27.0-37.0	
<b>Gender:</b>				
Male	5	25.0	7	35.0
Female	15	75.0	13	65.0
<b>Side of lesion:</b>				
Rt	6	30.0	10	50.0
Lt	14	70.0	10	50.0
<b>Co morbidity:</b>				
DM	4	20.0	5	25.0
Br. asthma	1	5.0	0	0.0
HTN	5	25.0	4	20.0
Peptic ulcer	1	5.0	1	5.0

Fig. (1): Patient demographics.

#### - Surgical approach:

Midline skin incision then a medial para patellar approach was used.

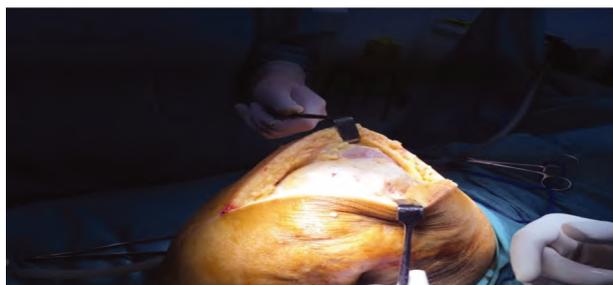


Fig. (2): Mid-line skin incision of the knee.

#### - Operative steps:

##### 1- Femoral preparation:



Fig. (3): The trial of the femoral component being applied following femoral preparation.

##### 2- Tibial preparation:

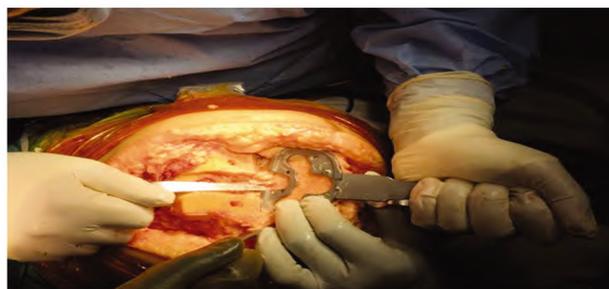


Fig. (4): Tibial preparation.

Then the Flexion and extension gabs were adjusted and balanced.

##### Post-operative stage:

The vital signs and the distal neurovascular status were checked and Intravenous Ceftriaxone 1gm every 12 hours postoperatively for 5 days.

##### - Rehabilitation protocol:

- Week 1, change dressing and review home exercise program [3].
- Weeks 2-4, Suture removal and progress flexion range of motion, gait training, balance / proprioception exercises were continued and the functional and the aerobic exercise as tolerated [3].
- Weeks 4-6, The balance/proprioception exercises (i.e. heel-to-toe walking, assisted single-leg balance) were continued [3].
- Weeks 6-8, The lateral training exercises and the single-leg exercises were incorporated as able [3].

##### - Follow-up:

All patients had clinical evaluation at 2 weeks, one month, 3 months, 6 months, 9 months and 1 year post operative. Radiological evaluation by plain knee radiographs was taken immediately postoperatively, 2 weeks and one year post operative in the coronal and sagittal planes for measuring the reference axes of the knee.

##### - Clinical evaluation:

In our study the new knee society scoring system (K.S.S 2011) [4-7]. Was used to evaluate the knee function at 2 weeks and one month then every 3 months until 12 months postoperatively.

## Results

Forty patients were followed-up for 12 months. Functional assessment using KSS (2011) was done to assess every patient pre-operatively, 2 weeks, 3 months and then every 3 months till 12 months

post-operatively. Active knee flexion was also measured at 12 months post-operatively. The study patients were divided into two groups according to the type of prosthesis used: Group I included 20 patients who received FB TKA and Group II included 20 patients who received MB TKA according to sealed opaque envelope randomization technique.

*Statistical analysis:*

Statistical analysis was carried out using the SPSS computer package version 21.0 (SPSS Inc., Chicago, IL, USA). For descriptive statistics: The mean  $\pm$  standard deviation (SD) was used for quantitative variables while the number and frequencies (%) were used for qualitative variables. Fisher's Exact test (FET) was used to assess the differences in frequency of qualitative variables while for quantitative variables, independent samples *t*-test was used to compare means of both groups and paired samples *t*-test was used to compare two means within the same group. The statistical methods were verified, assuming a significant level of  $p < 0.05$ .

1- *Comparing The post operative Knee Society Score (objective score):*

At 1 year Post.Op the mean  $\pm$  SD of the K.S.S (objective score) for fixed bearing was  $86.1 \pm 10.0$  but for mobile bearing it was  $86.5 \pm 13.48$ . *p*-value 0.916.

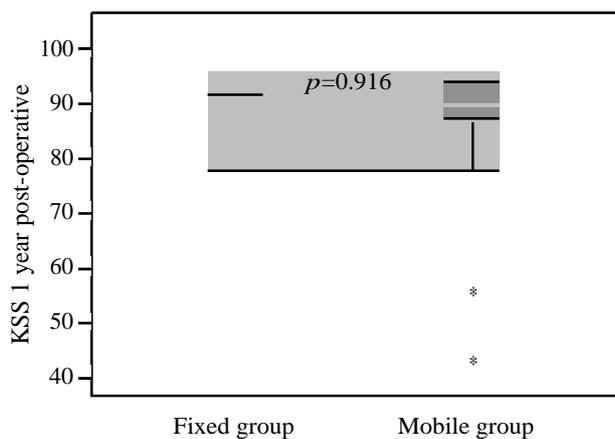


Fig. (5): Comparing Knee Society Score 1 year post-operative.

2- *Comparing final range of motion among the studied groups:*

The mean  $\pm$  SD of the final range of motion among the mobile prosthesis group was  $(104.3 \pm 7.19^\circ)$  but for the fixed prosthesis group it was  $(102.1 \pm 6.7^\circ)$  with no statistical significant difference.

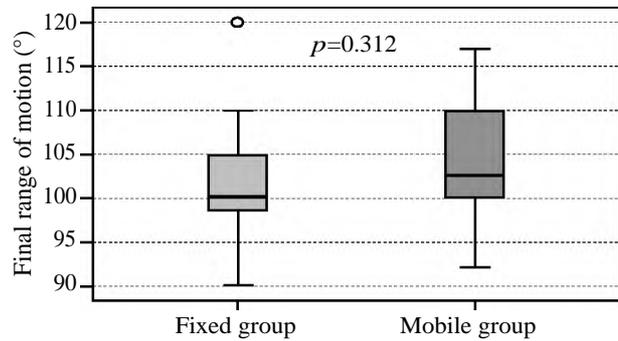


Fig. (6): Comparing final range of motion among the studied groups.

3- *Comparing the patient's expectation among the studied groups. (15 points):*

The mean  $\pm$  SD of the Post Op. patient's expectation for the fixed bearing prosthesis was  $8.55 \pm 1.85$  but for the mobile prosthesis it was  $8.8 \pm 2.1$  with *p*-value 0.691.

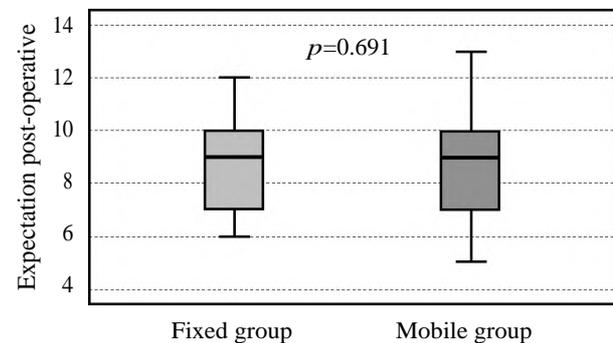


Fig. (7): Comparing post-operative expectation among the studied groups.

4- *Comparing the patient's satisfaction among the studied groups. (40 points):*

The Post.Op. Mean  $\pm$  SD of the patient's satisfaction for the fixed bearing prosthesis at 1 year was  $26.6 \pm 3.79$  but for the mobile prosthesis it was  $26.0 \pm 3.73$  with *p*-value 0.617.

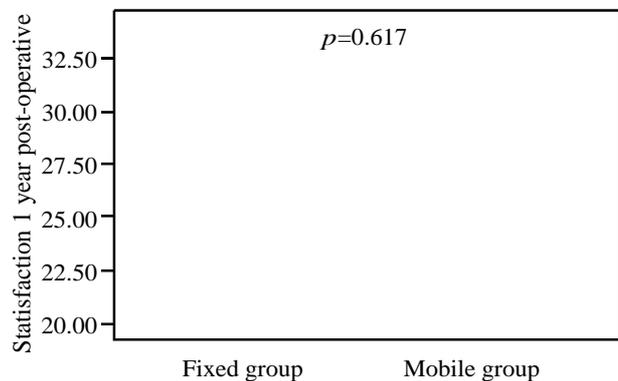


Fig. (8): Comparing 1 year post-operative satisfaction among the studied groups.

5- Comparing walking & standing among the studied groups. (30 points):

The Pre.Op. Mean  $\pm$  SD of the patient's walking & standing score for the fixed bearing prosthesis was  $5.65 \pm 4.61$  while the post Op. one was  $15.75 \pm 4.23$  (improved significantly) with  $p$ -value  $< 0.001$ .

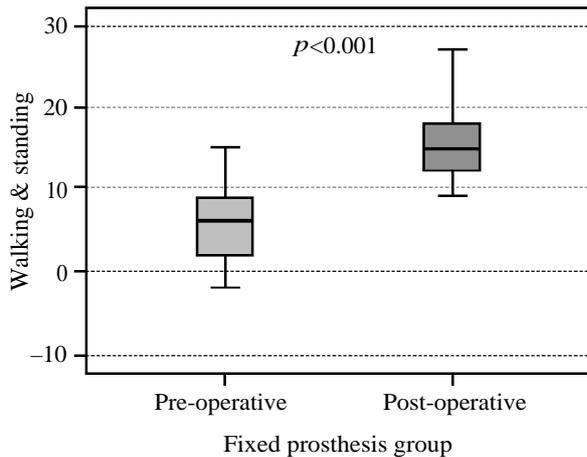


Fig. (9): Comparing the pre, and post op. scores of the walking & standing scores for the fixed bearing prosthesis group.

The Pre.Op. Mean  $\pm$  SD of the patient's walking & standing score for the mobile prosthesis was  $5.5 \pm 4.83$  while the post Op. one was  $17.1 \pm 4.78$  (improved significantly) with  $p$ -value  $< 0.001$ .

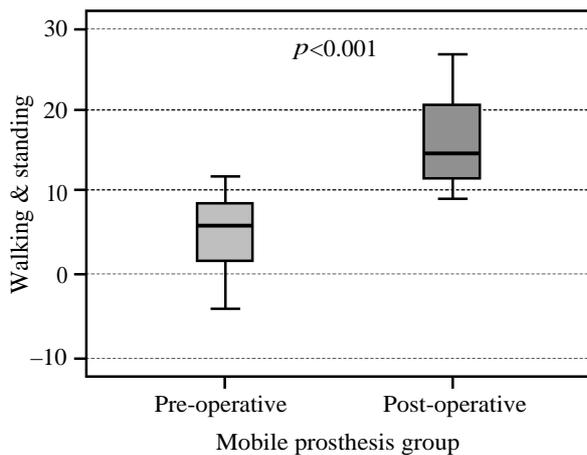


Fig. (10): Comparing the pre, and post op. scores of the walking & standing scores for the mobile bearing prosthesis group.

6- Comparing standard activities among the studied groups. (30 points):

The Pre.Op. Mean  $\pm$  SD of the patient's standard activities score for the fixed bearing prosthesis group was  $10.35 \pm 2.87$  while the post Op. one was  $18.6 \pm 4.1$  (improved significantly) with  $p$ -value  $< 0.001$ .

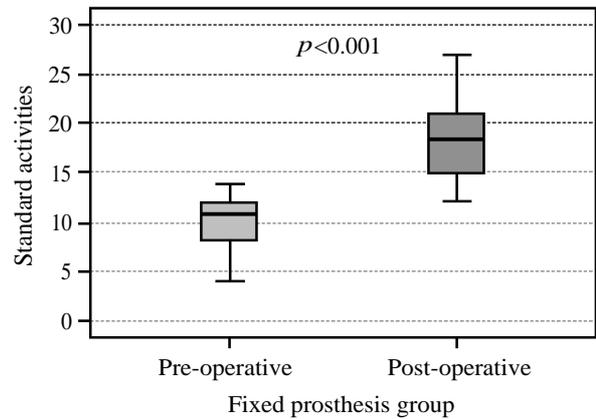


Fig. (11): Comparing the pre, and post op. standard activities scores for the fixed bearing prosthesis group.

The Pre.Op. Mean  $\pm$  SD of the patient's standard activities score for the mobile bearing prosthesis group was  $7.15 \pm 2.8$  while the post Op. one was  $17.85 \pm 4.15$  (improved significantly) with  $p$ -value  $< 0.001$ .

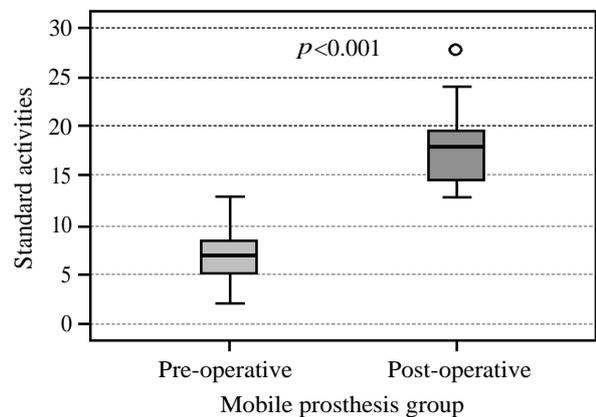


Fig. (12): Comparing the pre, and post op. standard activities scores for the mobile bearing prosthesis group.

7- Comparing the advanced activities among the studied groups. (25 points):

The Pre.Op. Mean  $\pm$  SD of the patient's advanced activities score for the fixed bearing prosthesis was  $6.1 \pm 3.38$  while post Op. it was  $11.1 \pm 4.0$  (improved significantly) with  $p$ -value  $< 0.001$ .

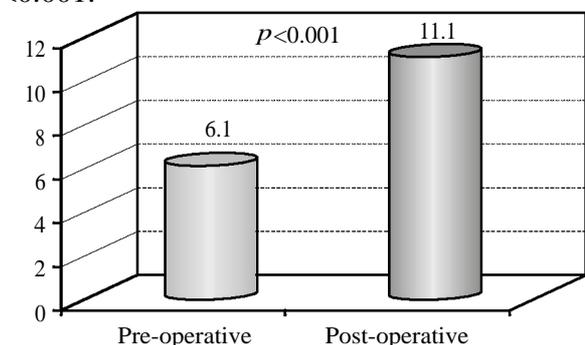


Fig. (13): Comparing the pre, and post op. advanced activities scores for the fixed bearing prosthesis group.

The Pre.Op. mean  $\pm$  SD of the patient's advanced activities score for the mobile bearing prosthesis was  $3.0 \pm 1.38$  while post Op. it was  $11.35 \pm 4.1$  (improved significantly) with  $p$ -value  $< 0.001$ .

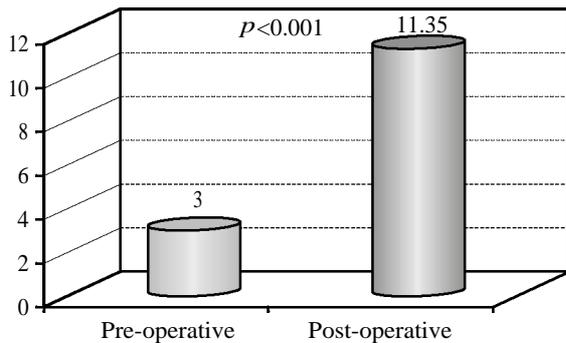


Fig. (14): Comparing the pre, and post op. advanced activities scores for the mobile bearing prosthesis group.

8- Comparing discretionary activities among the studied groups. (15 points):

The Pre.Op. Mean  $\pm$  SD of the patient's discretionary activities score for the fixed bearing prosthesis was  $0.45 \pm 1.39$  while post Op. it was  $4.15 \pm 4.14$  (improved significantly) with  $p$ -value  $< 0.001$ .

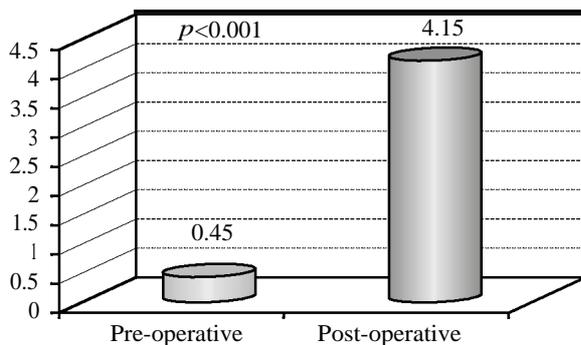


Fig. (15): Comparing the pre, and post op. discretionary activities scores for the fixed bearing prosthesis group.

The Pre.Op. Mean  $\pm$  SD of the patient's discretionary activities score for the mobile bearing prosthesis was  $0.8 \pm 1.99$  while post Op. it was  $4.8 \pm 4.38$  (improved significantly) with  $p$ -value  $< 0.001$ .

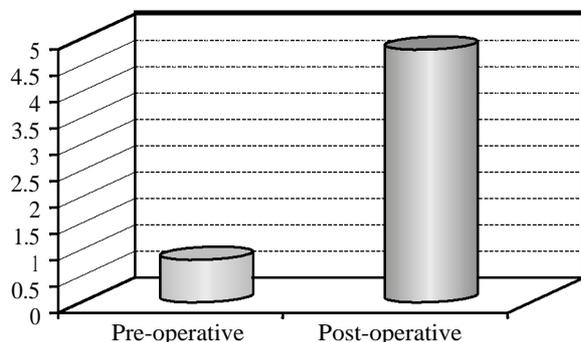


Fig. (16): Comparing the pre, and post op. discretionary activities scores for the mobile bearing prosthesis group.

Discussion

TKA with a FB design has yielded good long-term results, but there were concerns related to the polyethylene wear, osteolysis and the higher incidence of loosening so when the MB knee replacement was designed in the late 1970s by Goodfellow and O'Connor they proposed that the MB design offers better kinematics, range of motion, function, and durability compared to the existing FB knee implants [9,10].

Regarding the post-operative active flexion achieved, the results of this study were close to what was previously reported. In this study, the mean active flexion for both groups was nearly equivalent where the FB group Achieved  $102^\circ$  compared to  $104.3^\circ$  for the MB group. Price et al., [11] reported mean flexion of  $101.5^\circ$  for the FB group and  $101.7^\circ$  for the MB group at one year follow-up. Jacobs et al.; reported mean flexion of  $99.9^\circ$  for the MB group and  $101^\circ$  for the FB group [12]. The results of this study by using the new K.S.S (2011) were also nearly consistent with what was reported previously; the mean K.S.S (knee score) in this study was 86.1 for the FB group and 86.5 for the MB group. Hanusch et al., [13] reported mean of 84.3 for the MB and 84.5 for the FB. Lampe et al., [14] had mean KSS (knee score) of 85 for the FB and 88 for the MB. Also the functional score of the new K.S.S (2011) in this study were nearly similar mean of 49.55 for the FB group and 51.1 for the MB group. Jacobs et al., [12] reported mean functional KSS (1989) of 84.9 for the MB and 88.8 for the FB groups.

The functional score of the new K.S.S (2011) is more accurate than the K.S.S (1989) because it contains special scores for the patient's expectation and satisfaction in addition the functional score is divided into four component which are (walking; standing, standard, advanced, and discretionary activities).

- Points of strength and limitation in this study:

- 1- As a point of strength in our study, there are 4 patients had bilateral TKR; one side was fixed bearing and the other side was mobile bearing type, these cases numbers are (fixed bearing No. 2,6,12 and 18; mobile bearing No. 21,24,31 and 36 respectively).
- 2- The usage of the new K.S.S (Knee Society Scoring System 2011) including knee scoring and function which represents the most widely used scoring system for assessment of knee function following TKA. The used scoring system includes both patient filled and clinician filled questionnaires.

Case No.	Satisfaction		Functional score	
	Pre.op	Post op	Pre.op	Post op
2 (Fixed)	10	22	15	38
21 (Mobile)	10	26	14	57
6 (Fixed)	16	26	24	44
24 (Mobile)	10	30	16	70
12 (Fixed)	12	32	17	73
31 (Mobile)	16	26	18	51
18 (Fixed)	22	34	40	83
36 (Mobile)	14	26	19	45

Fig. (17): Cases of bilateral T.K.R each side of different prosthesis's type.

- 3- Also all patients in this study had regular follow-up without skipping, this was another point of strength.
- 4- The type of this study as a randomized controlled comparative trial with adequate power is considered the main strength of this study.

But the main limitation was the short follow-up duration. However, the main interests of the study were active flexion and functional outcomes, which is clinically relevant within the first year postoperatively.

*- Complications occurs for our cases:*

*In our study, 5 cases (representing 12.5% of all cases) had 2 complications:*

Four cases of deep venous thrombosis (D.V.T) cases number (1, 2 F.B), cases number (21, 22 M.B) (10%) and one case of deep wound infection; case number 8 (F.B) (2.5%). All cases are treated successfully with good results clinically and functionally.

There was nearly no difference between the results of this study compared to those reported in similar published series, in terms of complication rates, range of motion, and functional outcome scores.

*Conclusion:*

This study showed that the clinical and radiographic results of both FB and MB total knee implants at one year follow-up were encouraging. However, it was founded nearly no statistically significant difference to prove the superiority of the MB total knee implant over the FB total knee implant in the short term follow-up so it would be recommended to perform long term follow-up studies.

## References

- 1- AGLIETTI P., BALDINI A., BUZZI R., LUP D. and DE LUCA L.: Comparison of mobile-bearing and fixed-bearing total knee arthroplasty: A prospective randomized study. *J. Arthroplasty*, 145-153, 2005.
- 2- CALLAGHAN J.J., INSALL J.N., GREENWALD A.S., DENNIS D.A., KOMISTEK R.D., MURRAY D.W., BOURNE R.B., RORABECK C.H. and DORR L.D.: Mobile-bearing knee replacement-concept and results, 50: 431-49, 2001.
- 3- HENRICSON A., DALÉN T. and NILSSON K.G.: Mobile bearing do not improve fixation in cemented total knee arthroplasty. *Clin. Orthop. Relat. Res.*, 448: 114, 2006.
- 4- COX J. and TETSWORTH K.: Knee reconstruction: Comparisons between mobile-bearing and fixed-bearing total knee replacement. *Curr. Orthop. Pract*, 20: 35, 2009.
- 5- SANSONE V. and DE GAMA MALCHÈR M.: Mobile-bearing total knee prosthesis: A 5- to 9-year follow-up of the first 110 consecutive arthroplasties. *J. Arthroplasty*, 19: 678, 2004.
- 6- DELPORT H.P., BANKS S.A. and DE SCHEPPER J.: A kinematic comparison of fixed-and mobile-bearing knee replacements. *J. Bone Joint Surg. [Br.]*, 88-B: 1016, 2006.
- 7- GRUPP T.M., KADDICK C. and SCHWEISAU J.: Fixed and mobile bearing total knee arthroplasty - influence on wear generation, corresponding wear areas, knee kinematics, and particle composition. *Clin. Biomech.*, 24: 210, 2009.
- 8- SEHAT K., DEVANE P. and HORNE G.: Fixed bearing or mobile bearing total knee arthroplasty? A review of the recent literature. *Curr. Opin. Orthop.*, 18: 66, 2007.
- 9- COLIZZA W.A., INSALL J.N. and SCUDERI G.R.: The posterior stabilized total knee prosthesis. Assessment of polyethylene damage and osteolysis after a ten- year-minimum follow-up. *J. Bone Joint Surg. Am.*, 77: 1713-20, 1995.
- 10- GOODFELLOW J. and O'CONNOR J.: The mechanics of the knee and prosthesis design. *J. Bone Joint Surg.*, 60B: 358-369, 2008.
- 11- PRICE A.J., REES J.L., BEARD D., JUSZCZAK E., CARTER S., WHITE S., DE STEIGER R., DODD C.A., GIBBONS M., MCLARDY-SMITH P., GOODFELLOW J.W. and MURRAY D.W.: Mobile-bearing total knee prosthesis compared with a fixed-bearing prosthesis. A multicenter single-blind randomized controlled trial. *J. Bone Joint Surg Br.*, 85 (1): 62-7, 2003.
- 12- JACOBS W.C., CHRISTEN B., WYMENGA A.B., et al.: Functional performance of mobile versus fixed bearing total knee prostheses: A randomised controlled trial. *Knee Surg Sports Traumatol. Arthrosc.*, 20: 1450-1455, 2012.
- 13- HANUSCH B., LOU T.N., WARRINER G., HUI A. and GREGG P.: Functional outcome of PFC Sigma fixed and rotating-platform total knee arthroplasty. A prospective randomised controlled trial. *Int. Orthop.*, 34: 349-354, 2010.
- 14- LAMPE F., SUFI-SIAVACH A., BOHLEN K.E., HILLE E. and DRIES S.P.: One year after navigated total knee replacement, no clinically relevant difference found between fixed bearing and mobile bearing knee replacement in a double-blind randomized controlled trial. *Open Orthop. J.*, 5: 201-208, 2011.

## دراسة مقارنة بين مفصل الركبة الصناعي الكامل ذو السطح الثابت وذو السطح المتحرك

تمثل خشونة مفصل الركبة مشكلة كبيرة للمرضى، وذلك لما ينتج عنها من الآم حادة تؤثر على النشاط اليومي للمريض. وتوجد عدة طرق لعلاج هذه المشكلة، بدءاً من العلاج التحفظي الدوائي وتخفيف الوزن وصولاً إلى إجراء عمليات جراحية لتغيير مفصل الركبة باستخدام مفصل صناعي كامل اسمنتي. تغيير مفصل الركبة باستخدام مفصل ركبة صناعي كامل اسمنتي يعتبر من الطرق الناجحة جداً لعلاج مرضى خشونة الركبة حيث أنه يسمح للمريض بالحركة بدون ألم

توجد أنواع مختلفة لمفاصل الركبة الصناعية، فمنها ما يحافظ على الرباط الصليبي الخلفي ومنها ما يقوم بعمله. ظهر نوع جديد من هذه المفاصل يتميز بوجود سطح بلاستيكي متحرك أعلى الجزء الخاص بالساق. ذلك مقارنة بالنوع السائد حيث كان هذا الجزء البلاستيكي مثبت بالجزء الخاص بالساق ولا يسمح بالدوران. هذا هو موضوع البحث : المقارنة ما بين هذين التصميمين.

هدفت هذه الدراسة إلى استعراض لأبحاث المنشورة المتوفرة حول المقارنة بين النتائج الوظيفية المصاحبة لهذين التصميمين، إضافة إلى استعراض علم التشريح والميكانيكا الحيوية التطبيقية وراء هذين التصميمين. كما قمنا في الجزء الثاني من هذه الرسالة بإجراء دراسة استطلاعية لمقارنة النتائج الوظيفية ومجال حركة الركبة والمضاعفات المصاحبة لكل من هذين التصميمين.

تمت هذه الدراسة الإستطلاعية على ٤٠ حالة خشونة مقدمة بمفصل الركبة. تم علاج ٢٠ حالة بواسطة مفصل ركبة ذو سطح ثابت وتم علاج العشرون حالة الأخرى بواسطة مفصل ركبة ذو سطح متحرك، تمت متابعة المرضى لمدة عام بعد الجراحة.

ثم قمنا بإجراء مقارنة لهذين النوعين من المفاصل فيما يتعلق بـ : النتائج الوظيفية المصاحبة لكل نوع باستخدام أشهر المعايير وهو The New Knee Society Score بعد مرور أسبوعين ثم شهر ثم كل ثلاثة أشهر بعد إجراء الجراحة حتى مرور عام.

وأظهرت النتائج التي توصلنا لها عدم وجود فروق ذات دلالة إحصائية في المجموعات المدروسة بشأن هذه المعايير، كما أظهرت النتائج أيضاً عدم وجود فروق ذات دلالة إحصائية فيما يتعلق بدرجة ثني الركبة المصاحبة لإستخدام أى من هذين النوعين من المفاصل.

استنتجنا من هذه الدراسة أن النتائج الوظيفية المصاحبة لإستخدام مفصل الركبة الصناعي الكامل ذو السطح المتحرك تطابق النتائج الوظيفية المصاحبة للمفصل ذو السطح الثابت.

وهناك حاجة إلى دراسة أكبر بعينة أكبر ومدة متابعة أطول لكي يتسنى لنا أن نشير إلى الاختلافات بين هذين التصميمين على المدى البعيد.