Original Article

Effect of total knee arthroplasty on type II diabetes mellitus and hypertension: A prospective study

Shrinand V Vaidya, Arvind Arora, Ambarish A Mathesul

Abstract

Context: Advanced osteoarthritis of knee joint if bilateral, severely restricts patient mobility. This acts as an aggravating factor for pre existing comorbid elements of metabolical syndrome (MS) like Type II diabetes mellitus and hypertension as patients are unable to carry out therapeutic walks. Successfully implanted total knee arthroplasty (TKA) increases physical activity and enables to carry out therapeutic walks thus may help in better control of type II diabetes mellitus and hypertension. The objective of this prospective study was to find whether TKA for osteoarthritis knee had any effect to improve blood glucose levels and reduce blood pressure.

Materials and Methods: A prospective study was done in which patients operated for tricompartmental osteoarthritis of knee with associated comorbidities like Type II diabetes mellitus or hypertension during a period of 2008 and 2009 were studied. One hundred and twenty patients were enrolled (55 diabetics, 65 hypertensives) who met our inclusion criteria. Preoperative knee society score, lower extremity activity scale fasting blood glucose level and systolic and diastolic blood pressure were compared with one year followup values. The KSS and LEAS scores were analysed by the Wilcoxon signed ranked test, while the fasting blood glucose (FBG) levels and systolic and diastolic blood pressure levels were analysed by paired '*t*' test.

Results: The reduction of systolic blood pressure by 8 mmHg (t = 5.6, *P* value < 0.05) and diastolic blood pressure by 6 mmHg (*t* = 7.6, *P* value < 0.05) was recorded which was statistically significant. However, no statistically significant effect on fasting blood glucose levels was observed (*t* = -0.77, *P* value = 0.442). KSS improved in DM from preoperative 29 to 86 and LEAS improved from 6.7 to 11.3.

Conclusions: Authors are of the opinion that successful total knee replacement results in increased physical activity and reduces blood pressure (systolic and diastolic) in hypertensives. However, the same is not seen in blood glucose level. Increased physical activity and reduced dependence on NSAIDS postoperatively, may be contributing in reduction of systolic and diastolic blood pressure. Further studies in this aspect are necessary.

Key words: Diabetes mellitus, hypertension, metabolic syndrome, total knee arthroplasty, type II diabetes mellitus

Introduction

Osteoarthritis is a chronic degenerative disease, affecting adults and a major contributor to physical disability, morbidity, and utilization of health care resources worldwide.[1-5] Osteoarthritis was previously considered as a degenerative disease but now is viewed as a metabolically dynamic process amenable to treatment. Osteoarthritis is frequently associated with diabetes mellitus and/or hypertension.[6] Diabetes mellitus (DM) and hypertension are among the most prevalent noncommunicable diseases in elderly population especially in India. The Sentinel Surveillance Project, documented 10% overall prevalence of diabetes and 28% of hypertension from 10 regions of the country in the age group 20-69.[7] Adipose tissue acts as a main seat for the production of proinflammatory factors which along with DM and hypertension have been hypothesised as a cause of osteoarthritis.[6,8] Osteoarthritis causes significant disability in terms of deformity and limitation of physical activity thus compounding DM and hypertension.[6,9,10] TKA has been demonstrated to provide functional improvement and pain relief for most patients with advanced knee osteoarthritis. Few studies showing real health status improvement after TKA have been published so far and which show no benefit of TKA on risk factors of MS.[11-17]

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Access this article online	
Quick Response Code:	Website: www.ijoonline.com
	DOI: 10.4103/0019-5413.106913

In this prospective study, we tried to find if TKA as a treatment for osteoarthritis knee has any effect on baseline fasting blood glucose (FBGL) in diabetic and on systolic and diastolic blood pressure in hypertensives. We hypothesised that TKA as a treatment for osteoarthritis would not completely eliminate BP and DM, but would help in better control by improved physical activity.

Materials and Methods

This is a prospective study in which patients operated for tri-compartmental osteoarthritis of knee with preoperatively diagnosed diabetes mellitus or hypertension during a period of 2008 and 2009 were evaluated.

Inclusion criteria of the patients were:

1. Patients who had undergone TKA for osteoarthritis knee with diagnosed diabetes mellitus on dietary, oral or insulin treatment.
2. Age more than 50 years.
3. Patients diagnosed to have hypertension and on antihypertensive medication.

The study enrolled 120 patients (55 having diabetes, 65 with hypertension who met our inclusion criteria. All patients underwent bilateral TKA (simultaneous or staged). Patients with DM with coexisting hypertension, other comorbidities (e.g., endocrine problems) were excluded.

Those patients, who were lost to followup due to any reason and patients who have stopped the medications for DM and hypertension were excluded. Twenty patients had lost to followup.

Detailed analysis of the data collected was done. The preoperative knee society score (KSS), Lower-extremity activity scale (LEAS), fasting blood glucose level (FBGL) and systolic and diastolic blood pressures were recorded. The systolic and diastolic blood pressure was measured with a standard sphygmomanometer in a supine position with 20 minutes of prior rest. The measurements were done by single physician. The FBGL was measured with set standards at the same laboratory.

The KSS[18] was used for the purposes of functional assessment and outcome measurements. The patient's physical activity level was assessed with the LEAS.[19]

At the end of followup of 1 year postoperative period, KSS, LEAS, FBGL and systolic and diastolic blood pressure were recorded. It was observed that the drugs and dosage of antihypertensive and antidiabetic drugs remained same throughout the period.

Statistical analysis

The KSS and LEAS scores were analysed by the Wilcoxon signed ranked test, while the FBGL and systolic and diastolic blood pressure levels were analysed by paired '*t*' test.

Results

A total of 120 patients were enrolled but only 100 patients could be followedup at one year hence were evaluated. Out of these 50 patients were diagnosed preoperatively with diabetes mellitus and remaining 50 patients with hypertension.

Study graph of diabetic patients: The mean age of patients in this group was 63 years (range 51-78 years). There were 30 female and 20 male patients. The average KSS was 29.98 preoperative increased significantly to 85.76 postoperatively (1 year) ($P < 0.001$) at the end of 1 year [Table 1]. The mean preoperative FBGL was 133.8 (SD -12.624) and postoperative (1 year) FBGL was 135.10 (SD-12.569) [Figure 1, Table 2]. This change was statistically not significant ($P = 0.0442$).

Hypertensive group: The mean age of patients in this group was 68 years (range 57 to 80 years). There were 32 female and 18 male patients. The average KSS was 31.3 preoperative which increased significantly to 89.26 postoperatively (1 year) [Table 3].

Preoperative mean systolic and diastolic blood pressure

Table 1: Preoperative and postoperative KSS and LEAS scores in type II diabetes mellitus patients

	Preoperative	Postoperative (1 year)	*P* value
KSS	28.98	85.76	<0.005
LEAS	6.7	11.3	<0.005

KSS = Knee society score, LEAS = Lower-extremity activity scale

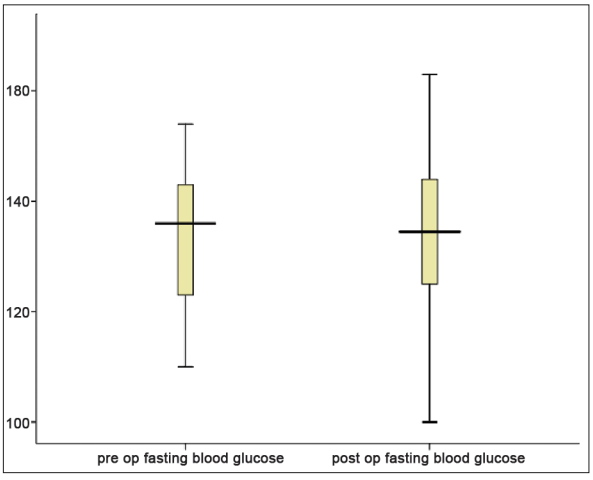

Figure 1: Bar diagram showing preoperative and postoperative blood glucose level in patients with type II diabetes mellitus undergoing TKA

was 143.96 (SD 12.876) and 90.68 (SD 6.485) mmHg, respectively. Postoperative (1 year) mean systolic and diastolic blood pressure was 135.72 (SD 11.234) and 85.36 (SD 5.166) mmHg, respectively [Figures 2-3]. When compared statistically the above values the *P* value was significant. This implies that with the given dosages there was better control of hypertension [Table 4].

Discussion

In this study we evaluated the health improvement after TKA by assessing the base line values of FBG in diabetics and systolic and diastolic blood pressure in hypertensive patients. Diabetes mellitus and hypertension are highly prevalent in elderly population.[6] We were able to demonstrate a significant increase in knee function and physical activity as measured by KSS and LEAS from preoperative condition to 1 year after.

Sedentary lifestyle due to osteoarthritis knee renders a heavy medical and economical burden on individuals and societies.[13,16] There is growing evidence that osteoarthritis is not simply a disease related to aging or mechanical stress of joints but rather a "metabolic disorder" in which various interrelated lipid, metabolic, and humoral mediators contribute to the initiation and progression of the disease process. Indeed, osteoarthritis has been linked not only to obesity but also to other cardiovascular risk factors, namely, diabetes, dyslipidemia, hypertension, and insulin resistance.[8] Physical activity is a key component of effective treatment of diabetes, dyslipidemia, hypertension, and insulin resistance.[20] Physical activity can improve the control over blood glucose and blood pressure level in diabetes and hypertensive, respectively. In the Finnish Diabetes Prevention study, individuals who increased their leisure time of physical activity were about 75% less likely to develop metabolic syndrome (MS).[21]

MS is a known risk factor for the development of osteoarthritis[22] Adipose tissue is now regarded as an active endocrine organ that produces tumor necrosis factor α, interleukin-6, and C-reactive protein, which together induce a systemic proinflammatory state Moreover, visceral adipocytes release the peptide hormone leptin that also promotes systemic inflammation.[23-26] This overall elevated inflammatory state has been linked to chondrocyte death and matrix degeneration.[27,28] Moreover, a recent hypothesis has been put forward suggesting a link between obesity-induced atherosclerosis and osteoarthritis.[29] Microvascular disease, particularly in the subchondral bone,

Table 2: Preoperative and postoperative fasting blood glucose

Fasting blood glucose	*N*	Mean	SD	Range	*t*	*P* value
Preoperative	50	133.88	12.624	110-154	-0.775	0.442
Postoperative (1 year)	50	135.10	12.569	100-163		

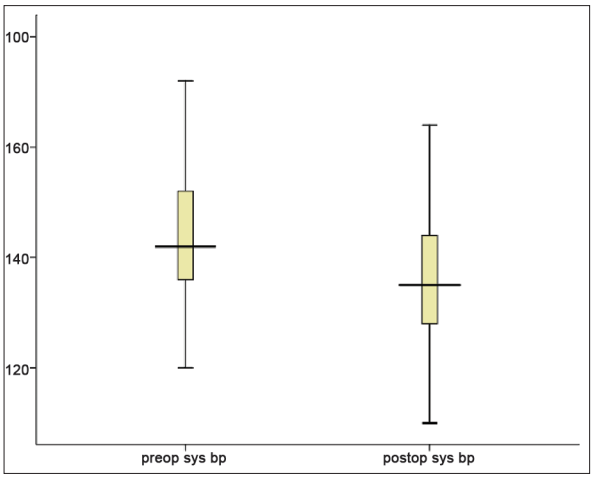

Figure 2: Bar diagram showing preoperative and postoperative systolic blood pressure in patients with hypertension undergoing TKA

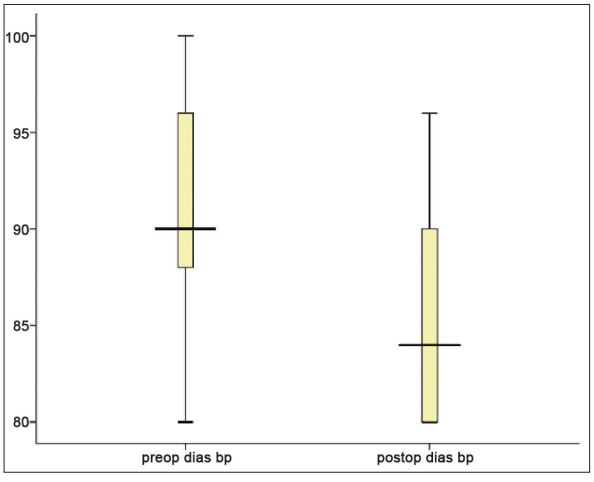

Figure 3: Bar diagram showing preoperative and postoperative diastolic blood pressure in patients with hypertension

Table 3: Preoperative and postoperative KSS and LEAS in patients with hypertension

	Preoperative	Postoperative (1 year)	*P* value
KSS	31.3	89.2	<0.005
LEAS	7.9	10.4	<0.005

KSS = knee society score, LEAS = Lower-extremity activity scale

Table 4: Mean preoperative and postoperative systolic/diastolic blood pressure

	Mean	*N*	SD	Range	*t*	*P* value
Preop SYS BP	143.96	50	12.876	120-172	5.632	<0.005
Postop (1 year) SYS BP	135.72	50	11.234	110-164		
Preop Dias BP	90.68	50	6.485	80-100	7.663	<0.005
Postop (1 year) Dias BP	85.36	50	5.166	80-96		

SYS = Systolic, Dias = Diastolic, BP = Blood pressure

may lead to cartilage degeneration through poor cartilage nutrition and a direct ischemic insult.[8]

One of the hypothesized mechanisms to explain the independent beneficial role of physical activity may be the antiinflammatory affect of exercise. The association between low-grade systemic inflammation and MS has been supported by many studies[30,31] Bauman *et al*.[32] reported that patients who undergo TKA maintain a moderate activity level and may program active/very active levels of activity. However, in our study increased physical activity after TKA had significant effect on blood pressure level as reduction of systolic BP by 8 mmHg and diastolic BP by 6 mmHg was recorded.Implementation of a healthier lifestyle with an increase in physical activity and a reduction of body weight is the basis for the prevention and treatment for both type 2 DM. Both exercise and diet induced weight loss provides similar reductions in obesity and insulin resistance.

Our study showed no significant increase in the mean FBGL between preoperative and postoperative (1 year) condition. The US diabetes prevention program research graph preformed a lifestyle modification study that focused on 3234 obese subjects with impaired blood glucose tolerance. The lifestyle modification growth that had goals of 7% weight loss and 150 minutes of physical activity per week resulted in 38% reduction in the incidence of type 2 DM.[33] In the present study, TKA did not reduce the FBGLs contrary to our hypothesis. Thus, diabetes was not a reversible condition with the TKA intervention. With respect to blood pressure TKA had a positive effect. It leads to decline in baseline blood pressure values in hypertensives about 8-10 mmHg in systolic and 0-6 mmHg for diastolic BP implying better control with the drugs.

Several randomized studies[34,35] have demonstrated that various NSAID elevate the blood pressure in elderly and hypertensive individuals. TKA, gives relief from pain and hence NSAID intake would be stopped postoperatively. This might also be one of the reasons coupled with increase in physical activity for lowering of blood pressure in hypertensive at the end of 1 year postoperative.

Physical activity reduces risk factors of cardiovascular accidents, lowers all cause mortality and acts as a key treatment modality against MS.[9,36] Our study showed increased physical activity postoperatively, and reduction in systolic and diastolic blood pressure, though this cannot be attributed entirely to increased physical activity, reduced dependence on NSAIDS may have also acted as a contributor. Further research in this aspect is necessary. Diabetes mellitus patients benefit the most from their ability to walk, which in turn helps to reduce antidiabetic drug dependence which was not seen in our study. We recommend stricter monitoring of FBGL and diet control for effective control of diabetes as our study showed minor elevation of FBGL postoperatively.

Authors are of the opinion that total knee replacement coupled with increase in physical activity postoperatively definitely reduces blood pressure in hypertensives; however, the same is not seen in blood glucose level.

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How to cite this article: Vaidya SV, Arora A, Mathesul AA. Effect of total knee arthroplasty on type II diabetes mellitus and hypertension: A prospective study. Indian J Orthop 2013;47:72-6.

Source of Support: Nil, **Conflict of Interest:** None.