INTRODUCTION

The primary concern of any total knee arthroplasty is to provide the best possible outcome for the patient. The success of any total knee arthroplasty is influenced by a complex interaction between the geometry of the components and the soft tissue envelope that surrounds this articulation.[1]

The long term results of total knee arthroplasty with symmetric fixed bearing designs have shown high degree of clinical success especially in older and less active individuals[2] there is concern, however, with regard to problems related to patellofemoral articulation, polyethylene wear, and osteolysis.[3]

Mobile bearing arthroplasties were introduced with the aim of reducing polyethylene wear and related osteolysis, which were seen with some fixed bearing designs.[4] Congruency between the femoral component and the superior surface of the rotating polyethylene in a mobile bearing design was intended to reduce polyethylene wear, while rotation between the inferior polyethylene surface and the metal tray was intended to reduce stress on the metal tray and the tibial bone interface.[5]

The risk of bearing subluxation and dislocation associated with the mobile bearing (Rotating platform) knee replacement is a cause for concern and may necessitate early revision.[6]

Various long term studies have been done independently on both Rotating platform and fixed bearing prosthesis, but only few studies, are available comparing the two prosthesis, hence this study has been done to compare Rotating platform (mobile bearing) versus Fixed bearing in patients undergoing total knee arthroplasties, with regard to clinical and radiographic outcomes .[6]

AIMS & OBJECTIVES

To study the clinical and radiological outcome of rotating platform (mobile bearing) and fixed bearing prosthesis in primary total knee arthroplasty.

DESIGN INNOVATION- MOBILE BEARING INSERT

"Life is lived forwards but understood backwards". So an understanding of the evolution of knee implants helps to understand the trend towards mobile bearing knees. The first successful knee implants in 1970s were all polyethylene tibia, which articulated with the total condylar metallic femoral component. Although they produced consistent results, they were found to be associated with a high incidence of radiolucent lines at the prosthesis-cement interface and a high incidence of loosening.[7-9]

The next step in the evolution of knee implants was the development of metal backing to the tibial implant. This evolved in two directions, a fixed bearing design where tibial plastic was locked on the metal tray and a mobile bearing design where tibial plastic allowed to slide or SS rotate over the tibial tray. But these designs introduced an additional interface-the undersurface with a possibility of wear. These components now had dual surface wear-undersurface wear and the existing articular surface wear. With the fixed bearing design, flexion-extension and rotational movements occurred at the articulation between femoral component and polyethylene liner. This feature restricted the articular conformity greatly. With mobile bearing design, these movements were

decoupled, flexion-extension occurred at the femoral component and polyethylene liner interface, and rotational movement occurred at polyethylene liner and tibial interface. This feature was intended to reduce the surface and subsurface stress at the bearing surfaces and at the bone-implant surfaces by maximizing the conformity of the tibial and femoral components.

MOBILE BEARING KNEE: DESIGN, EVOLUTION, AND RESULTS

Mobile bearing knee prosthesis are not new. The first to be used was the Oxford device [21](Biomed, Bridegen, South Wales), which was designed in late 1970s, and the second was the low contact stress (LCS) prosthesis [22](Depuy, Warsaw, Indiana) based on similar concepts.

The concept of mobile bearing knee prosthesis is to address the three issues that have been discussed.

- Providing larger contact area by allowing increased conformity of the articular surface.
- Rotation is decoupled and allowed at the additional interface of undersurface.
- Minimization of under surface wear by eliminating locking mechanism and optimizing undersurface articular environment.

The rationale was that mobile bearing knee implants allow increased tibio-femoral articular conformity without restricting axial rotation. This increased conformity enhances surface contact area and reduced contact stresses, thus potentially reducing polyethylene wear.

One of the principal features of mobile bearing knee design is the promotion of load sharing through the relative displacement between the tibial and femoral components. Simply stated, this design allows the torque and shear forces of gait cycle to be transferred by way of displacements to soft tissue in a fashion similar to that of normal knee. Load sharing has many potential advantages. It reduces the loosening stresses that are transferred to the implant bone interface, and it also promotes soft tissue strengthening (Roux's law).[14] Soft tissue, unlike the inert prosthesis, has the capacity to respond and remodel to the challenges of the expanding activities performed as the pain-free knee is rehabilitated. Finally, load sharing may contribute to the reduction of articular wear of these devices by reducing the joint loads. Thus, in general, soft tissue involvement should be encouraged in order to decrease the dependency on the increasing constraints afforded by the condylar geometry. Contemporary mobile bearing knee design achieves this involvement, and they can be described in terms of the plateau mobility, which can be (i) pure rotation, (ii) rotation with anteroposterior translation, (iii)unconstrained movement.[23]

Through extensive work, Professor Fisher at Leeds University, England has evaluated the wear rates per million cycles of the different types of mobile bearing total knees. Pure rotation knees such as rotating platforms are classified as unidirectional, whereas the other types that have rotation and anteroposterior translation are multidirectional. The wear per million cycles is less with unidirectional knees by a factor of 9 over multidirectional knees.[24] This study concluded that guided bearing surfaces

like rotating platform offered the best solutions in mobile bearing knee systems.

Long-term evaluation of the LCS meniscal total knee system with use of wear simulator that proximated 10-year in vivo service life demonstrated low volumetric loss of ultra high molecular weight polyethylene compared with that in fixed bearing designs.[23] Specifically, a 160mg weight loss over 10 million stance-phase cycles, from a bearing plateau that initially weighed 16000mg has this particular design.[23,25] Reason for this result is the substantial reduction in the proximal and distal contact stress levels suggested by finite element computation analysis.[26,27] The low contact stresses on both articulating surfaces greatly attenuate any damaging effect that increased sliding distances may have on abrasive wear and debris generation.[28,29]

After the first two introductions of Oxford and LCS knee, there was a large interim period. With their success, since 1990, there has been resurgence and almost each of the major manufacturing companies is either designing or has already introduced a mobile bearing knee(table1).

TABLE I.

List Mobile Bearing Knees

Brand name	Launch yr	Company
Oxford	1977	Biomet
LCS	1978	Depuy
SAL	1990	Sulzer
PFC Sigma RP	1995	J &J
Interax I.S.G Duracon	1995	Howmedica

Scorpio	1995	Osteonics
MBK	1997	Zimmer
T.R.A.C	1998	Biomet
Genesis II profix	1999	S & N
Medial Pivot	1999	Wright med
LPS Flex Mobile	2000	Zimmer
PFC RPF	2005	J & J

The individual clinical performances of the devices are strongly influenced by the particular design kinematics of both the proximal and the distal surface as well as the distribution on contact stresses. In addition, the quality of the polyethylene and finishing of the articular metallic component is important. With regard to these parameters, not all mobile bearing knees systems perform the same. Some systems with a central metal post on the tibial base plate and others with a peripheral post to stop mobile bearing from spinning off in vivo have produced significant amount of wear in these areas, sufficient to abandon their use. LCS knee is the only one that had been approved by FDA, USA till 2000 and has the longest clinical use of more than 20 years.

OVER VIEW

Reduction of contact pressures leading to reduced wear and osteolysis associated with fixed bearing knee was the primary motive for development articular and with rotational movement decoupled to undersurface. Laboratory and clinical data have substantiated reduction in

wear with these designs, more substantially with monodirectional mobile bearing knees. Long –term clinical use has shown satisfactory outcome with survival of 98% at 20 years. Surgical technique is more exacting and flexion balance is crucial. Newer developments with posterior stabilized rotating platform have improved stability and range of movement. Long-term results of these designs are yet awaited, but they do appear promising.

MATERIAL:

32 patients undergoing total knee arthroplasty (16 patients in Fixed bearing group and 16 patients in Mobile bearing group) were prospectively followed for the study from August 2008 to July 2010. Average follow up period was 6 months to 12 months (Short-term follow up study). There were 20 females and 12 male patients with mean age of 63.65 years. Patients were operated by the same surgeon using same instrumentation (Exactech –FIXED BEARING(Cruciate Retaining {CR})/ MOBILE BEARING Posterior stabilised{PS} by Optetrek Company). Patients received a similar course of postoperative rehabilitation after each surgery.

The knee society scoring system was used for assessment of pre op and postoperative clinical and radiological outcome at each follow up.

RESULTS/OBSERVATIONS:

Present study was designed for prospective randomized analysis of the patients undergoing total knee arthroplasty with a fixed bearing knee or a mobile bearing knee.

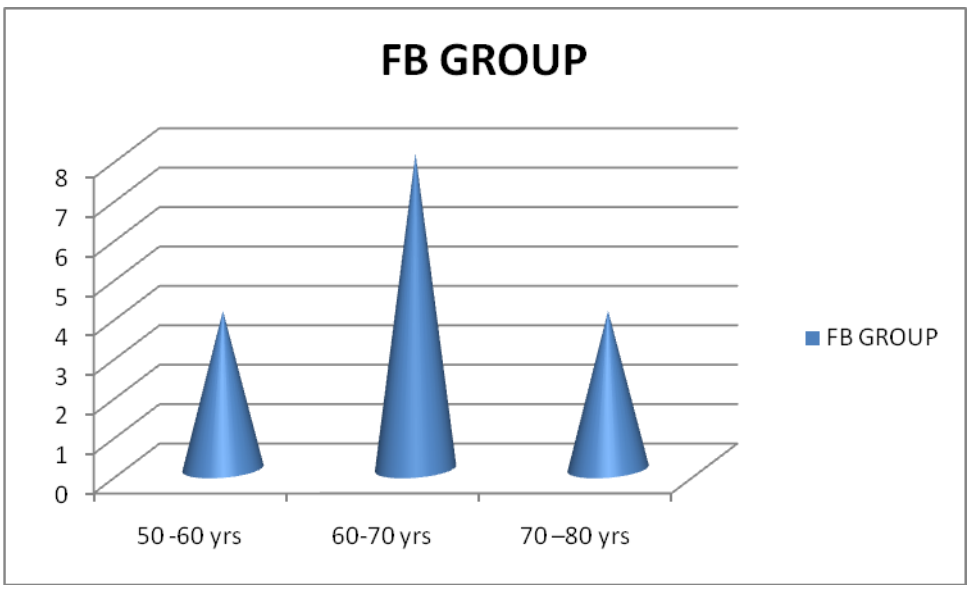
32 patients undergoing total knee arthroplasty (16 Fixed bearing knee and 16 Mobile bearing knee) were prospectively followed for the study from August 2008 to July 2010. Average follow up period was up to 12 months (Short-term follow up study). In the FB group there were 10 females and 6 male patients with mean age of 63.68 years. In the MB group there were 10 females and 6 male patients with mean age of 63.75 years.

All the patients were suffering from primary osteoarthritis of both the knees with Minimum age of the patient in the study was 50 yrs and maximum 73 years, mean age was 63.65 years. Patient age did not show any relation to the functional outcome of the surgery.

Tableno1: AGE DISTRIBUTION IN FIXED BEARING GROUP

GROUP	**50-60 yrs**	**60-70 yrs**	**70–80 yrs**
FB GROUP	4	8	4

Graph no 1: CONE DIAGRAM SHOWING AGE DISTRIBUTION IN FIXED BEARING GROUP:

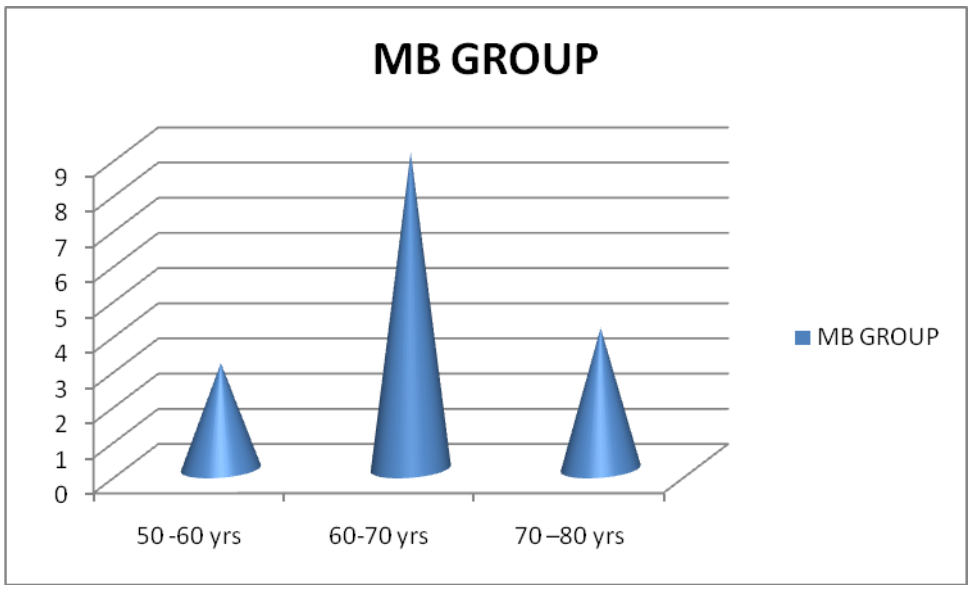


In the fixed bearing group there were 4 patients in the age group of 50-60 years, 8 patients in the age group of 60-70 years, 4 patients in the age group of 70-80 years.

Table 2:AGE DISTRIBUTION IN MOBILE BEARING GROUP

GROUP	50 -60 yrs	60-70 yrs	70 –80 yrs
MB GROUP	3	9	4

Graph no 2: CONE DIAGRAM SHOWING AGE DISTRIBUTION IN FIXED BEARING GROUP:

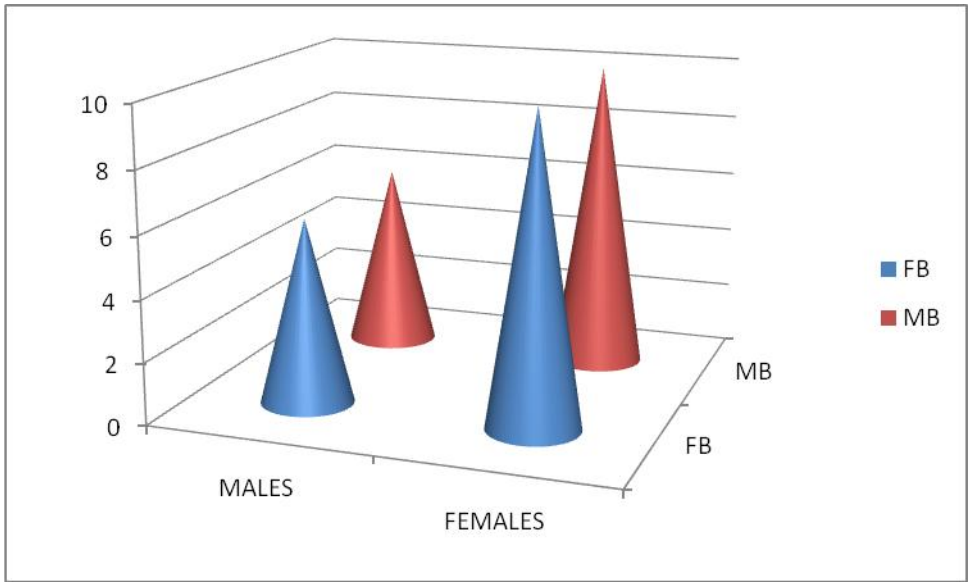


In the mobile bearing group there were 3 patients in the age group of 50-60 years, 9 patients in the age group of 60-70 years, 4 patients in the age group of 70-80 years.

Table no 3: SEX DISTRIBUTION IN FIXED AND MOBILE BEARING GROUPS:

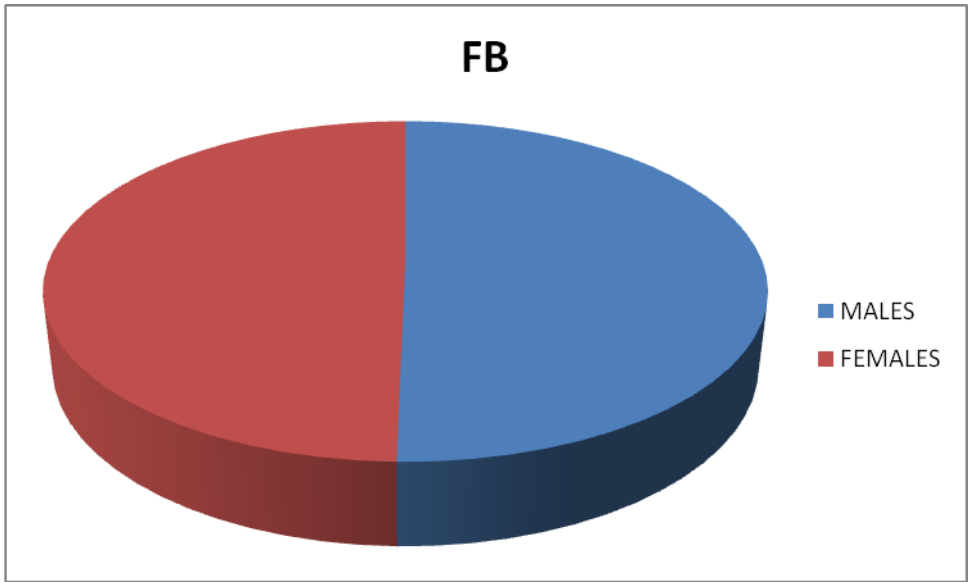
GROUP	MALES	FEMALES
FB(n=16)	6	10
MB(n=16)	6	10

Graph no 3: 3D CONE DIAGRAM SHOWING SEX DISTRIBUTION:



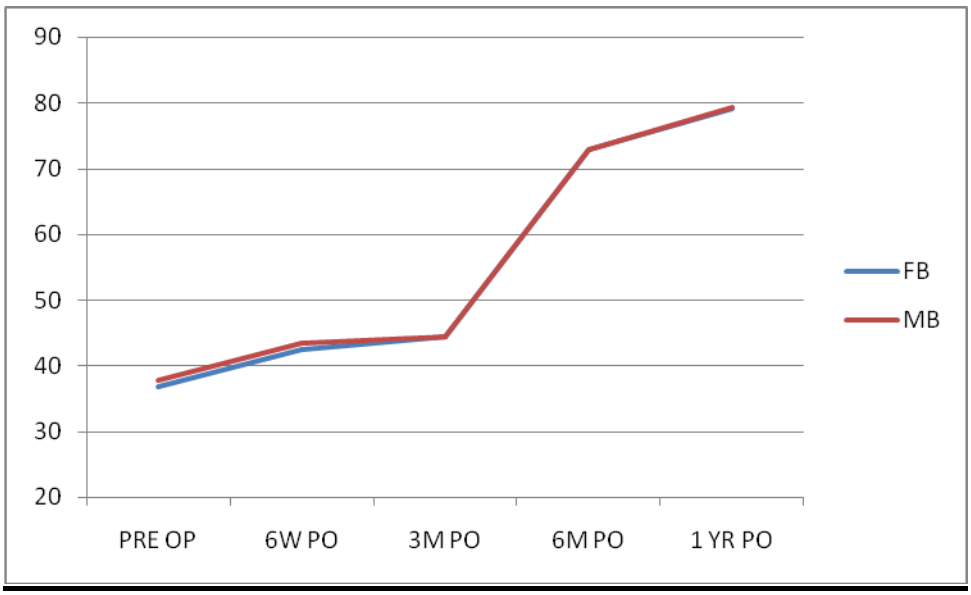
In the fixed bearing group there were 6 males and 10 females, and in the mobile bearing group there were 6 males and 10 females, there was no significant statistical difference in the sex ratio of bothe the groups.

Pie chart no 1: PIE CHART SHOWING SEX RATIO IN FB GROUP:



etween the objective scores of fixed bearing and mobile bearing groups, p value >0.05.

Graph no 13: GRAPHICAL REPRESENTATION OF TREND OF MEAN FUNCTIONAL SCORES OF FIXED AND MOBILE BEARING GROUPS:



There is consistent increase in the mean functional scores of fixed bearing total knee arthoplasty group over 1 year. Preoperative functional score of the fixed bearing group was 44.18. At the end 1 year the functional score of the fixed bearing group was 91.75. There is consistent increase in the mean functional scores of mobile bearing total knee arthoplasty group over 1 year. Preoperative functional score of the mobile bearing group was 42.31. At the end 1 year the functional score of the mobile bearing group was 93.12. There was no significant statistical difference between the functional scores of fixed bearing and mobile bearing groups, p value >0.05.

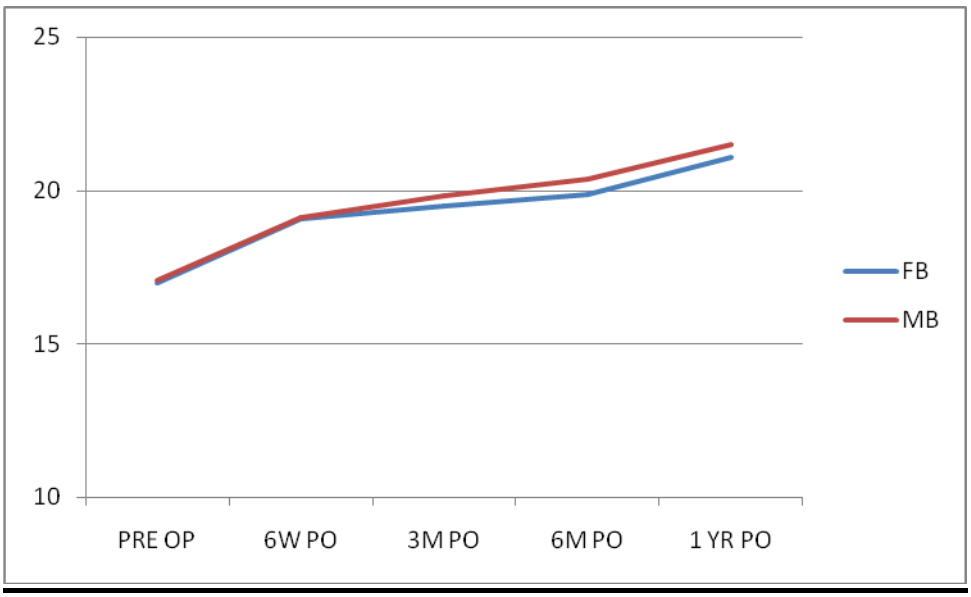
Table no 12: MEAN RANGE OF MOTION (IN DEGREES) AT VARIOUS FOLLOW-UP VISITS:

GROUP	PRE OP	6W	3M	6M	1YR
FB(n=16)	85^o	95^o	95^o	95^o	105^o
MB(n=16)	85^o	95^o	100^o	100^o	105^o

Table no 13: MEAN RANGE OF MOTION IN FIXED BEARING AND MOBILE BEARING GROUP AT VARIOUS FOLLOW-UP VISITS:

GROUP	PRE OP	6W	3M	6M	1YR
FB(n=16)	17	19.06	19.5	19.87	21.06
MB(n=16)	17.06	19.12	19.81	20.37	21.5
P value	ns(p>0.05)	ns(p>0.05)	ns(p>0.05)	ns(p>0.05)	ns(p>0.05)

Graph no 14: GRAPHICAL REPRESENTATION OF TREND OF MEAN RANGE OF MOTION (IN DEGREES) OF FIXED AND MOBILE BEARING TKR:



There is consistent improvement in the range of motion (ROM) in both the groups, at the end of 1 year the range of motion in the fixed bearing group was about 105^{o}. At the end of 1 year the range of motion (ROM) in the mobile bearing group was also about 105^{o}. When mean scores were compared there was no significant statistical difference in the range of motion (ROM) scores either in the pre operative period or during all the follow up periods.

Table no 13: MEAN RADIOGRAPHIC RESULTS

PARAMETERS	DURATION	FB	MB
VARUS	PRE OPERATIVE	7.625^{o}	7.5^{o}
	POST OPERATIVE	0.5^{o}	0.5^{o}
VALGUS	PREOPERATIVE	11^{o}	10^{o}
	POST OPERATIVE	5^{o}	5^{o}
FEMORAL COMPONENT ALIGNMENT	ANTERO POSTERIOR(α angle)	95^{o}	95.25^{o}
	SAGITTAL(γ angle)	4^{o}	3.5^{o}
TIBIAL COMPONENT ALIGNMENT	ANTERO POSTERIOR(β angle)	91.12^{o}	1^{o}
	SAGITTAL(σ angle)	83.56^{o}	83.5^{o}
RADIOLUCENT LINE	FEMORAL	1	1
	TIBIAL	1	1
PATELLLAR TILT		-	-
PATELLAR SUBLUXATION		-	-
PATELLAR HEIGHT	PREOPERATIVE	-	-
	LAST F.U	-	-

The mean pre operative varus deformity in the FB group 7.625 degrees, the mean pre operative varus deformity in the MB group 7.5 degrees. The mean postoperative varus deformity in the FB group 0.5 degrees, the mean postoperative varus deformity in the MB group 0.5 degrees.

The mean pre operative valgus deformity in the FB group 11 degrees, the mean pre operative valgus deformity in the MB group 10 degrees. The mean postoperative valgus deformity in the FB group 5 degrees, the mean postoperative valgus deformity in the MB group 5 degrees.

Femoral component alignment anteroposterior (α angle) in the fixed bearing group was 95 degrees, and 95.25 degrees in mobile bearing group. Femoral component alignment sagittal (γ angle) in the fixed bearing group was 4 degrees, and 3.5 degrees in mobile bearing group.

Tibial component alignment anteroposterior (β angle) in the fixed bearing group was 91.12 degrees, and 91 degrees in mobile bearing group. Tibial component alignment sagittal (σ angle) in the fixed bearing group was 83.56 degrees, and 83.5 degrees in mobile bearing group.

There were no significant implant loosening as suggested by a radiolucent line >2mm, were noted in both the study groups.

The components of patellar tilt, subluxation and height were not assessed as we have not done patellar replacement in any of the patients.

DISCUSSION

Present study was designed for prospective randomized analysis of the clinical, functional & radiological outcome of the patients undergoing total knee arthroplasty with a fixed bearing knee or a mobile bearing knee.

The study done was “COMPARATIVE STUDY OF TOTAL KNEE ARTHROPLASTY, ROTATING PLATFORM (MOBILE BEARING) VERSUS FIXED BEARING (CONGRUENT) KNEE DESIGNS”.

32 patients undergoing total knee arthroplasty (16 Fixed bearing knee and 16 Mobile bearing knee) were prospectively followed for the study from August 2008 to July 2010. Average follow up period was 12 months (Short-term follow up study). In the Fixed bearing group there were 10 females and 6 male patients with mean age of 63.68 years. In the Mobile bearing group there were 10 females and 6 male patients with mean age of 63.75 years.

All the patients were suffering from primary osteoarthritis of both the knees with Minimum age of the patients in the study was 50 yrs and maximum 73 years, mean age was 63.65 years. Patient's age did not show any relation to the functional outcome of the surgery.

Strict preoperative protocol was observed for all the patients. Patients were randomized and were allocated the prosthesis according to the randomization table (annexure no. IV).

The functional and radiological outcomes of the patients in both the were measured at 6 weeks, 3 months, 6 months and 1 year post operative period and were compared.

VARIOUS STUDIES IN COMPARISON IN DISCUSSION:

STUDIES	**DURATION**	**AVERAGE AGE (In Years)**		**MEAN KNEE SOCIETY K SCORE**		**MEAN KNEE SOCIETY FUNCTION SCORE**		**RESULT**
		FB	**MB**	**FB**	**MB**	**FB**	**MB**	
Paolo Aglietti et al.	4 years	69.5	71	93	93	79	80	BOTH ARE EQUAL
P VALUE (ns<0.05)		ns		ns		ns		
Attique Vasdev, et al.,	3.5 years	63 (57-76)	63 (55-76)	91.7	91.2	-	-	BOTH ARE EQUAL
P VALUE		ns		ns		ns		

(ns<0.05)								
Present study	1 year	63.68 (52-74)	63.75 (50-73)	91.75	93.125	79.06	79.37	BOTH ARE EQUAL
P VALUE (ns<0.05)		ns		ns		ns		

COMPARISON OF DURATION IN DIFFERENT STUDIES:

The average duration of our study period was 1 year, where as in the study conducted by Paolo Aglietti et al., the duration was 4 tears, and in the study by Attique Vasdev et al., the duration of the study was 3.5 years.

Compared to both these studies our study was a short term study.

COMPARISON OF AGE GROUPS IN DIFFERENT STUDIES:

In the study conducted by Paolo Aglietti et al., the average age of patients undergoing fixed bearing and mobile bearing total knee replacement was 69.5 and 71 years respectively.

In the study conducted by Attique Vasdev et al., the average age of patients undergoing fixed bearing and mobile bearing total knee replacement was 63 and 63 years respectively.

Where as in our study the average age of patients undergoing fixed bearing and mobile bearing total knee replacement was 63.68 and 63.75 years respectively.

The mean age was comparable to the other mean ages of patients in the above studies.

COMPARISON OF MEAN KNEE SOCIETY KNEE SCORES IN DIFFERENT STUDIES:

In the study conducted by Paolo Aglietti et al., the mean knee society knee scores in fixed bearing and mobile bearing total knee replacement, at the end of 1 year were 91 and 92 and at the end of 4 years were 93 and 93 respectively.

In the study conducted by Attique Vasdev et al., the mean knee society knee scores in fixed bearing and mobile bearing total knee replacement, at the end of 3.5 years were 91.7 and 91.2 respectively.

In our study the mean knee society knee scores in fixed bearing and mobile bearing total knee replacement, at the end of 1 year were 91.75 and 92.12 respectively.

The mean knee society knee scores were comparable to the mean society knee scores in other studies.

COMPARISON OF MEAN KNEE SOCIETY FUNCTION SCORES IN DIFFERENT STUDIES:

In the study conducted by Paolo Aglietti et al., the mean knee society function scores in fixed bearing and mobile bearing total knee replacement, at the end of 1 year were 82 and 84 and at the end of 4 years were 79 and 80 respectively.

Where as in our study the mean knee society function scores in fixed bearing and mobile bearing total knee replacement, at the end of 1 year were 79.06 and 79.37 respectively.

The mean knee society knee scores were comparable to the mean society knee scores in other studies.

COMPARISON OF MEAN KNEE RANGE OF MOTION (ROM) IN DIFFERENT STUDIES:

In the study conducted by Paolo Aglietti et al., the mean knee range of motion (ROM) in fixed bearing and mobile bearing total knee replacement, at the end of 1 year were 0-114^{o} and 0-110^{o} and at the end of 4 years the range of motion (ROM) was 0-112^{o} and 0-108^{o} respectively.

In the study conducted by Attique Vasdev et al., the mean knee range of motion (ROM) in fixed bearing and mobile bearing total knee replacement, at the end of 1 year were 0-114^{o} and 0-110^{o} and at the end of 4 years the range of motion (ROM) was 0-101^{o}+/-7.8^{o} and 0-102^{o}+/-7.7^{o} respectively.

In our study the mean knee range of motion (ROM) in fixed bearing and mobile bearing total knee replacement, at the end of 1 year were 105^{o} and 105^{o} respectively.

The mean knee range of motion (ROM) at the end of 1 year in our study was comparable to the mean knee range of motion (ROM) at the end of 1 year in other studies.

COMPLICATIONS: There were no complications either in the fixed bearing or mobile bearing total knee arthroplasty groups.

LIMITATIONS OF THE STUDY: The post operative follow up is very short of only 1 year duration and thus the long term outcome of the two prosthetic designs can't be assessed in the present study.

CONCLUSION:

The clinical, functional and radiological outcome of both fixed bearing total knee arthroplasty and mobile bearing total knee arthroplasty were compared. The knee society knee score and the functional scores improved consistently in the post operative period. The knee range of movements (ROM) also improved. Both the groups were followed in prospective manner for 1 year and data collected was assessed by statistical methods.

There was no significant statistical difference in clinical, functional and radiological out come in both fixed bearing and mobile bearing prosthetic designs.

Our study has shown that using a fixed-bearing or a mobile-bearing design, when all the other variables are controlled, did not seem to influence the outcome in short-term FU.