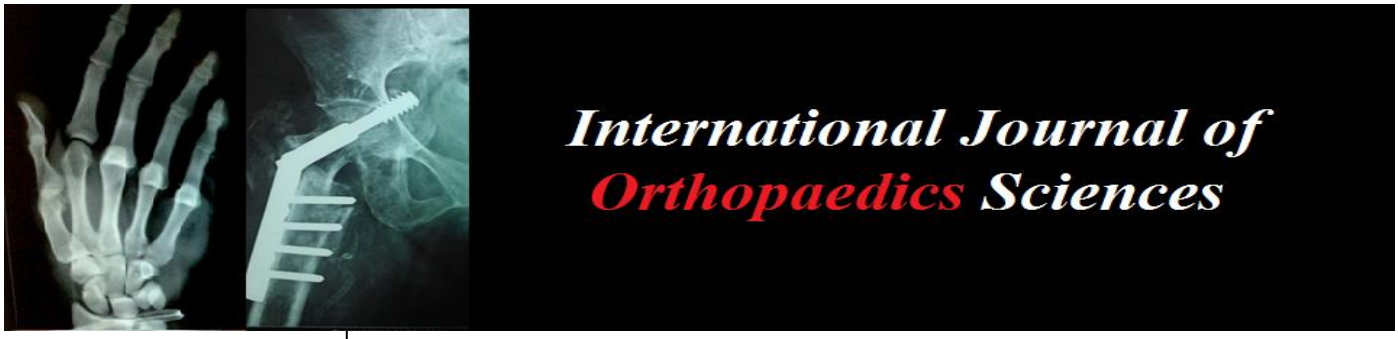

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Factors determining the burden for patients of south Indian population following total knee replacement in terms of hospital stay: A retrospective single center study

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Abstract
Background: Total knee arthroplasty being the definite procedure in degenerative arthritis of the knee is associated with a high cost that includes the cost of implants & in-hospital length of stay (LOS). Incurring such high costs will put a burden on the patients economically, so the goal being the reduction of LOS yet improving the functional outcome with better patient satisfaction. The purpose of this study is to identify the perioperative risk factors increasing the LOS of patients, by quantifying them, efforts can be done to manage those risks providing better satisfaction to patients.
Materials and Methods: The study design is a retrospective analysis of 1022 patients of primary elective total knee arthroplasty, performed in our institution. The potential factors recorded were: age, sex, hemoglobin levels, albumin levels, BMI calculated with patients height and weight, ASA grading, smoking alcohol status, diagnosis for which TKA was done and comorbids were analysed
Results: We looked at 1022 patients and found the average length of stay is 6 days, with age, comorbids, BMI, ASA, Diagnosis, blood transfusion, hemoglobin and albumin all played a role to influence Length of stay
Conclusion: Our study showed that LOS after TKA is multifactorial. Various risk factors are present at the time of presentation, some of which are modifiable and some non-modifiable. It is important to acknowledge all the factors that increase the in-hospital LOS & to do one's uttermost use of medical resources.

Keywords: Length of stay, total knee arthroplasty, south India

1. Introduction
The burden of osteoarthritis has continued to expand in the society and health care system, due to the increased life expectancy of the population and increasing prevalence of degenerative diseases [1, 2] particularly in nations like India, where patients present late with deformity. Total knee arthroplasty being the definite procedure in such cases are associated with a high cost that includes the cost of implants & in-hospital length of stay [1]. Incurring such high costs will put a burden on the patients economically and mentally, so the goal being the reduction of LOS yet improving the functional outcome with better patient satisfaction. Overzealous reduction of LOS is to be promptly avoided, as it might pose a risk of hospital readmission rates with improper functional outcomes. There is also an increased demand on hospital resources to provide adequate care to all patients in terms of beds, rehabilitation units and healthcare professionals that puts a burden on the hospital. Sometimes the patients have to wait for a few months without getting operated on due to limited resources [4]. The cost of technology and labor in this decade threatens to offset the control of hospital expenses. To balance the cost to benefit ratio, hospitals are anxious to cut short the LOS in a dedicated way [2, 3, 6].
The game plan to shrink the LOS can include daily goal setting, rapid rehabilitation and proper pain management and pre-operative screening of potential risk factors [2, 3]. We feel the latter being paramount of success to diminish LOS more healthily. Potential risk factors include age, sex, comorbids, hemoglobin & albumin levels, smoking & alcohol, BMI, American Society of Anesthesiologists (ASA) grading and few others.

Malnutrition has also emerged as one such preoperative risk to increase morbidity following TKA. The purpose of this study is to identify the pre-operative risk factors increasing the LOS of patients, by quantifying them, efforts can be done to manage those risks providing better satisfaction to patients, yet lower hospital stays among patients undergoing TKA in a single tertiary care center in South India. We hypothesize that several variables will be related to an increase in hospital stay after TKA.

2. Materials and Methods

The study design is a retrospective analysis of an observational cohort of all patients who underwent unilateral TKA in our institution from 2012 to 2019 who were registered in this study. Patients were included if they were above 18years of age and consented to primary TKA in our hospital. The exclusion criteria for this study included patients undergoing revision or multi-staged TKA and those with data being unavailable in the institutional electronic database. The potential factors recorded were: age, sex, hemoglobin levels, albumin levels, BMI calculated with patients height and weight, ASA grading, smoking alcohol status, diagnosis for which TKA was done, comorbids calculated with Charles comorbid index and all these variables were equated to their Length of hospital stay.

All TKA's were performed by senior-most arthroplasty surgeons of our institution. General or spinal anesthesia was used as per the compliance of the patient and anesthetists choice and a tourniquet was used for almost all patients. As a routine practice cephalosporin coverage was administered to all patients prophylactically 30mins to 1hr before surgery. All TKA's were performed by median parapatellar approach. The use of the implant and drain was by the choice of the surgeon. Postoperatively multimodal pain management in the form of 50mg tramadol or 75mg diclofenac (if not contraindicated) and antibiotics was administered twice daily. Routine administration of Chemical prophylaxis (Enoxaparin or LMWH) & mechanical prophylaxis (pneumatic compression) is given to all patients for 2 days to prevent any deep vein thrombosis. Mobilisation with full weight-bearing as tolerated was started from postoperative day 1 along with quadriceps & hamstring strengthening exercises by physiotherapy and rehabilitation team for at least one hour a day. Wound inspection and the dressing was done under sterile conditions. The plan for discharge was made if patients have the following criteria including the absence of any wound-related or systemic complications, good knee flexion with an angle equivalent to at least preoperative status or more, VAS score less than 3, liberated walking without support and it includes training them to manage bed to chair transfer, stair climbing and personal care. The operating team then decides the discharge day if the above conditions are met. The primary outcome of this study was Length of stay (LOS) which is defined as the number of days in the hospital from the day of admission to the day of discharge inclusive.

All the details were collected from the institutional Medical records department after eliminating the personal details, and the series of factors compassing age, sex, hemoglobin levels, albumin levels, BMI calculated with patients height and weight, ASA grading, smoking alcohol status, diagnosis for which TKA was done, comorbids calculated with Charles comorbid index were taken.

3. Result

3.1 The total number of patients included in the study were 1022 out of which 706 were female and 316 were male. Indications for TKA in patients were noted, 917 patients underwent TKA for primary osteoarthritis knee joint, 96 for arthritis of knee joint secondary to rheumatoid arthritis and 9 patients underwent TKA for fracture of the proximal tibia and stress fractures. Various parameters were taken into consideration at the time of admissions such as age, sex, hemoglobin, albumin, BMI, substance abuse (Smoking), comorbids including neurological disorder and ASA grade to evaluate for risk factors and their effect on patients in terms of length of hospital stay, depicted in Tab 1.

Patients were categorised according to age with age < 50 years, 51 - 60 years, 61 - 70 years and >71 years. As the age increases the length of hospital stay increases. Patients with age < 50 years have a mean duration of hospital stay of 5.9 days and age > 71 days has a mean duration of stay of 7.84 days with a significant p-value of 0.001 (Fig.1).

The mean duration of hospital stay in male patients was 6.48 days and 6.71 days in females which was found to be insignificant with the p-value of 0.32 (Fig.2).

For patients who underwent TKA for proximal tibia fracture, the duration of stay and cost of rehabilitation was much more when compared with patients who underwent for OA or arthritis of knee secondary to RA. The mean duration of stay in case of fracture was 13 days as compared to OA and RA with a mean duration of stay of 6.5 days and 6.55 days with a significant p-value of 0.001 (Fig.3).

Patients with low hemoglobin and albumin need a frequent intraoperative and postoperative blood transfusions. 128 patients with < 10 mg/dl Hb for which perioperative blood transfusion were done to optimize Hb more than 10gm/dl. Even after optimizing Hb, 18 out of 128 patients needed an intraoperative or postoperative blood transfusion due to blood loss during surgery. Patients with hemoglobin less than <10mg/dl, mean length of stay was 8 days, as compared to patients with >10mg/dl with a mean duration of stay of 6 days with a significant p-value of 0.001(Fig.10)(Fig 5.).

Patients with a history of substance abuse (Smoking) more frequently need preoperative optimization of lung condition in the form of bronchodilator and delay in surgery in case of wheeze which was present even after bronchodilator. Delay in surgery ranges from 2 days to 4 days till the lung condition was optimised. The mean duration of hospital stay was 8 days in smokers as compared to a non-smoker with a mean duration stay of 6 days with a significant p-value of 0.001(Fig.7). Postoperative DVT prophylaxis in the form of both mechanical and chemical prophylaxis was more commonly used in smokers and further increased the cost of stay.

BMI was also calculated for the patient out of 1022 patients only 281 patients have normal BMI. High BMI leads to difficult rehabilitation and increased risk of DVT with a need for DVT prophylaxis both with mechanical and chemical prophylaxis and increased stay in hospital with a mean hospital stay of 7 days (p-value 0.001) (Fig.6).

Charles Comorbidity Index also plays an important role in the case of length of stay. Patients with more comorbids tend to stay longer in hospitals with more need for ICU care as compared to patients with fewer comorbids. Patients with Charles Comorbidity Index of 0 stays in hospital for a mean duration of 3.4 days and people with Charles Comorbidity Index of 6 stays for a mean duration of 9.3 days with a significant p-value of 0.001(Fig. 11).

Patients with ASA III & IV and neurological disorders more frequently require ICU postoperatively as compared to

patients with ASA I & II and without any neurological disorder, increasing the hospital stay as well as an economic burden. Mean duration of stay in ASA grade I & II was 6 days and 8 days in the case of ASA grade III & IV with a significant p-value of 0.001 (Fig.9) and in case of neurological disorder mean duration of stay in patients without any neurological disorder was 6.4 days as compared to with neurological disorder with a mean hospital stay of 8.9 days (p-value 0.001)

Table 1

Variable	Sample, N (%)	Mean +/- SD	Mean LOS	p - value
Age				
< 50 years	111	5.95+/-3.201	5.95	0.001
51-60 years	334	6.03+/-2.407	6.03	
61-70 years	356	6.68+/-3.818	6.68	
> 71 years	221	7.84+/-3.855	7.84	
Sex				
Male	316 (30.9%)	6.48+/-3.376	6.48	0.32
Female	706 (69.1%)	6.71+/-3.451	6.71	
Diagnosis				0.001
OA	917 (89.7%)	6.55+/-3.395	6.55	
RA	96 (9.4%)	6.90+/-2.278	6.9	
Fracture	9 (0.9%)	13.33+/-8.139	13.33	
Hemoglobin				
< 10 mg/dl	128 (12.5%)	8.03+/-4.456	8.03	0.001
10.1 - 12.5 mg/dl	684 (66.9%)	6.56+/-3.149	6.56	
> 12 mg/dl	210 (20.5%)	6.06+/-3.371	6.06	
Albumin				
< 3	39 (3.8%)	7.69+/-4.420	7.69	0.001
3.1 - 4	548 (53.6%)	7.02+/-3.549	7.02	
>4	435 (42.6%)	6.06+/-3.074	6.06	
BMI				
<18.5	17 (1.7%)	3.71+/-1.572	3.71	0.001
18.5 - 24.9	281 (27.5%)	6.04+/-3.605	6.04	
25 - 29	389 (38.1%)	6.65+/-3.218	6.65	
> 30	335 (32.8%)	7.28+/-3.424	7.28	
Smoking / Alcohol				
Yes	143 (14.0%)	8.54+/-3.455	8.54	0.001
No	879 (86%)	6.33+/-3.324	6.33	
Neurological Disorder				
Present	70 (6.8%)	8.94+/-3.004	8.94	0.01
Absent	952 (93.1%)	6.47+/-3.399	6.47	
Charles Comorbidity Index				
0	298 (29.2%)	3.41+/-1.572	3.41	0.001
1	378 (37.0%)	6.12+/-3.605	6.12	
2	263 (25.7%)	6.43+/-3.208	6.43	
3	79 (7.7%)	7.23+/-3.104	7.23	
6	4 (0.4%)	9.32+/-3.623	9.32	
ASA				
I and II	791 (77.4%)	6.25+/-3.194	6.25	0.001
III and IV	231 (22.6%)	7.96+/-3.852	7.96	
Perioperative Transfusion				
No	891 (87.2%)	6.33+/-3.157	6.33	0.001
1 Unit	113 (11.1%)	8.36+/-3.691	8.36	
2 Unit	18 (1.8%)	11.06+/-3.428	11.06	

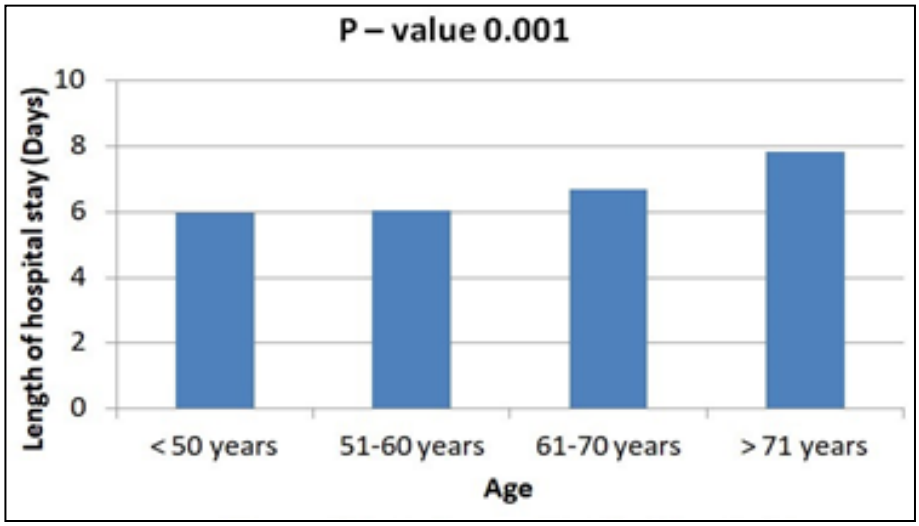

Fig 1: Effect of age on length of hospital stay.

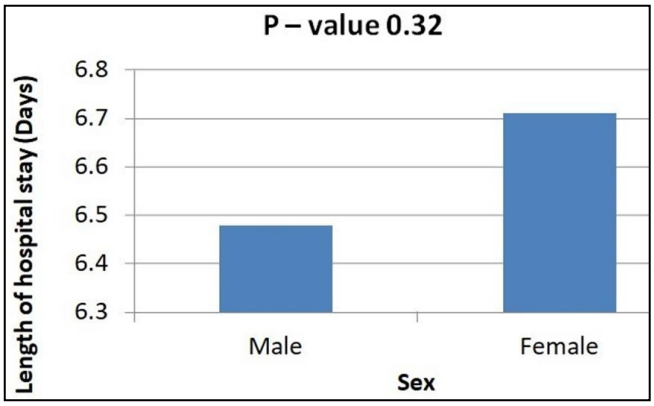

Fig 2: Effect of sex on length of hospital stay.

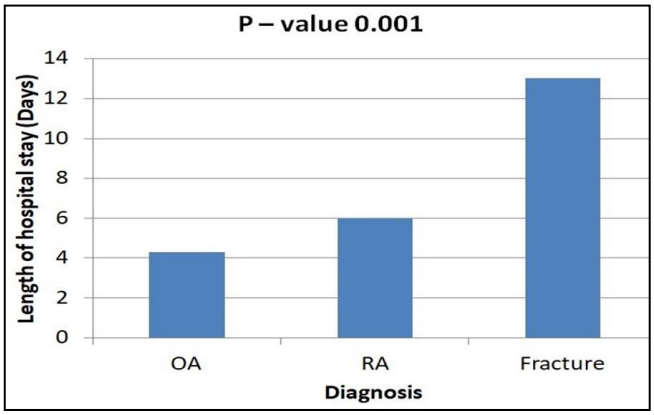

Fig 3: Effect of diagnosis on length of hospital stay.

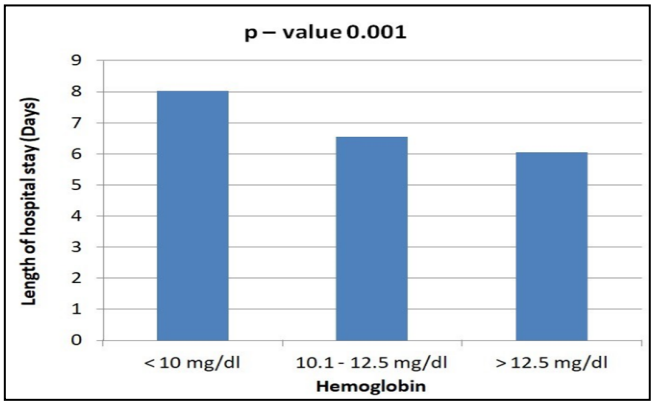

Fig 4: Effect of hemoglobin on length of hospital stay.

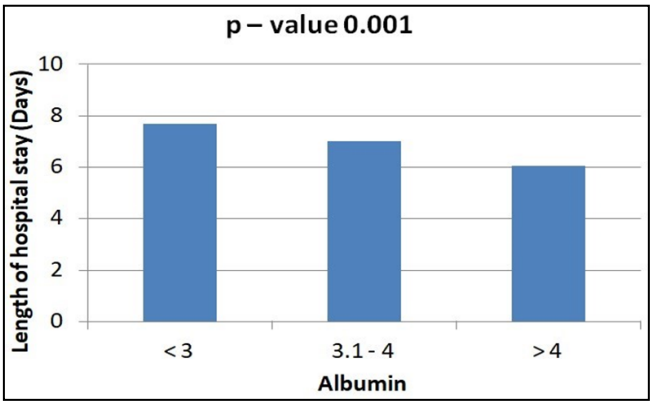

Fig 5: Effect of albumin on length of hospital stay.

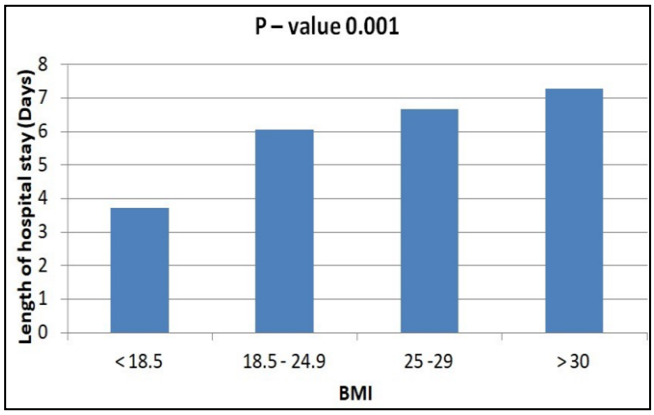

Fig 6: Effect of BMI on length of hospital stay.

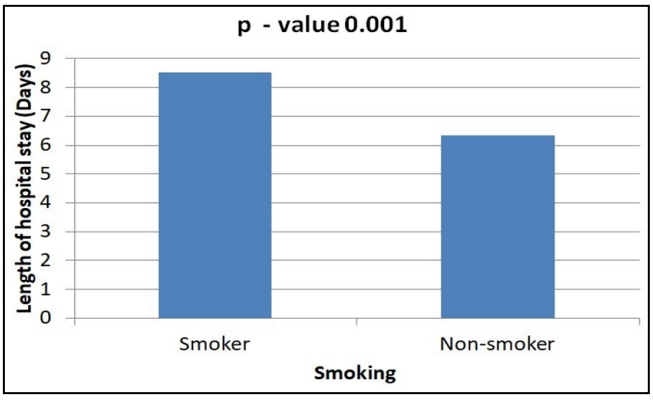

Fig 7: Effect of smoking on length of hospital stay.

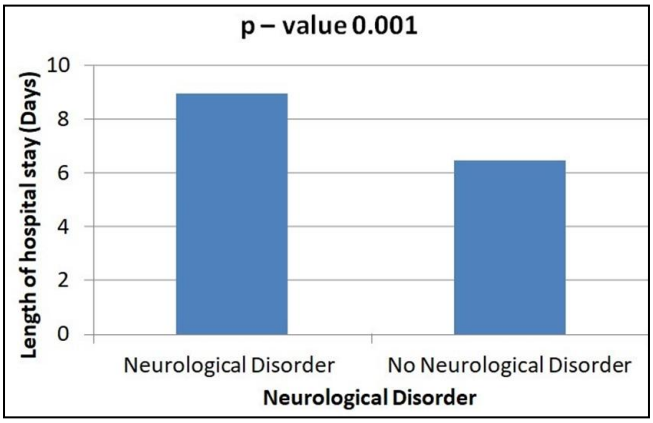

Fig 8: Effect of neurological disorder on length of hospital stay.

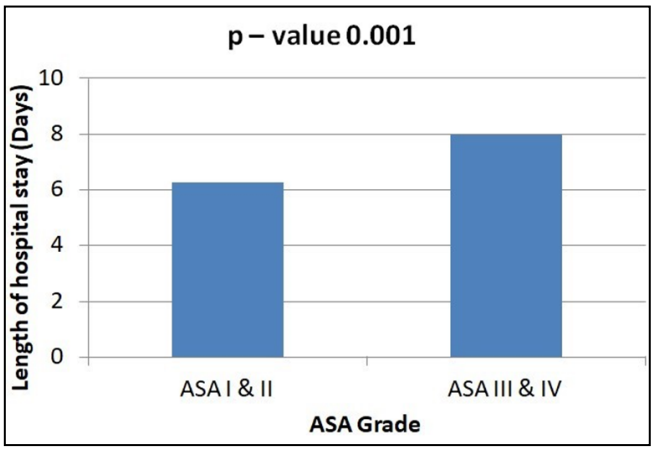

Fig 9: Effect of ASA grade on length of hospital stay.

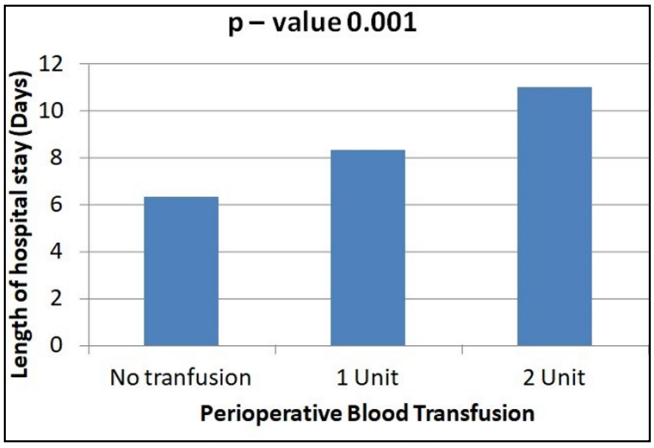

Fig 10: Effect of perioperative blood transfusion on length of hospital stay.

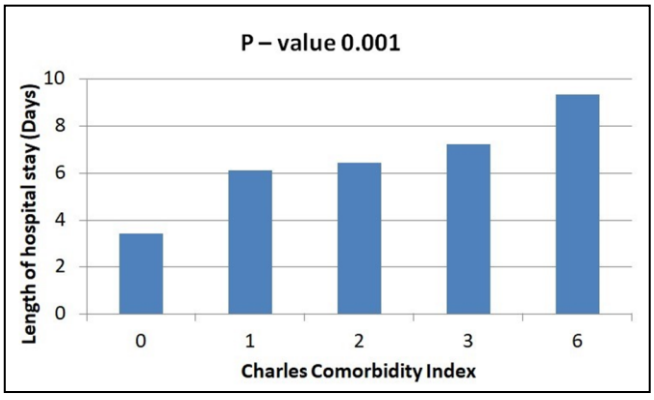

Fig 11: Effect of Charles Comorbidity Index on length of hospital stay

4. Discussion

The most important maneuver to reduce the LOS following primary TKA is proper preoperative planning of the patient's health status. This will improve the inflow of patients to facilitate better treatment, less waiting and proper use of hospital resources. One important result from our study shows a shorter stay was not significantly associated with increased complications, proved also in a study by Scholes *et al.* [1]. The former sentence is contrasted by Galbraith *et al.* [7], in his study stated that shorter hospital stays may reduce the quality of care and poorer outcomes if patients are discharged even before they are ready for it. Notably increasing age, female sex, presence of comorbids, presence of a complication, Low preoperative hemoglobulin and albumin, postoperative blood transfusion was associated with increased LOS and proved costly a treatment, burdening the patient. The patients' age at surgery and presence of comorbids has been extensively reported to increase LOS [1, 2, 4, 5, 7, 8] younger age with decreased LOS are explained in literature [7]. Older patients are liable to be physically weak, furthermore, they need caregiver support than the younger age group which can increase LOS. The presence of complications invariably extends the LOS as patients cannot be discharged without getting the same corrected. Overall our study & most of the literature concludes that patients age and basal health status should be cardinal in the consideration of the patient's LOS [1, 2]. Recent advances in medical management and a better rehabilitation teaching process have allowed surgeons to offer TKA's to more older and complex patients [2]. Despite this betterment, certain older comorbid patients will require extended LOS for better medical optimization before surgery and discharge, to make them so ambulant and self-trained before being safely discharged. A delay in diagnosis or patients who seek medical attention quite late has large deformities making the result of the surgery quite complicated. In a study Losina *et al.* [8], described that patients undergoing TKA from vulnerable populations are associated with increased perioperative complications contributing to increased LOS, thereby educating the rural population which should vary from population to population undergoing joint replacement [3, 8]. Another study by Cram *et al.* [15], reported that speciality hospitals have more volume of TKA operated cases than general hospitals and so better patient outcomes and fewer complications compared to general hospitals thereby having a reduced LOS. One cause to argue is that specialty hospitals are mostly non-academic & urban with high volume load, so they reduce the LOS to maintain more annual volume. Women stayed longer than men which were consistent in many studies, though there is no clear cut explanation and not statistically significant like our study [2, 9], and some studies found no consensus between sex in increased LOS [4, 11]. One possibility could be the muscle strength of males thereby speeding up their rehabilitation and discharge rates, whereas females have high rates of obesity, postoperative blood transfusion and postoperative complications, unfortunately, the satisfaction rate of a female is also relatively low, making their satisfaction relatively high [17]. Patients who sustained inpatient complications were more likely to have increased LOS, most significant being cardiovascular, pulmonary and infections that is also consistent with many other studies [2, 4, 9]. Efforts if made to optimize the comorbids before TKA have better outcomes following procedures which will potentially reduce the overall cost and burden on the patient and the health care system. The American Society of

Anesthesiologists (ASA) classification is routinely used by the Anesthetists to grade each patient can actually define the general physical health condition of the patient [4, 10] and the risk of operation. Keeping it simple, ASA III/IV often stay longer than the ASA I/II, as the former require extra time to meet the desired rehabilitation results and get physically trained for mobilization. Among the complications, we wonder that neurological comorbids influence an increased LOS as it makes the patient's rehabilitation protocol difficult after surgery, and it is consistent with the study of song *et al*. [4]. Though not mentioned in our study few articles have studied the correlation between the day of surgery and LOS, and found that midweek surgeries have prolonged the LOS. The plausible reason for this could be that the ancillary services including physiotherapy are understaffed during weekends hence patients operated earlier during the week who have their predicted discharge over the weekend are not comfortable going home and spend some more time at the beginning of the next week [11]. Unilateral TKAs performed earlier during the week and later on, the weekend is associated with a significantly lower LOS. The role of another factor being BMI in LOS is still under debate. Nunez *et al*. [12], found a negative association between BMI and the quality of life after TKR. Few studies have shown no correlation between obesity and increased LOS [13, 14]. In our study, we found a correlation between an increased BMI and extended LOS in both males & females.

Talking about BMI, another modifiable risk factor for perioperative morbidity is serum albumin, which is a marker for malnutrition. Sarah *et al*. [16] has found that decreased serum albumin is associated with increased cost, reflecting financially on the patient and increasing the LOS needed for albumin transfusion. In our study reduced serum albumin is significantly associated with increased LOS especially below 3.5 g/dL. The increased cost and increased LOS due to hypoalbuminemia is also due to its potential to cause perioperative infections and increasing unexplained intubations & readmissions [16]. Nutrition support in the form of high preoperative serum albumin promotes wound healing [17]. The primary disease will alter the patient LOS & satisfaction. TKA done for rheumatoid arthritis will have longer LOS, due to increased intraoperative blood loss as it is an inflammatory disease & the need for blood transfusion is present, chances of wound complications can occur. An associated morning stiffness & other small joint involvement makes the early rehabilitation relatively late [18]. In our study, we found RA patients stayed longer than TKA done for primary OA. TKA is an acceptable treatment of choice for proximal tibia fractures with degenerative joint disease, but the outcome in the elderly is affected by osteoporosis [19]. Such cases need a long period of postoperative immobilization & non-weight bearing mobilization, all this will increase the LOS to a significant level. The LOS in our study among the 13 cases of TKA operated for proximal tibia fracture was a mean of 13 days.

Galbraith *et al*. [7] showed the improved LOS in Danish units because the arthroplasty patients were kept in separate units from other orthopedic patients. In these arthroplasty units the nursing, physician & rehabilitation team are more tuned to provide rapid discharge that aids in reduced LOS. This is in contrast to our institution where all patients are grouped together.

For elective surgery, care should be taken to at least address the modifiable risk factors. Some of the modifiable risk factors which can be addressed pre-operatively include BMI, substance abuse (Smoking), low hemoglobin and albumin.

Patients should be encouraged for non-weight bearing exercises and quadriceps and hamstring strengthening exercises to reduce BMI and further help in postoperative rehabilitation. Patients when coming for the first consultation should be advised to stop smoking and alcohol. Patients should be advised to have a high protein diet if no contraindication is present. All these factors reduced the duration of stay, cost of rehabilitation and postoperative need for mechanical and chemical DVT prophylaxis, thus reducing the cost of stay and burden on patients.

There are several strengths of our study, first, our sample size of 1022 is large and collected from a single institution operated by prime specialists all having the primary diagnosis of RA or OA or fractures around the knee, and all had the same operative and postoperative rehabilitation protocol.

There are few limitations in our study. Firstly all the data were taken from the medical records and factors like the pain score, range of movements and symptoms may not be accurate, but for its large sample volume, this bias can be accepted. Also, these values are homogenous from a single institution and may not contribute to represent the whole of south India.

5. Conclusion

Multiple predictors were associated with an increased LOS following primary TKA, some of which are modifiable and some non-modifiable. It is important to acknowledge all the factors that increase the in-hospital LOS & to do one's uttermost use of medical resources without a significant escalation in the rate or severity of the complication or subsequent readmission and to optimize perioperative protocols for at-risk patients for an increased LOS during Total knee arthroplasty.

Abbreviation

TKA – Total knee Arthroplasty
TKR – Total knee replacement
LOS – Length of Stay
OA – Osteoarthritis
RA – Rheumatoid arthritis
BMI – Body Mass Index
ASA – American Society of Anesthesiology
Hb - Hemoglobin

Conflict of Interest: Nil

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