

Accuracy of Lower Limb Alignment in Patients with Total Knee Arthroplasty in Fajr Hospital, Tehran, 2008-2013

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This study was designed to evaluate accuracy of lower limb alignment in patients with Total Knee Arthroplasty (TKA) in Fajr Hospital of Tehran in 2008 to 2013. All patients evaluated in the study had undergone TKA surgery during the years 2008 to 2013. A checklist was used to collect data. Evaluations for the angle between the femoral mechanical axis and the tibial mechanical axis and lower limb mechanical axis were calculated from X-rays of alignment taken before and after the surgery. Assessment for effects of the surgery were made according to Knee Society scores (KSS) taken before the operation and 12 months after the procedure. This study evaluated 102 patients within average age of 65.79 ± 6.8 years. Fourteen patients were male and 88 were female. The mean for mechanical axis angle in the lower extremity was 1.54 ± 2.94 in various, the mean for range of motion (ROM) was 112.07 ± 18.75 , the mean for flexion contracture (FC) was 2.42 ± 3.77 degrees. Results determined no significant difference between these angles in terms of sex, side of the defect and the type of surgery. The mean duration of hospitalization was reported as 8.5 ± 3.46 days. KSS showed better results after TKA. The results showed that TKA, as a routine procedure in the treatment of the last stages of knee disorders as such as osteoarthritis, rheumatoid arthritis and the other defects can be useful and that factors such as sex, type of surgery and side of involvement made no difference in the results of TKA.

Key words: Total knee arthroplasty (TKA), radiographic alignment,
Mechanical axis of the lower limb, Knee Society scores (KSS).

Knee replacement surgery was first performed by Gluck more than 100 years ago in 1880 on three patients. Knee arthroplasty (TKA) is now one of the most common orthopedic surgeries used for pain reduction and functional correction in patients with knee osteoarthritis (OA) in later

stages of the disease¹⁻⁵. TKA has standard practice; it is a common procedure for older people and those with broad ranging indications. However, in people with this type of surgery, range of motion (ROM) can be limited, there is a long rehabilitation process and the procedure is associated with the risk of a worse functioning joint. Following up has shown that survival rate for the procedure is 98%⁶. One of the basic principles of TKA is improvement of implant durability and it should be considered that during performance of this procedure, limb alignment should be corrected

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and the mechanical axis should be in the range 3 ± 0 degrees⁷. However, if the difference of these angles is more than 3 degrees (particularly in the varus), then results indicate a lower KSS [8-9] and a higher failure rate¹⁰⁻¹². Abnormal valgus and varus axis can lead to loss of the implant. Abnormal femoral rotation can also be a major cause of patellofemoral problems¹³⁻¹⁵, but some studies have reported that there is a weak correlation between survival of TKA and mechanical axis alignment¹³. In the case of aligned TKA, there is hip-knee-ankle alignment in the lower extremity, with no angles at the joints in the coronal section; in other words, there is a straight line. When an axis is created, the mechanical axis of the leg passes from the center and perpendicular to the knee joint¹⁶⁻¹⁷. Although the mechanical axis of TKA improves a patient's performance, studies in the field of joint replacement have shown that 20% to 25% of patients remain dissatisfied^{18,13,19} and 7% of patients need further arthroplasty treatment^{13,20}. But in any case, such interference is expanding well and has predictable and publishable outcomes in aging populations¹⁻³ and in the coming years, with the world's aging population and increasing incidence of associated knee abnormalities, a large number of patients will seek this type of operation⁴. Surgical techniques for TKA are done to maintain posterior cruciate ligament (PCR) and remove posterior cruciate ligament (PS). Studies on PCR have shown that TKA surgery has had excellent results and higher implant survival rates²¹⁻²². Long-term studies have shown that TKA has had successful outcomes in patients with OA and other related disorders^{13,23}. However, this technique can also defeat its purpose in that the primary reason for the failure of TKA includes pain, stiffness and instability after surgery. Pain is caused by weight bearing, and is most often mechanical with loosening, component failure or malfunction of the patella²⁴. According to research, success will be achieved in patients with suitable mechanical axis after replacement with prosthetic components²⁵. However, other studies have mentioned that despite scientific claims, clinics try to maintain a mechanical axis of 3 ± 0 degrees, the survival rate was surprisingly low^{26-29,7}. Based on existing research and the development of reconstructive surgery such as total knee replacement and the importance of awareness of its complications, the

present study was designed to evaluate lower limb alignment in patients with total knee arthroplasty in Fajr Hospital, Tehran between the years 2008 to 2013.

METHOD AND MATERIALS

The present study was done prospectively on patients referred from Fajr Hospital, Tehran during the years 2008 to 2013 that had undergone TKA surgery, they were evaluated for lower limb alignment. All patients received prophylaxis antibiotic during anesthesia. After an internal patellar approach, the first technique was performed on the femur. For femur tests intra-medullary tools were used and for tests on tibia extra-medullary tools were used. Re-coating of the patella had not been applied to patients in the study, and in posterior cruciate ligaments was preserved with the exception of five cases. Rehabilitation after surgery was performed in these patients according to integrated standard care pathways. After TKA, patients were discharged from the hospital according to the single protocol. Each patient had a clean and dry wound and satisfactory movement with at least flexion of 80 degrees. All patients had clinical preparation and were appropriately discharged from the hospital. A checklist was used to collect data that included demographic information such as age and gender as well as information about the patient (including the side of involvement, type of surgery, range of motion (ROM), the mechanical axis evaluation, and flexion contracture (FC) and length of hospitalization). For evaluation of lower limb alignment, before and after surgery, alignment radiographs were taken for each patient. Experienced surgeons performed the operations. Prostheses were often used retention of the cruciate ligament, including cemented prosthesis. Exclusion criteria included, patients with a varus of more than 15 degrees preoperatively and patients with re-arthroplasty. Calculations were made for angle between the femoral and tibial mechanical axis from photographs before and after surgery. X ray images were taken before and after surgery of the mechanical axis of the lower limb (the line between the midpoint of the femoral head center and talus) and the difference between these two angles were calculated and recorded. Assessments were made to record the effects

and results of surgery according to Knee Society scores (KSS) before surgery and 12 months after surgery. This test was a standard scoring system based on results of the knee surgery and the test had two subsets, one contained the knee scoring calculations based on expression of pain, ROM and the other set consisted of evaluations for stability and patient function, in terms of a patient's ability to walk, use of walking aids and the ability to climb stairs³⁰. For statistical analysis, data was entered into a computer and analyzed by the software SPSS16. Data were analyzed using descriptive statistics including means and frequencies. To compare data mean, T- test was used to evaluation of parametric data and Man-Whitney for non-parametric data.

RESULTS

In this study, 102 patients were evaluated with an average age of 65.79 ± 6.8 years old. Fourteen patients (72/13%) were male and 88 patients (%) were female. The average age of males was 71.92 ± 5.64 years and the average age of females was 64.88 ± 6.5 years. In 73 cases (71.6%), the disease was unilateral and in 29 patients (28.4%) it was bilateral. In 36 patients (35.3%) the operation was performed on the right knee,

and in 37 patients (36.3%) it was done on the left knee and in 29 patients (28.4%) both knees were involved, the knee involved in 65 cases (49.6%) on the right side and in 66 cases (4.50%) on the left. The means for mechanical alignment of the lower limbs were $1.54 \pm 2.94^\circ$ in the varus in males and in females $1.57 \pm 2.97^\circ$ and there was no significant difference between this angle between males and females ($p > 0.05$, Table 1). The mean for angle of the lower limb mechanical alignment was studied in terms of side of involvement. It was $1.63 \pm 2.65^\circ$ varus in right side and $1.2 \pm 3.12^\circ$ varus in left side and was not observed significant difference in the involvement sides ($p \leq 0.05$, Table 2). The mean of angle of the lower limb mechanical alignment depending on surgery type was studied. In PS, it was $0.36 \pm 3.09^\circ$ and in CR was $1.96 \pm 2.8^\circ$. There was no significant difference in terms of surgery type for evaluations of this angle ($p \leq 0.05$, Table 3). The ROM mean in patients was $112.07 \pm 18.75^\circ$. It was $104.29 \pm 16.35^\circ$ in males and 111.56 ± 16.23 in females and there was no significant difference in terms of sex for evaluations of this angle ($p \leq 0.05$, Table 1). The means for ROM were studied in terms of side of body that treatment involved. It was $113 \pm 15.95^\circ$ on the right side and $111.14 \pm 21.37^\circ$ on the left side. It was reported that there was no significant difference in terms of side

Table 1. The mean of the mechanical axis angle, ROM, FC and KSS test in patients according to their sex

Mean	Sex		p-value
	Male	Female	
Mechanical axis	$1.54 \pm 2.94^\circ$	$1.57 \pm 2.97^\circ$	0.508
ROM	$104.29 \pm 16.35^\circ$	111.56 ± 16.23	0.696
FC	3.14 ± 6.37	$2.73 \pm 2.9^\circ$	0.431
KSS	140.82 ± 2.91	138.62 ± 2.83	0.221

Table 2. The mean of the mechanical axis angle, ROM and FC in patients according to the side of involvement

Mean	Side of involvement		p-value
	Right	Left	
Mechanical axis	$1.63 \pm 2.65^\circ$	$1.2 \pm 3.12^\circ$	0.309
ROM	$113 \pm 15.95^\circ$	$111.14 \pm 21.37^\circ$	0.939
FC	$1.94 \pm 2.73^\circ$	$2.91 \pm 3.72^\circ$	0.228

of involvement for evaluations of this angle ($p \leq 0.05$, Table 2). The ROM mean was studied in terms of surgery type. It was evaluated as $110.26 \pm 16.53^\circ$ in the PS type and $112.75 \pm 19.62^\circ$ in the CR type. No significant difference was reported in terms of surgery type for evaluations of this angle ($p \leq 0.05$, Table 3). The FC mean in patients was $3.77 \pm 2.42^\circ$. The mean FC, in males was $3.14 \pm 6.37^\circ$ and in females the evaluation was $2.73 \pm 2.9^\circ$ and there

was no significant difference in terms of sex for evaluations of this angle ($p \leq 0.05$, Table 1). The FC mean was studied for side of the body that treatment involved. It was reported as $1.94 \pm 2.73^\circ$ on the right side and $2.91 \pm 3.72^\circ$ on the left side, and no significant difference was determined in terms of side of the body that treatment involved in this angle ($p \leq 0.05$, Table 2). The FC mean was studied according to surgery type. It was

Table 3. The mean of the mechanical axis angle, ROM and FC in patients according to the type of surgery

Mean	Type of surgery		p-value
	PS	CR	
Mechanical axis	$0.36 \pm 3.09^\circ$	$1.96 \pm 2.8^\circ$	0.528
ROM	$110.26 \pm 16.53^\circ$	$112.75 \pm 19.62^\circ$	0.591
FC	$3.68 \pm 4.35^\circ$	$1.96 \pm 2.67^\circ$	0.131

Table 4. The mean for duration of hospital stay (days) according to the type of surgery

Type of surgery	Hospital stay	p-value
PS	8.93 ± 3.27	0.216
CR	8.31 ± 3.55	

determined as $3.68 \pm 4.35^\circ$ in the PS type and $1.96 \pm 2.67^\circ$ in the CR type. Evaluations showed no significant difference in terms of surgery type for evaluations of this angle ($p \leq 0.05$, Table 3). The mean of the preoperative KSS was $85.6 \pm 3.15^\circ$ and the postoperative evaluation was $140.02 \pm 2.95^\circ$. Evaluations determined significant difference between these measures before and after surgery ($p \leq 0.05$), but there was no correlation between KSS after surgery and the other variables (lower limb mechanical, ROM, and FC angles after surgery and hospitalization). For this test after surgery, no significant differences was determined between males and females and surgery type ($p \leq 0.05$, Table 1). The mean for duration of hospital stay was 8.5 ± 3.46 days. The mean for duration of hospital stay was studied in relation to surgery type. It was determined as 8.93 ± 3.27 days in PS type and 8.31 ± 3.55 in CR type. Evaluations showed no significant difference in terms of surgery type for duration of hospital stay ($p \leq 0.05$, Table 4). Also, no correlation was determined between age and

lower limb mechanical axis, ROM and FC angles ($p \leq 0.05$).

DISCUSSION

The purpose of this study was to evaluate lower limb mechanical alignment and ROM after TKA surgery. In this study, the mean of mechanical alignment was $1.54 \pm 2.94^\circ$ in varus. The mean ROM of evaluations in patients was $112.07 \pm 18.75^\circ$ and the mean of FC evaluations was $3.77 \pm 2.42^\circ$. The mean of hospitalization duration was 8.5 ± 3.46 days. According to related studies, the basic principle of TKA is to improve durability of the implant, and lower limb alignment should be improved by the procedure, to a score within the range of $3 \pm 0^\circ$ ⁷. Research by Jeffery *et al.* determined that correction of the coronal axis was an important factor in relation to prevention of a loosening prosthesis². In vitro studies on cadavers showed that if deviation with the lower limb mechanical alignment had an evaluation of 3° then the best results would be obtained during gait analysis and dynamics' studies^{31-32,29,33}. However, research by Bourne *et al.*, demonstrated a weaker correlation between survival of the TKA and mechanical axis than had been reported in other studies¹¹.

Dennis *et al.* showed that ROM in patients with TKA was lower than that in healthy people³⁴.

However, Ritter *et al.* showed that after surgery ROM would improve and that FC would reduce. Results of this study showed that factors affecting ROM after surgery, including patient's weight and preoperative ROM³⁴. Ritter *et al.* in another study showed that FC and decreased ROM were present when patients had postoperative pain³⁵. This study showed no significant difference between the lower limb mechanical axis, ROM and FC in terms of gender. KSS test results showed no significant difference on postoperative outcomes between females and males. Despite the lack of statistical difference in this test, evaluations were higher in males and this may have affected pain scores in females. Ritter *et al.* examined the impact of gender on results of TKA and showed no difference in outcomes and knee function in the long-term between males and females³⁵. The study of pain in patients showed that females experienced more pronounced moderate to severe pain than did males and that the experience of surgery was more painful for women³⁶⁻³⁷. The possibility of corrective re-operation in men was more likely than in women and this relates to other research on the effect of gender on pain and activity in patients before and after surgery³⁸.

The results of this study showed no significant difference between lower limb mechanical alignment, mean ROM and FC in terms of side of the body that treatment involved. Based on the results obtained, it could be argued that side of the body that treatment involved would not have an effect of surgical outcome. In previous studies, results for such evaluations have not yet been reported. Surgery type in this study was determined by PS and PCR. No significant difference was determined between lower limb mechanical alignment, ROM and FC in terms of type of surgery. Also, no significant difference was determined for duration of hospitalization and type of surgery. Results of this study determined no difference in terms of type of surgery so indicate that each of these techniques can be performed for TKA. Several studies have shown that the PCR type of TKA surgery had excellent results with higher survival rates and lower instability has been observed from this technique^{22,21}. Abdel *et al.* demonstrated that survival rates were higher from the PCR-type surgery³⁹. Miller *et al.* showed that long term inadequacy and instability of posterior

cruciate ligament rarely caused defects in PCR TKA in patients with rheumatoid arthritis⁴⁰. According to the study of Dennis *et al.* in an absence of weight bearing, ROM was similar in both types of surgery. But in terms of weight bearing, ROM in PS was greater than in PCR. Also ROM before surgery was lower than evaluations after surgery⁴¹. It has also been reported that preoperative ROM could be a predictive factor for postoperative ROM⁴². KSS test results also showed that patients good outcomes from the surgery. Most patients that had undergone TKA surgery were in the older age range, better joint function as a result of TKA could help them do their work and improve quality of life. Several studies, based on different criteria, have been done to evaluate patients under TKA treatment, long-term follow-up showed a significant improvement in their condition compared to that prior to the operation⁴³⁻⁴⁶. In general, the results of this study showed that TKA can be used as a routine procedure to treat the last stages of knee disorders such as osteoarthritis, rheumatoid arthritis. It can be stated that factors such as gender, type of surgery and side of the body that treatment involves makes no difference to results of TKA, and furthermore age does not affect results of the procedure.

CONCLUSIONS

In general, the results of this study showed that TKA can be used as a routine procedure to treat the last stages of knee disorders such as osteoarthritis, rheumatoid arthritis. It can be stated that factors such as gender, type of surgery and side of the body that treatment involves makes no difference to results of TKA, and furthermore age does not affect results of the procedure.

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