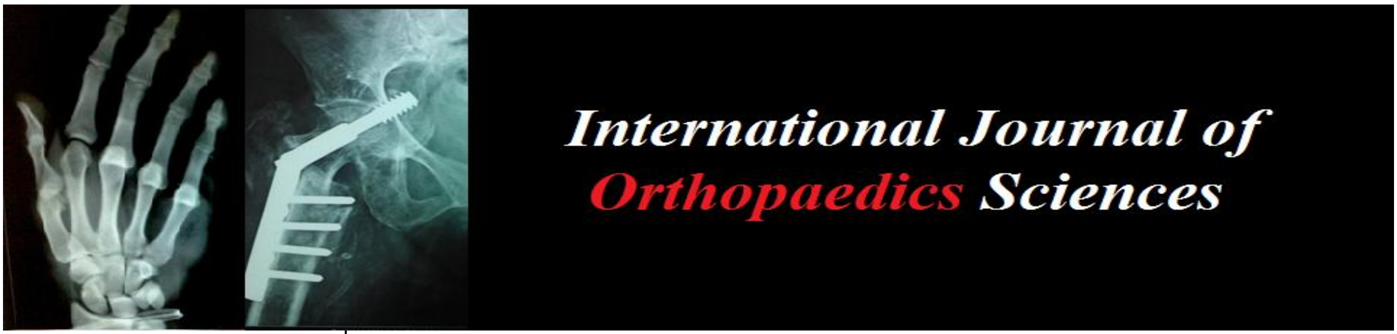

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A Study on limb alignment in computer navigated total knee arthroplasty in patient with Osteoarthritis

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Abstract
The success of total knee replacement depends on several factors, including patient selection, prosthesis design, soft tissue balancing, and alignment of the limb. Proper rotational and translational alignment of the prosthetic components and of the limb are important factors that influence the outcome of knee replacement. All cases of Total knee replacement done using computer. 65 patients with 72 knee were available for the follow-up with their previous records, annual x-rays and follow-up papers. Pre-operative deformities and its values were recorded for the study from the hospital case sheets and discharge summaries. For the 72 knees in our study the average mechanical axis angle was 1.25 degree varus. 1 knee (1.38) had -4 varus, 2 knee (2.77%)had -3 degrees varus, 4knees (5.55%) had -2 degrees varus, and 2 knee(2.77%) had -1 degrees varus. 9 knees (12.5%) had +2 degrees of valgus, 8(11.1) knee had +3 degrees valgus, 5knees (6.9%) had degrees +4 valgus and 1 knees (1.38%) had +5 degrees valgus. Overall the mechanical axis radiological score excellent in 65 knees (90.27%) and 7 knees (9.72%) had good radiological score. Furthermore, all systems depend on the reflective trackers remaining stationary relative to their respective bones during the surgical procedure. If a pin loosens in osteopenic bone or if it is forcibly bumped during the operative procedure, the accuracy of the system is lost. The long term benefits of Computer navigated TKA over Convention jig based TKA is yet to be known.

Keywords: Limb alignment, computer navigated total knee arthroplasty, osteoarthritis

1. Introduction

Total knee replacement is widely used to relieve pain and improve function in patients with degenerative joint disease. Although total knee replacement is generally successful, failures from component loosening, instability, dislocation, fracture, or infection occur in approximately 5% to 8% of cases. With growing numbers of total knee replacement being performed for various arthritis of knee, there has been a constant search for refined techniques in order to increase the longevity of the prosthesis insitu and better functional outcome as well as better patient satisfaction [1].

Computer assisted navigation in surgery uses the same principle of the global positioning satellite in aerospace navigation. Virtual points of the hip, knee and ankle centre are determined. Using this normal mechanical axis of lower limb is achieved. The success of total knee replacement depends on several factors, including patient selection, prosthesis design, soft tissue balancing, and alignment of the limb. Proper rotational and translational alignment of the prosthetic components and of the limb are important factors that influence the outcome of knee replacement [2].

Navigation of total knee arthroplasty is an exciting new development in the field of computer-assisted surgery. It allows the surgeon to obtain accurate mechanical alignment, to verify the alignment and adjust surgery accordingly while in the operating theatre. All navigation systems require tracking the body and instruments in space, kinematic and anatomic registering these objects to the computer and finally guiding the surgeon to perform the surgery on the virtual plan. Most systems also give information on kinematic and ligament balance and allow a printout of the information to be stored with the patient's record. Human error and the use of conventional jigs may be the reasons for the inaccuracy of conventional total knee arthroplasty [3].

Total knee arthroplasty is now being performed all over the world using manual and computer assisted techniques. Long term results following total knee arthroplasty depend on the alignment of the prosthetic components. Incorrect alignment induces eccentric loading and contributes to the loosening of prosthesis. Although mechanical alignment guides have been designed to improve alignment accuracy, there are several fundamental limitations of this technology that will inhibit additional improvements. navigation could achieve a greater degree of accuracy concerning the afore mentioned aspects The purpose of this study is to determine the outcome following computer assisted navigated total knee arthroplasty in terms of clinical, functional and radiological assessment [4].

Methodology

All cases of Total knee replacement done using computer. 65 patients with 72 knee were available for the follow-up with their previous records, annual x-rays and follow-up papers. Pre-operative deformities and its values were recorded for the study from the hospital case sheets and discharge summaries. There were 22 males and 43 females with ages ranging from 44 to 80 with an average age of 65.3 yrs at the time of surgery

Pre-Operative Planning

Clinical Assesment

Detailed history and proper clinical examination was carried out to find out the life style, predisposing factors, duration of illness, conservative treatment, previous surgical treatment if any, any focus of infection in the body, sensory and motor examination, vascularity of limb, ambulatory status of the patient, deformities of the knee, ROM, and status of the other joints.

Radiological Assessments

Standing AP View of the knee joint, knee in extension, centred over distal patella was taken in all cases

To look for position osteophytes.

To look for bony defects in tibia and femur and quality of bone.

To assess the collateral ligament laxity or subluxation of tibia if present.

To determine size of implants. Medio-lateral sizing of the femoral and tibial components.

Knee joint in Lateral Projection: Knee in 30degrees flexion centred over distal patella-to look osteophytes, anterior-posterior sizing of tibia and femoral components and anterior curvature of the femur.

Patella-Tangential X-Ray: Knee in 30degrees, caudocranial radiation, centred over distal patella are taken to look for patello femoral arthritis.

Anesthesia

Epidural anesthesia was used in all the patients with epidural catheter retained for 48hrs postop. Postop DVT prophylaxis was restarted after removal of epidural catheter and continued till discharge.

Surgical Technique

The basic surgical technique has been described by Krackow *et al.* 1990. It includes the midline skin incision, splitting interval of vastus medialis and rectus femoris gives a wide exposure of the knee and facilitates lateral dislocation of the patella. ACL and both menisci are removed and PCL retained. Using a drill and bicortical screw the distal femoral tracker is mounted and similarly the proximal tibia tracker is also attached, the aesculap columbus autopilot 3 workstation is placed at distance of 1.5 mtrs with no hindrance to the optical cameras, this is followed by the registration of anatomical landmarks, the hip center is determined by passively taking the hip through various range of motion, this is followed by the medial and lateral femoral epicondyles, the anterior cortex, the distal articular surface mapping. Simillary the landmarks on tibia is also registered the tibial plateau, the joint centre the medial and lateral malleolus and the and the middle of the ankle joint, this whole process of navigation registration took about 10 to 20 mins with average of 15 mins. This is followed by the usual stages of the TKA. Ligament balancing is performed prior to bone resection by release of the contracted soft tissues on the concave side of the any fixed angular deformity. In the knee with varus deformity, this release is performed distally by recession of the capsular flap consisting of the tibial insertion of the superficial collateral ligament, the deep collateral ligament and at times, the pes anserinus tendon. In the knee with valgus deformity the release is performed proximally, after exposing the peroneal nerve. The femoral attachment of the lateral collateral ligament, the popliteus tendon and the overlying iliotibial band are elevated.

It is possible to correct relatively minor flexion contractures by removal of bone, but when a contracture is severe it is advisabe to divide the posterior capsule transversely. The median or central part of the capsule is removed with the cruciate ligaments and the remainder is cut until the muscle fibres of the gastrocnemius are seen. The appropriate ligament and soft tissue releases are done before beginning the bone cuts.

The bone cuts are performed using the navigation as calculated by the computer from the previous registration data. The surgeon is guided by the computer at all stages of navigation. The valgus alignment, the posterior slope, the rotation, the joint line and axial alignment are all described by the orthopilot navigation workstation

The trials are used to determine the adequacy of soft tissue balancing in extension and flexion and data is recorded through the ROM in the computer determining the alignment. Finally the definitive components are fixed in place with bone cement. Patellar resurfacing was not done in our study instead patelloplasty was done. This was followed by closure in layers with a drain, compression dressing was applied before the deflation of the tourniquet.

The average blood loss during the surgery was recorded as 310 ml, which is in par with most studies.

Post-Operative Protocol

The knee is immobilized in Jones compression bandage and knee immobilizer. 2nd post-operative day dressing changed, drain tip sent for culture and smaller dressing is applied. Check x-rays are taken and static quadriceps exercise are started. 4th post-operative day passive knee flexion is begun with help of physiotherapist. 10th post-operative day alternate sutures are removed and 14th day full sutures are removed, discharged from the hospital to be reviewed after a month.

Antibiotics are administered IV for 3 days, later switched over to oral antibiotics for further 5 days more. DVT prophylaxis was given in the form of low molecular weight heparin for the first 30 days after removal of the epidural cannula. Compression stockings, passive and active lower limb exercise and deep breathing exercises were also started simultaneously.

Post-Operative Rehabilitation Protocol
All patients underwent the same post-operative rehabilitative protocol with active range of motion exercises and straight leg raising started on the 1st POD. Weight bearing with an assisting device and active, passive ROM exercises were started on the 3rd POD and were progressed as per patient's tolerance.

Method of Evaluation
A) Clinical assessment is done by noting and recording post-operative range of movements.
B) Radiological Indices: Mechanical Axis, coronal inclination of the femoral and tibial prostheses in standing AP and lateral radiographs taken at 6mnth after surgery.

Radiological assessment was done by measuring various component alignment angles using standard roentgenographic techniques after careful evaluation by the same doctor for all 65 patients and were read as Excellent (0°-3° deviation on mechanical axis; 0°-2° deviation on the other axes), good (4°-5° mechanical axis deviation; 3°-4° deviation for the other axes), and poor (>5° mechanical axis deviation; >4° deviation for the other axes). Results were defined according to recommendations from the literature.

a) Mechanical axis is the angle formed between the lines joinin the centre of femoral head to the centre of the femoral condyles to that join the centre of the tibial condyles to the centre of the ankle joint.
b) Sagittal plane alignment was measured on a lateral radiograph.
c) The sagittal tibial component angle is the posterior angle between the midline axis of the tibia and a line drawn across the tibial tray.
d) The sagittal femoral component angle is the angle between the ventral cortex axis of the femur and a line drawn perpendicular to the distal part of the femoral component.
e) The coronal plane alignment was measured on an AP radiograph. The coronal tibial component angle is the medial angle between the anatomic axis of the tibia and the horizontal axis of the tibial tray.

The coronal femoral component angle is the medial angle between the mechanical load axis of the femur and the horizontal axis of the two prosthetic condyles.
The measurement of the femoral and tibial component rotation was not part of this study as this this needed knee CT scan and hence excluded from our study.

Results

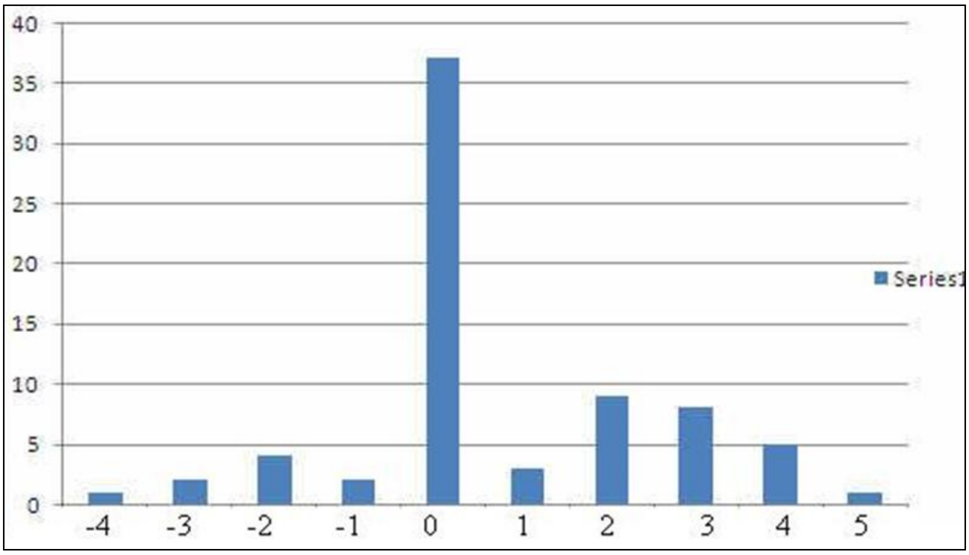

Fig 1: Mechanical axis

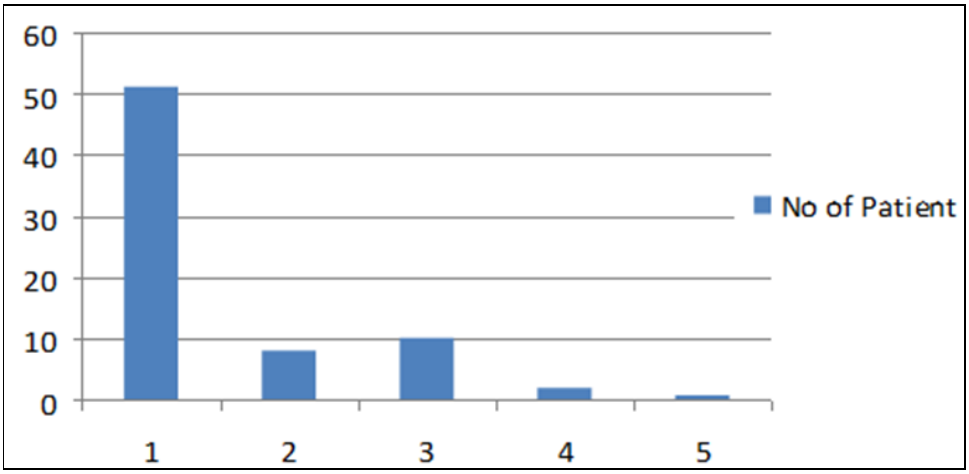

Fig 2: Sagittal femoral axis

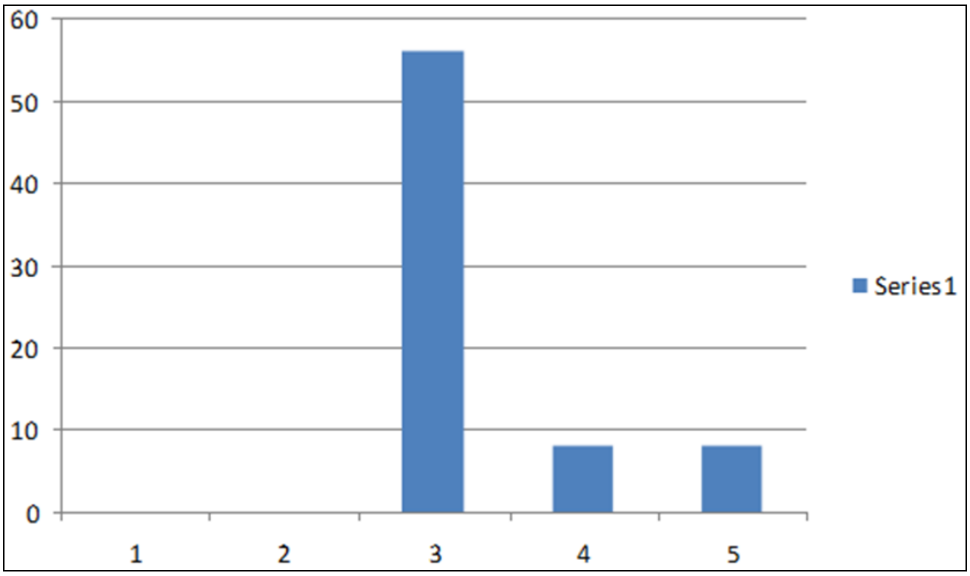

Fig 3: Sagittal tibial axis

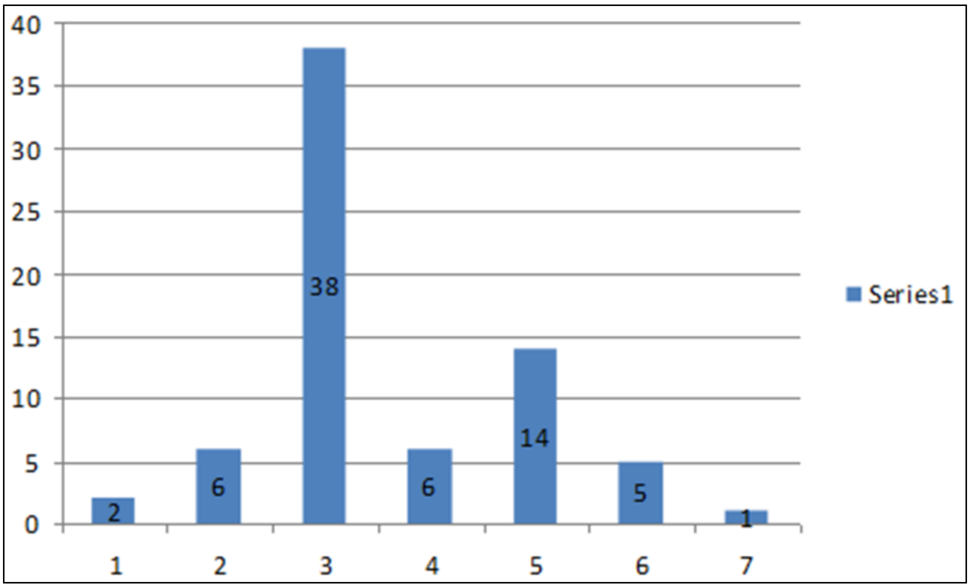

Fig 4: Coronal Femoral

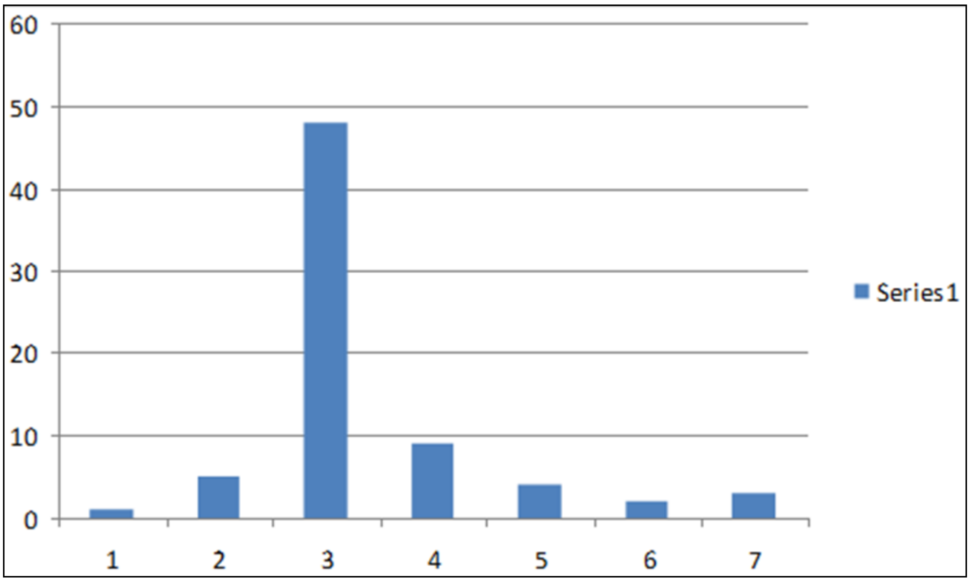

Fig 5: Coronal tibia

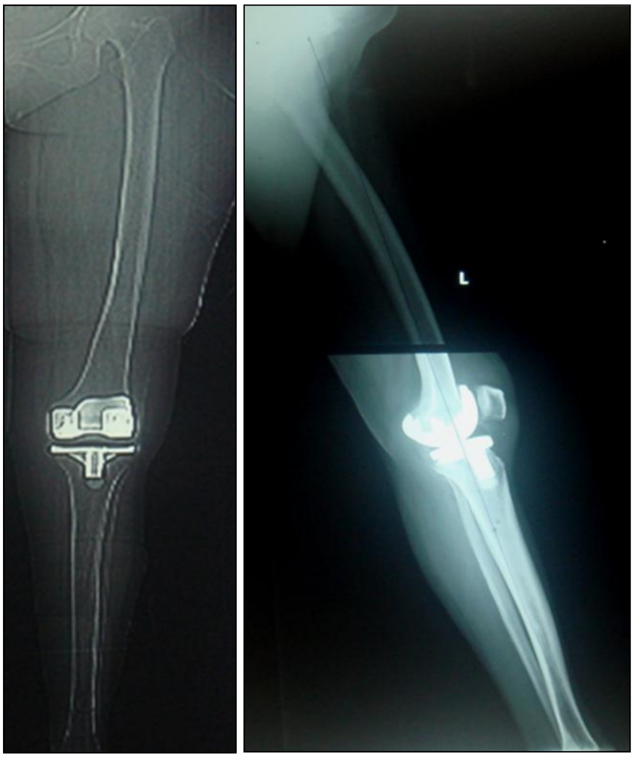

Fig 6: Post-operative X rays

We did the radiological assessment using the criteria described by Haaker, Stockheim *et al.* [23] (CORR Volume 433, April 2005, pp 152-159).

Excellent (0°-3° deviation on mechanical axis; 0°-2° deviation on the other axis), good (4°-5° mechanical axis deviation; 3°-4° deviation for the other axis), and poor (>5° mechanical axis deviation; > 4° deviation for the other axis).

For the 72 knees in our study the average mechanical axis angle was 1.25 degree varus. 1 knee (1.38) had-4 varus, 2 knee (2.77%) had -3 degrees varus, 4knees (5.55%) had-2 degrees varus, and 2 knee (2.77%) had-1 degrees varus. 9 knees (12.5%) had +2 degrees of valgus, 8(11.1) knee had +3 degrees valgus, 5knees (6.9%) had degrees +4 valgus and 1 knees (1.38%) had +5 degrees valgus. Overall the mechanical axis radiological score excellent in 65 knees (90.27%) and 7 knees (9.72%) had good radiological score.

On measuring the sagittal femoral component angle, of the 72 knees, 51 knees (70.83%) had the femoral component placed in 0 degrees of flexion, 8 knees (11.11%) in 1 degree of flexion, 10 (13.88%) knees had the femoral component placed in 2 degrees and 2 knee (2.77%) was in 3 degrees of flexion, 1 knee (1.38) had in 4 degrees. No femoral component in our study had been placed in extension. Overall 69 knees (95.83%) had excellent score and 3 knees (4.16%) had good radiological score for placement of the femoral component in the sagittal plane.

On measuring the sagittal tibial component angle (posterior slope of 3degrees is considered as 0) among the 33 knees, 56 knees (77.77%) had a slope 0 degrees (=3degrees), 8 knees (11.11%) had 1degrees (=4 degrees slope), 8 knees (11.11%) had 2 degree slope (=5degrees). No knee in our study had the tibial component placed in hyperextension in the sagittal plane.

On measuring the coronal femoral component, among the 72 knees 38 were placed in 0 degrees of valgus, 6 knees (8.33%) in 1 degree of valgus, 14 knees (19.44%) were in 2 degrees valgus, 5 knees (6.94%) were in 3 degrees of valgus, 1 knee (1.38%) had 4 degrees valgus, 6 knees (8.33%) had-1 degrees varus and 2 knees (2.77) had -2 degrees varus. Overall 66 knees (91.66%) had an excellent radiological score and 6 knees (8.33%) had good radiological score. 2 knees had the femoral component place in varus greater than -1 degrees in the coronal plane.

On measuring the coronal tibial component angle, of the 72 knees 48 knees(66.66%) were in 0 degrees of varus, 9 knees (12.5%) were in 1 degree of varus, 4 knee (5.55%) had 2 degrees of varus, 2 knees (2.77%) were in 3 degrees of varus and 3 knee(4.16) was in 4 degrees of varus and 5 knee(6.9) was in-1 degree valgus,1 knee(1.38)was in -2 degrees of valgus in our study. Overall 67 knees (93.02%) had an excellent radiological score and 5 knees (6.94%) had a good radiological score.

Discussion

The sagittal femoral component positioning was good or excellent in 100% of cases, which is in par with other studies. 51 knees (70.83%) of the 72 knees had femoral component positioned accurately in the sagittal plane which is comparable to other studies in literature.

The sagittal tibial component position was excellent or good in 100% of cases.56 knees (77.77%) of 72 knees had tibial component positioned accurately in sagittal plane which is comparable to other studies in literature.

The coronal femoral component positioning was good or excellent in 100% of cases, which is in par with other studies. The implant had been positioned accurately in 38 knees (52.77%) only in our study as compared to 66% knees in the study by sparmann *et al*. only 1 knee (3.03%) in our study had been positioned in 4 degrees valgus as against none by sparmann *et al.* [5].

The coronal tibial component positioning was good or excellent in 100% of cases which is in par with other studies. Only 48 knee (66.66%) in our study had been accurately positioned tibial component in the coronal plane as compared to 82% by sparmann *et al*. We have not analysed the rotation of the femoral and tibial components. It would only have been possible to determine the angles of rotation using CT analysis of the limb. However such analyses are done without definitive landmark, which limits the interpretation of the results. Rotation of the tibia and femur can only be defined by kinematic alignments (Sparmann *et al.*) [5]

However radiographic and navigation measurements of TKA limb alignment do not correlate as suggested by Mark A *et al.* [6]. They stated that intraoperative navigation produced consistent navigation alignment results that were within 1 degrees of desired alignment. They concluded in there study that the difference between preoperative radiographic and navigation measurements varied by as much as 12 degrees and difference between post-operative radiographic and navigation measurements varied as much as 8 degrees.

Alignment measurements using navigation are obtained on extremities that are non-weight bearing. Kendoff [7] et.al found the effect of weight bearing of one-half body weight will cause mechanical axis deviation of 0.4 degrees, Whereas Specogna *et al.* [8] notes an average axis deviation of 1.6 degrees in supine versus double limb standing radiographs.

Soft tissue conditions like flexion contractures and inconsistencies in patient positioning particularly in obese patients. Lonner *et al.* [9] have noted variation in radiographic alignment measurement by upto 4 degrees with varying combinations of knee flexion and internal or external rotation. Physiological rotation of the foot with respect to the tibia may also introduce error.

Human error during the process of alignment evaluation is a potential source of measurement variability. Prakash U *et al.* [10] noted that intra- and interobserver measurements of the mechanical axis on standard radiographs can vary by more than 1-3 degrees.

The average duration of navigation was 15 minutes, which improved over time during the period of study.

Although stress riser effect of the cortical drilling, increased length of the incision and early infection have all be noted by other authors. Another advantage using a navigation system is to avoid the instrumentation of the intramedullary canal. There is concern about fat embolisms with intramedullary techniques. The introduction of rods into the canal seemed to increase the intramedullary pressure and cause fat embolisms. This may result in respiratory symptoms, with changes observed on chest radiographs, neurologic symptoms, and even death.

The pre-operative range of movement was 0-110 degrees which improved to 0-140 degrees. The maximal ROM was recorded to be 140 degrees, with a minimum of 110 degrees of ROM in most cases. Maloney *et al.* 1990, in the meta analysis of different studies found that independent of the implant design, post-operative improvement in the ROM is least when the pre-operative ROM is greatest. Paradoxically those patients with better pre-operative ROM have a better final ROM. He also mentioned the more limited the pre-operative ROM, the greater the quadriceps stiffness is likely to be, which an important determinant of post-operative flexion is. He also stated that that the post-operative knee motion may depend on many factors, including the prosthetic design, diseases, pre-operative ROM, post-operative regimen, patients compliance and motivation and surgical skill.

No patient in our study with an average follow-up 1 yrs 3 months demonstrated radiological signs of early loosening or component migration. Shcnieder *et al.* 1982 [11] have demonstrated, that a stable radiolucent line about the tibial component less than 2 mm is of no clinical significance. Ecker *et al.* 1987 [12] have demonstrated that the thin radiolucent lines do not seem to predispose to poor results as do thick globally occurring lines.

The present cost of most of the computerized navigation systems may limit its access for smaller, low-volume institutions. Because of the cost, hospitals may benefit from sharing a navigation system across a variety of orthopaedic implications.

Conclusion

Alignment of the component has a bearing on the long time survival of the total knee prosthesis. Navigation improves the alignment of the replacement component better than the conventional intramedullary jigs. Navigation is relatively safe and without significant complications. The average increase in duration of operative time is negligible. Lower complication rate and no evidence of implant loosening in our medium term follow up is encouraging. With help of navigation TKA proper rotational and translation alignment of the prosthetic components is possible.

References

1. Arima J, Whiteside LA, Martin JW, Miura H, White SE, McCarthy DS. Effect of partial release of the posterior cruciate ligament in total knee arthroplasty. Clin Orthop. 1998; 353:194-20.
2. Bargren JH, Blaha JD, Freeman MAR. Alignment in total knee arthroplasty: correlated biomechanical and clinical investigations. Clin Orthop 1983;173:178-83
3. Chauhan SK, Scott RG, Breidahl W, Beaver RJ. Computer-assisted knee arthroplasty versus a conventional jig-based technique: A RANDOMISED, Prospective TRIAL, April, Clin orthop CV mosby. 1990; 198:227-210, 2004; 86-B(3):372-377.
4. Delp SL, Stulberg SD, Davies BL, Picard F, Leitner F. Computer assisted knee replacement. Clin Orthop. 1998; 354:49-56.
5. Sparmann M, Wolke B, Czupalla H, Banzer D, Zink A. JBJS. 2003; 85-B(6):830-835.
6. Mark A, Yaffe MD, Samuel S. Koo MD-Radiographic and navigation measurements of TKA.Clin Orthop Relat Res. 2008; 466(11):2736-2744.
7. Kendoff D, Board TN-Navigated lower limb axis measurements: influence of mechanical weight bearing simulation J Orthop Res. 2008:26:553-561.
8. Specogna AV, Dasilva JS-Reliability of lower limb frontal plane alignment measurements using plain radiographs and digitized images J Knee Surg. 2004:17:203-210.
9. Lonner JH. Laird MT-Effect of rotation and knee flexion on radiographic alignment in TKA. Clin Relat Res. 1996; 331:102-106.
10. Prakash U, Rowley DI-Computerised measurements of tibio-femoral alignment. JBJS. 2001; 83:819-824.
11. Schnieder R, Hood RW, Ranawat. Radiological evaluation of total knee arthroplasty. Orthop clin North Am. 1982; 13:225.
12. Ecker, Lotke, Winsor. Long term results of total condylar knee arthroplasty. Significance of radiolucent lines. Clin orthop. 1987; 216:152.