



Clinical outcome of Primary Total Knee Arthroplasty in Diabetes Mellitus

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Introduction

Approximately 450 million people worldwide have diabetes mellitus. Since 1980, the age-standardized global prevalence of diabetes mellitus among adults has almost doubled from 4.7% to 8.5%⁽¹⁾. India, with 69.2 million people living with T2DM, is the world's second-largest population living with diabetes mellitus following to China. It decreases the capability of the person to improve from disease and injury, and can also lead to obesity, as well as growing occurrence of osteoarthritis and the essential for joint replacement. Knee and hip arthroplasties are also increasingly common amongst diabetic population due to numerous reasons, and the percentage is as high as 52 %⁽⁴⁾.

The Diabetic population has poor body resistance, poor tissue healing capacity, and high incidence of perioperative complications; the occurrence of stroke, urinary tract infections, intestinal obstruction, bleeding, and death has risen by 3.42-, 1.97-, 2.47-, 1.99- and 3.23-times respectively. Diabetes mellitus increases the occurrence of deep venous thrombosis (DVT) and infections in total knee replacement (TKR) patients with diabetes⁽⁵⁾. This interpretation is not universally accepted, however, and some researchers believe that the occurrence of complications such as deep vein

thrombosis, deep infection, and revision surgery does not differ between well-controlled diabetic and non-diabetic patients.

Challenged with such a vast diabetic population, the possible risk of perioperative or likely postoperative adverse effects stresses more research, such as how to adjust and control blood glucose, control infections, improve perioperative care, improve perioperative management and efficacy of arthroplasties in diabetic group.

Objectives

Primary Objective: To assess the clinical outcome of total knee arthroplasty in patient with diabetes mellitus attending Orthopaedics department, Government Medical College, Thiruvananthapuram, at the end of nine months follow up by HSS scoring scale.

Secondary Objective: To estimate the proportion of diabetes mellitus related complications such as the proportion of patients developing deep infections, the proportion of patients having osteolysis or loosening of prosthesis, revision surgery rate, the proportion of patients developing deep vein thrombosis, among patients undergoing total knee arthroplasty in Orthopaedics department, Government medical college, Thiruvananthapuram.

Review of Literature

Anatomy of the Knee

The patellofemoral joint, the medial tibiofemoral joint and the lateral tibiofemoral joint combinedly forms the knee joint.; the two latter compartments contain the fibro cartilaginous menisci. The Knee joint is mainly formed by three bony structures, patella, the distal femoral condyles, and the proximal tibial plateaus. femoral condyles articulate with the flat surface of tibial condyle

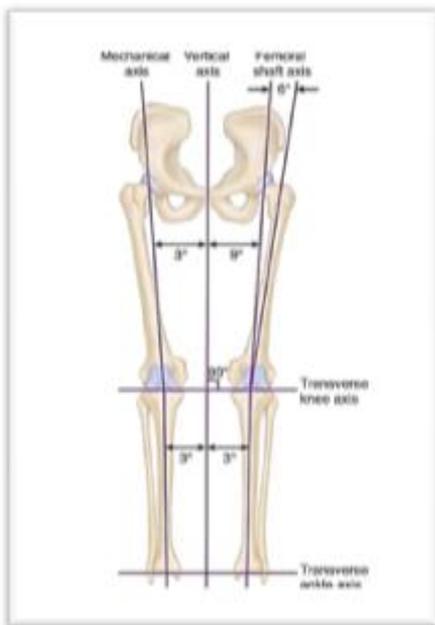


Figure 1: Anatomy of knee joint

The knee is stabilized by the succeeding structures: the articular capsule, the medial and lateral collateral ligaments, which provide medial and lateral stability to the knee joint, and the anterior and posterior cruciate ligaments, which provide anteroposterior support and rotatory stability, the musculotendinous units (the quadriceps mechanism, medial and lateral hamstring groups gastrocnemius, iliotibial band and popliteus). Both the medial and the lateral meniscus contribute to the stability of the knee joint. Knee motion is a mixture of flexion, extension and rotation. The tibia rotates internally on flexion of the knee and externally on the extension of the knee .the hamstring muscles contraction causes knee flexion and quadriceps femoris muscle contraction causes knee extension.

The usual range of movement of the knee joint is from slight hyperextension (~ 5 degrees) to 140 degrees of flexion. The joint permits rotation, which ranges from 5 to 25 degrees when the joint is flexed, whereas in extension no rotation is possible. External rotation of the tibia on the femur is executed by the biceps femoris, whereas the popliteus and semitendinosus muscles are involved in internal rotation of the knee joint

Clinical Examination of the Knee Joint

It is vital to clinically examine the patient as a whole considering all joints and the patient's general condition. It is important to get a complete description of the patient's symptoms. A full knee examination comprises an observation of the patient both standing and walking. valgus and Varus deviations of the knees are best noticed with the patient in standing. The patient should also be observed walking for the signs of gait abnormalities. Erythema, swelling and muscle atrophy are noted on inspection. In palpation, we check for swelling, warmth, crepitus tenderness and effusion of the knee joint. The Maximum range of knee flexion and extension is noted. Assess Patellar stability. Collateral ligamentous stability is tested by doing valgus and Varus stress test. The stability of cruciate ligaments is verified by anterior and posterior drawer tests, Lachman test and pivot shift test. Radiography is compulsory. Deformities, quality of bone, grade of erosions, position and shape of the patella can be accessed on the radiograph. The anatomical and mechanical axis are estimated.

Biomechanics of Knee

Biomechanics of the knee defines the function of the knee joint in terms of its mechanical components. This description becomes extremely important in trying to appreciate the behaviour of the knee when some intrinsic disorder exists in the joint. It is equally important to know the mechanical functioning of the knee when trying to rehabilitate patients with ailments of the knee after surgery or trauma. The knee consists of three

basics types of structures, ligaments are passive elastic structures and can be loaded in tension only, musculotendinous components are dynamic elastic structures and act only under tension, bone is nonelastic and aids to take the compressive loads in the joint.

Osteoarthritis of Knee Joint

Most common indication for total knee arthroplasty is osteoarthritis. Osteoarthritis (OA) is a common chronic condition leading to pain, fatigue, functional limitations, increased healthcare consumption and high economic costs to civilization. Repetitive mechanical loads and ageing is the reason for OA. The clinical indicators are joint pain, stiffness; decreased range of joint movement, muscle weakness of the quadriceps and alterations in proprioception⁽⁷⁾. During movements, crepitating can be heard because of the irregular joint surfaces⁽⁸⁾. Pathogenetically, knee OA is characterized by structural changes in and around the knee joint. The main structural changes are the loss of cartilage and the formation of osteophytes.

Pathophysiology

OA is viewed as a metabolically active, dynamic process, including both cartilage destruction and repair. Due to diminished repair abilities of chondrocytes, eventually, the concentration of proteoglycan decreases and collagen fibrillations declines. This course leads to splits in the cartilage extending down to the bone. The degenerated cartilage with the disrupted collagen network cannot regenerate, and this pushes the OA tissue to the point of no return.

Risk Factors

Knee osteoarthritis is a multi-factorial disease. The cause of osteoarthritis remains unknown, though there is clear evidence for major risk factors, such as age, joint trauma, obesity and heavy workload. The risk factors are divided into local biomechanical factors, such as joint injury and malalignment, overweight, and muscle

weakness and systemic factors (e.g. age, sex, genetics, and overweight). Abnormal mechanical loading in numerous sports activities or during heavy exertion may trigger the biochemical cascade that leads to joint degeneration and pain, but also even in normal mechanical loading if the cartilage is impaired. Joint injury upsurges the risk for knee osteoarthritis⁽¹⁰⁾. After the knee injury, women had a three-fold and men a five to six fold risk for developing osteoarthritis of the knee joint, compared to healthy panels.

Indications for total Knee Replacement

The primary indication for TKA is to relieve pain caused by severe arthritis (osteoarthritis, rheumatoid arthritis and post-traumatic arthritis, osteoarthritis being the most common). The pain should be significant and disabling. Night pain is most distressing. If dysfunction of the knee is producing a substantial reduction in the patient's quality of life, this should be taken into account. Correction of significant deformity is a vital indication but is infrequently used as the primary indication for surgical procedure.

Contraindications

Absolute contraindications for TKA are knee sepsis, remote source of ongoing infection, extensor mechanism dysfunction, severe vascular disease, recurvatum deformity secondary to muscular weakness and presence of a well-functioning knee arthrodesis. Relative contraindications for TKR are medical conditions that preclude safe anaesthesia and the demands of surgery and rehabilitation, skin diseases in the field of operation (e.g., psoriasis), history of osteomyelitis around the knee, neuropathic joint and obesity.

Diabetic Complications and Perioperative Management Considerations

Mortality rates in diabetic patients have been projected to be up to 5 times more than in nondiabetic patients, often connected to the end-organ damage caused by the disease. Chronic

complications resulting in microangiopathy (retinopathy, nephropathy, and neuropathy) and macroangiopathy (atherosclerosis) directly upsurge the need for surgical intervention and the incidence of surgical complications due to infections and vasculopathy⁽²⁵⁾. Infections account for 66per cent of postoperative complications and closely one-quarter of perioperative deaths in patients with diabetes mellitus. Data suggest impaired leukocyte function, including altered chemotaxis and phagocytic activity. The Strict control of serum glucose is vital to lessen infection. IN 2001 Van den Berghe and colleagues established a significant mortality benefit with using continuous insulin infusions to maintain glycaemic control at 80-110 mg/dl

In 1994, Serna F et al⁽²⁶⁾ conducted a study in Johns Hopkins University School of Medicine, Department of Orthopaedic Surgery, Good Samaritan Hospital, Baltimore, on “Total knee arthroplasty in diabetic patients Comparison to a matched control Group”. According to the study, in the diabetic group, there was an average clinical score of 85, with 43 knees rated excellent or good, ten knees were rated fair, poor or required revision (4 revisions). This was statistically different from the control group, which had an average clinical score of 92, with 51 knees rated excellent or good, 1 fair rating, and 1 revision

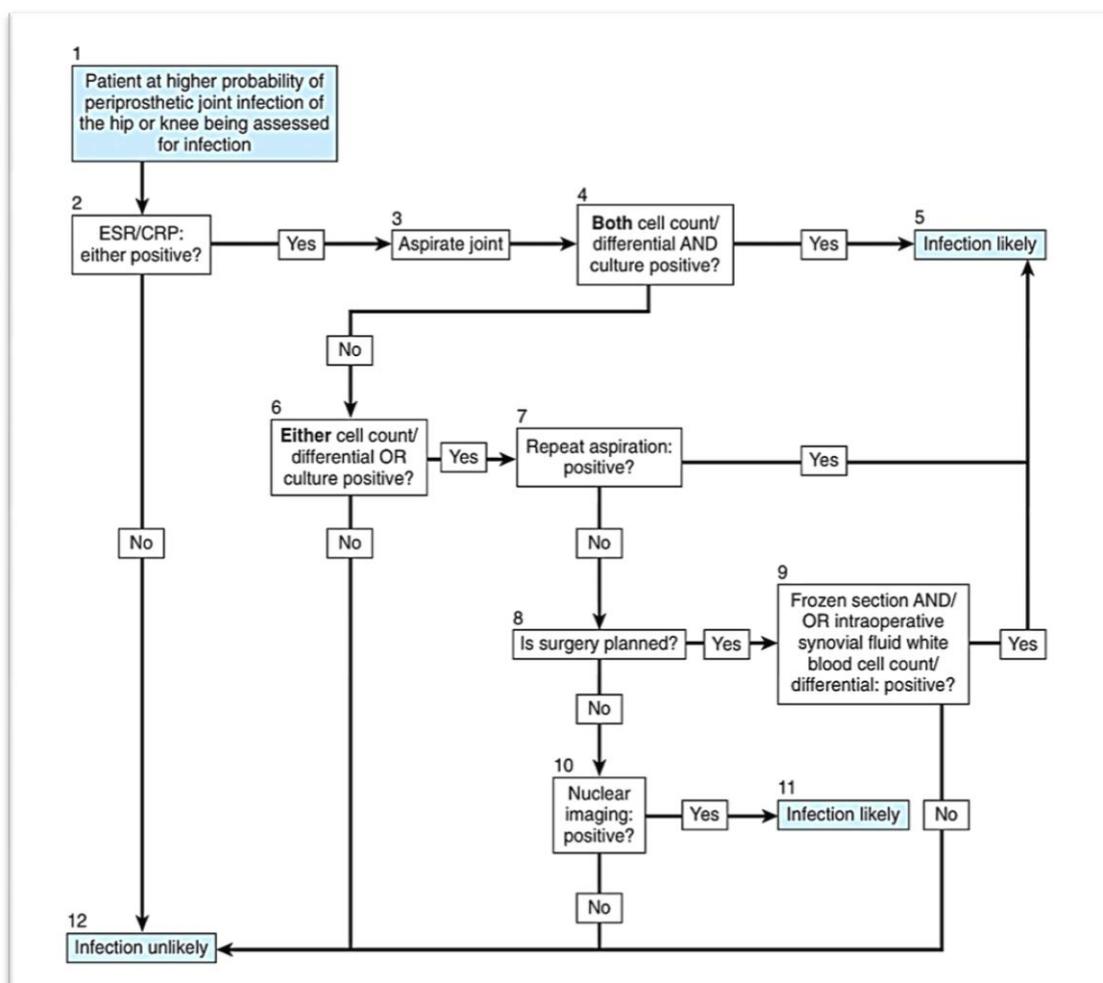


Figure 7: Algorithm for patients with higher probability (DM) of having periprosthetic joint infection.

In 2003, Meding JB et al⁽²⁷⁾ did a study on “Total knee replacement in patients with diabetes mellitus”, in Centre for Hip and Knee Surgery, St.

Francis Hospital-Mooresville”. The objective of the study was to evaluate the results of total knee arthroplasty (TKA) in patients with diabetes

mellitus and to exam the hypothesis that patients with diabetes attain lower results after TKA. In their study, Knee scores were higher in patients with diabetes preoperatively and postoperatively. Four deep infections (1.2%) occurred in patients with diabetes against 35 deep infections (0.7%) in patients who didn't have diabetes. The revision rate and incidence of infection was larger in diabetic patients (3.6% versus 0.4 %). Postoperative function scores, however, were inferior in patients with insulin-dependent diabetes. In the study group, all deep infections happened in patients with insulin-dependent diabetes.

In 2008, Hong Kyo Moon et al⁽²⁸⁾ conducted a study on "Factors Affecting Outcome after Total Knee Arthroplasty in Patients with Diabetes Mellitus" in Departments of Orthopaedic Surgery, Internal Medicine, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea. Their study concluded that both, diabetic patients and non-diabetic patients benefit equally well from TKA. However, diabetic patients were at an increased risk for overall postoperative complications and wound complications. Preoperative factors such as BMI and associated diseases may adversely affect the clinical outcome of TKA in diabetic patients. Therefore, it is necessary to balance the benefits of TKA against the risks and exercise extra caution in patient selection.

In 2009, Adams AL et al⁽²⁹⁾ conducted a study in the Department of Research and Evaluation, Kaiser Permanente Southern California, 100 South Los Robles Avenue, Pasadena, USA on "Surgical outcomes of total knee replacement according to diabetes status and glycaemic control", and stated that, there is no suggestively augmented risk of revision arthroplasty, deep venous thrombosis or deep infection was found in diabetic patients, compared with non-diabetic patients .in the study group of patients who undertook elective total knee replacement.

Methodology

This prospective observational study was carried out from July 2018 to October 2019, in patients with diabetes mellitus undergoing Total Knee Arthroplasty in the Department of Orthopaedics, Government Medical College Thiruvananthapuram, Kerala. The operated patients were followed up in the above hospital. A total of 33 patients were operated and followed up for minimum period of 9 months

Method

After obtaining institutional research committee and ethical committee clearance, study was started. Patients with known case of diabetes (on insulin or hypoglycaemic drugs) or newly detected diabetes mellitus according to the American Diabetes Association guidelines 2018 (if they had fasting blood glucose more than or equal to 126 mg/dl or postprandial 2-h blood glucose of more than or equal to 200mg/dl or HbA1C more than or equal to 6.5% or patients with classical symptoms of hyperglycaemia with random blood glucose value of more than or equal to 200 mg/dl) are included in the study. Patients not giving consent for the study or they had undergone previous surgeries on the same joint or they have any loco-regional tumour or metastasis, are excluded from the study.

Patients under study were admitted in the ward and strict glycaemic control was done with a strict diabetic diet and taking insulin before meals. The targets for blood glucose control, according to American Diabetic Association were fasting blood glucose 80-130mg/dl and 2-h postprandial blood glucose <180mg/dl. The following investigations were done routinely, they are- Hb%, total leukocyte count, differential count, blood grouping, fasting blood sugar, postprandial blood sugar, renal function test, liver function test, serum electrolytes, prothrombin time, viral markers, acute phase reactants like ESR , C-reactive protein, RA factor, urine sugar and acetone, chest x-ray, ECG. All the patients were evaluated for associated medical problems and

referred to respective departments. Anaesthesia fitness obtained. For preoperative planning weight-bearing, AP and lateral view x-rays are taken. Preoperative HSS score calculated. Preoperatively oral hypoglycaemic drugs were converted to insulin. Patient catheterised one day before surgery. The day before surgery the bedtime dose of insulin was reduced. On the day of surgery morning insulin dose was skipped and fasting blood sugar, urine acetone level tested.

Surgical Procedure

All the patients were preoperatively started with injection cefaperazone+salbactam 1.5 gm one day before the surgery. The patient under the effect of spinal or epidural anaesthesia was positioned on the operating table. A bump was placed in the foot end to support the hip and knee in about 90-degree flexion. The tourniquet was used in all patients.

Operative Technique

Incision and Exposure

The medial parapatellar approach issued

PCL Resection

Since our knee prosthesis is a posterior cruciate ligament substituting design, complete resection of the posterior cruciate ligament done and assessed for symmetry and balance of the flexion and extension gaps. Any differences in the gaps were addressed.

Varus Release

Soft tissue releases were made by progressive release of the tight medial structures until they reach the length of the lateral supporting structures.

Valgus Release

We move toward the valgus knee in a similar style to that described for the varusknee, the bone cuts are made before the ligament release, lateral osteophytes were excised.

The patella was inspected and osteophytes if existing were removed. The nerve innervations of the patella was ablated using diathermy. None of the patients in our study undertook patellar replacement procedure. Complete haemostasis is secured. The wound is closed in layers over a suction drain. The bulky dressing was done.

Postoperative

Postoperatively the knee was immobilized in an elastic crepe bandage and knee immobilizer. Postoperative check radiographs were taken. Patients were advised to continue static quadriceps exercises. On the second postoperative day, the wound was inspected and epidural catheter and drain were removed and knee flexion was started DVT prophylaxis was given in the form of enoxaparin sodium for five days starting after the removal of the epidural catheter. On the fifth postoperative day, intravenous antibiotics were changed to oral antibiotics and were given for another 5 more days. Patients with severe swelling of the affected limb and pain, and for whom there was a high degree of suspicion of DVT formation were immediately had a colour doppler ultrasound examination. Usually, Patients were discharged after the removal of staples. Patients were followed up regularly.

Results

This prospective observational study was carried out from July 2018 to October 2019, in patients with diabetes mellitus undergoing total knee arthroplasty in the department of orthopaedics, government medical college, Thiruvananthapuram, Kerala. Total of 33 patients were included in the study.

Age Incidence

In this study, the patients were in the age range of 48-71 years, the oldest patient was 71 years and the youngest patient was 48 years old. The mean age of patients in this study was 63.51 +/-5.84 years. The majority of the patients were in the age group of 61-70 years

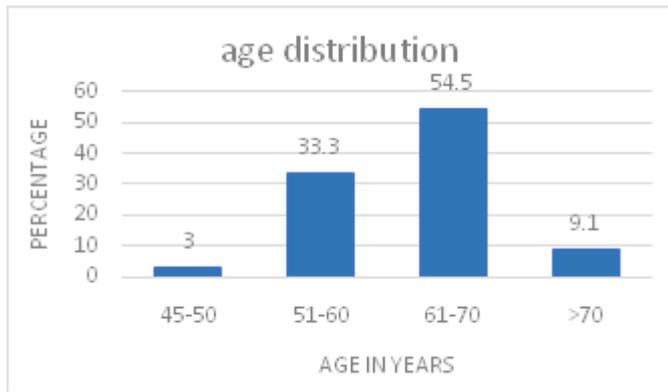


Figure 12: Percentage distribution of sample according to the age

Sex Incidence

10 patients in the present study were males and 23 were females. Male: female ratio was 1:2.3

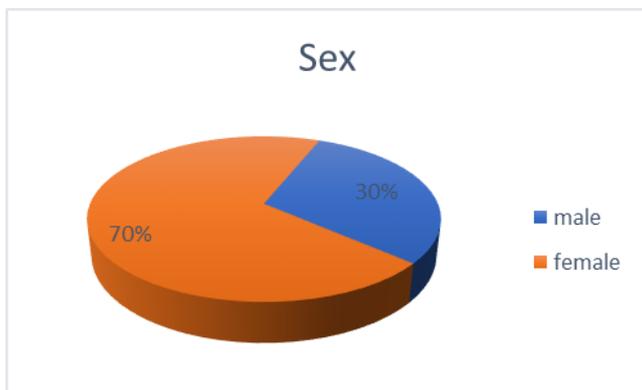


Figure 13: Percentage distribution of the sample according to the sex.

Socio-Economic Status

In the present study, 25 patients were below the poverty line, 8 were above the poverty line. APL: BPL ratio was 3.1:1.

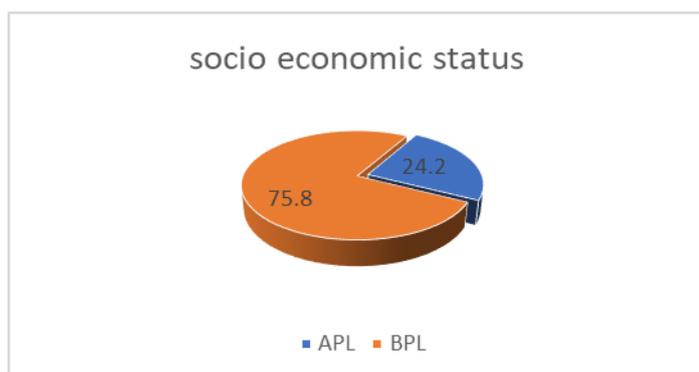


Figure 14: Percentage distribution of the patients according to the socio-economic status

Complaints

On analysing the presenting complaints of patients included in this study, 12 patients presented with only pain, 1 had an only deformity, 20 patients presented with both pain and deformity.

Table 5: Percentage distribution of the patients according to the presenting complaints

Complaints	Frequency	Percent
Pain only	12	36.4
Deformity only	1	3.0
Both pain and deformity	20	60.6

Blood Sugar

On analysing the preoperative blood sugars of 33 patients undergoing total knee replacement, it was seen that the majority of patients (78.78%) had good glycaemic control. Mean pre-operative fasting blood sugar was 116.27+/-16.76 mg/dl. Mean preoperative postprandial blood sugar was 172.54+/-31.74 mg/dl.

Table 8: Percentage distribution of the patients according to the fasting blood sugar

Preoperative fasting blood sugar in mg/dl	frequency	Percent
<80	1	3
80-130	26	78.78
>130	6	18.18

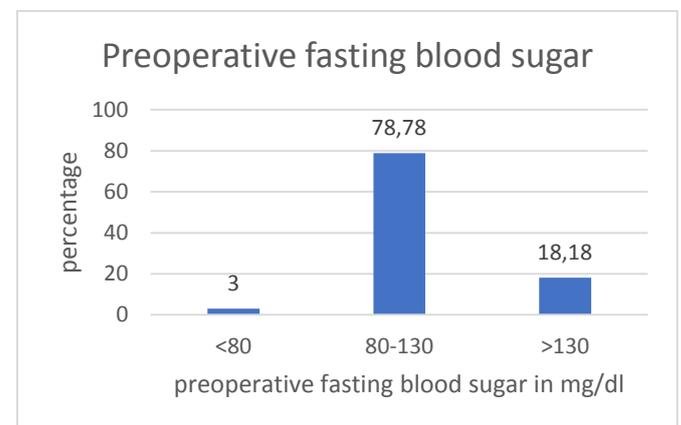


Figure 17: Percentage distribution of the patients according to the fasting blood sugar

Duration of Surgery

Duration of surgery for total knee replacement ranged from 96-134 minutes, mean duration being 113.42 +/-11.2 min.

Duration of Hospital Stay

In the present study duration of postoperative hospital stay ranged from 8-21 days. Mean duration of hospital stay was 14.3+/-3.15 days.

Analysis of Complications

On analysing the postoperative complications in the present study, it was seen that the majority of the patients did not show any complications. However, 2 patients had DVT.

Table 10: Percentage distribution of sample according to complications

Complications	Frequency	Percent
Intraoperative	0	0
DVT	2	6.1
Revision surgery	0	0
Implant loosening	0	0
Deep infection	0	0

Statistical Analysis of Clinical Outcome based on HSS Scoring System

In the present study, the preoperative HSS score was poor in all 33 patients, with an average score of 35.63+/-5.43. The clinical outcome of the surgery was calculated using HSS scoring system (at 9th month) and results were analysed. Among 33 patients, 19 had an excellent outcome (57.6%), 14 had a good outcome (42.2%). The mean HSS score was 85.51+/-4.91

Table 11: Distribution of HSS score

HSS score	Frequency	Percent
Poor	0	0
Fair	0	0
Good	14	42.4
Excellent	19	57.6
Total	33	100.0

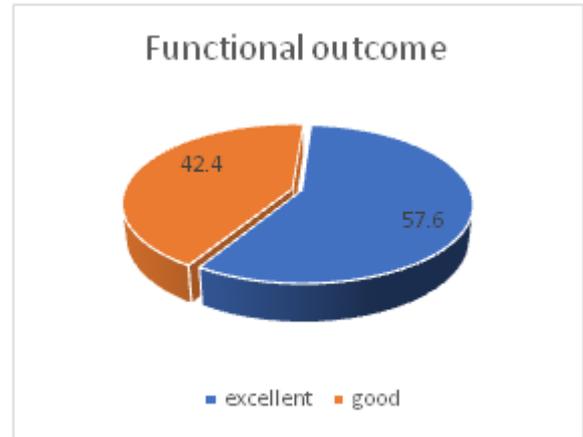


Figure 20: Percentage Distribution of HSS score

On analysing the clinical outcome of total knee replacement in diabetics based on HSS score, there was an overall improvement in the mean HSS score from 35.63 preoperatively to 85.51 postoperatively which was statistically significant (p < 0.00).

Table 12: Evaluation of HSS score

HSS score	Pre-OP	Post OP
N	33	33
Minimum	25	76
25% Percentile	32	81
Median	37	87
75% Percentile	40	90
Maximum	46	92
Mean	35.63	85.51
Std. Deviation	5.43	4.91

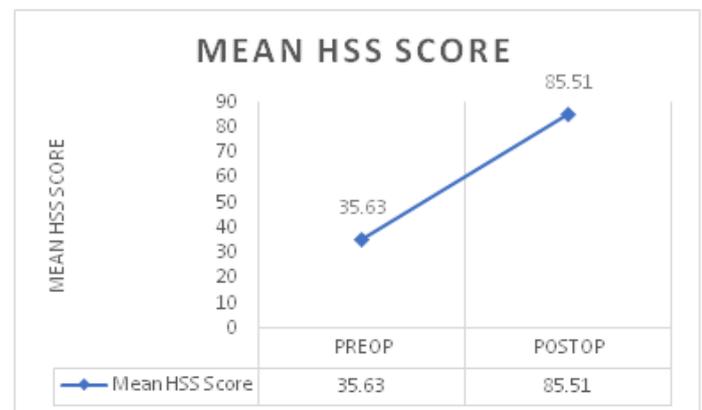


Figure 21: Comparison of preoperative and postoperative Mean HSS score

Age Dependant Functional Outcome

In 45-50, 51-60, 61-70 years age group the excellent outcome was more and accounted for

100%, 63.6%, and 55.6% respectively. In more than 70 years age group good outcome was more and accounted for 66.7%.

Table 13: Functional outcome in relation to age

Age in Years	HSS Score				Total
	Poor	Fair	Good	Excellent	
45-50	0	0	0(0%)	1(100%)	1
51-60	0	0	4(36.4%)	7(63.6%)	11
61-70	0	0	8(44.4%)	10(55.6%)	18
>70	0	0	2(66.7%)	1(33.3%)	3
Total	0	0	14(42.4%)	19(57.6%)	33

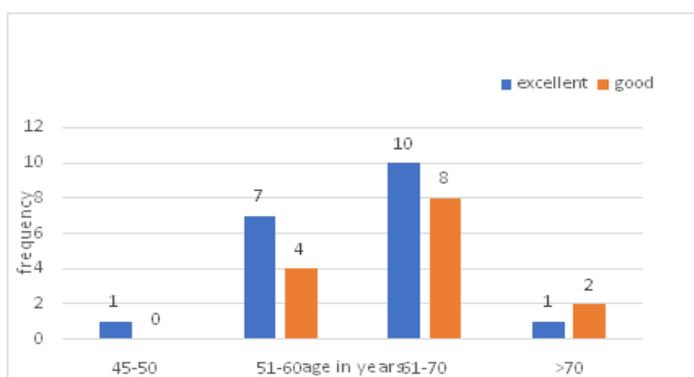


Figure 22: Functional outcome with relation to the age

Discussion

Total knee replacement is now a commonly done procedure to replace the weight-bearing surface of the knee joint to relieve pain and deformity. The outcome of total knee arthroplasty is affected by many factors, including diabetes mellitus. As the cases of diabetes mellitus are rising in India, diabetic osteoarthritis will reach its peak in the future, thus to elucidate the relationship of diabetes mellitus and osteoarthritis on total knee replacement is of special relevance.

In the present study the mean age of the patients was 63.51 years and patients were in the age range of 48-71 years. The findings of this study are in agreement with the study conducted by Pengcheng Liu et al⁽³³⁾ in 2016 on the “clinical outcome of primary total knee replacement in diabetes mellitus” wherein the age range of the patients was 47–83 years and the average age were 65.5 years. Similarly in another study conducted by Noumanmemon et al⁽³⁵⁾ in 2019 on

“Diabetes Mellitus is a Predictor for Poor Outcome After Total Knee Replacement, A Matched Cohort Study”, the mean age of the patients with diabetes mellitus was found to be 65 years.

Majority of the patients in the present study were females, females being 69.7% and males being 30.3%. Similar findings were obtained in the study done by Noumanmemon et al⁽³⁵⁾ in 2019, where the percentage of females among both diabetic and non-diabetic groups was 62%. Also, in the study conducted by Pengcheng Liu et al⁽³³⁾ in 2016 among 98, the majority were females (79 patients). This suggested that the incidence of osteoarthritis due to various causes were more in females than in males. Hormonal differences would have contributed to the increased development of osteoarthritis in women particularly postmenopausal females due to the decreased estrogen during that time⁽³⁷⁾. In a clinically related study, Zhang et al. established that postmenopausal women who take oestrogen replacement therapy have a reduced chance of developing radiographic evidence of knee arthritis. In the study, 12(36.4%) patients presented with only pain, 1(3.0%) has an only deformity, 20patients (60.6%) with both pain and deformity. Overall pain was the major complaint accounting for 97%. Being pain the most common complaints in chronic arthritis of the knee and the predominant psychological limiting factor for activities of daily living. The patients with pain opted for TKR.

Among 33 patients 2 patients (6.1%) were smokers and 5 patients (15.2%) were alcoholic. As females were the major chunk of the study and Indian females being less addicted to alcohol and smoking, the percentage of smokers and alcoholics were less.

In the study most of the diabetic patients (78.78%) had good glycaemic control (fasting blood sugar between 80-130mg/dl). Mean pre-operative fasting blood sugar was 116.27±16.76 mg/dl; mean preoperative post-prandial blood sugar was 172.54±31.74 mg/dl. Similarly, pengchengliu et al⁽³³⁾ in the study conducted in 2016, they attributed the excellent clinical outcome post total knee arthroplasty to good glycaemic control in diabetic patients.

In the present study, the majority of the patients did not show any complications only two patients had DVT. There was no incidence of prosthesis loosening, revision surgery and deep infections.

In this present study, preoperative HSS score was poor in all 33 patients, with an average score of 35.63±5.43. Clinical outcome of the surgery calculated at 9th month using HSS scoring system showed that among 33 patients, 19 had an excellent outcome (57.6%), 14 had a good outcome (42.2%). The mean HSS score was 85.51±4.91. There was an overall improvement in the HSS score from 35.63 preoperatively to 85.51 postoperatively which was statistically significant ($p < 0.00$). Similar conclusions were drawn from previous studies.

Conclusion

Patients with diabetes mellitus had positive clinical and functional outcomes from perioperative thorough assessment, prevention of infection, and DVT development, demonstrating the clinical efficacy of TKA. Diabetic patients did not tend to have a significantly higher risk of complications after total knee arthroplasty provided good glycaemic control was achieved preoperatively. A wider sample of clinical research is required to determine if diabetes increases the incidence of deep venous

thromboembolism and deep infection in patients following TKA.

Limitations of the study were a small sample size and no control group for comparison.

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