International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2022; 8(3): 100-108

www.orthopaper.com
Received: 23-04-2022
Accepted: 27-06-2022

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Does right knee behave differently from the left knee in Bilateral TKR patients: A prospective analysis

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DOI: https://doi.org/10.22271/ortho.2022.v8.i3b.3184

Abstract
Background: Bilateral total knee arthroplasty (TKA) is one of the most common surgeries performed in patients with Osteoarthritis knee. The functional assessment in between two knees have not been in literature which is an important evaluation to help provide patients with evidence based outcome. We evaluated the functional outcomes on operated Bilateral TKA patients and compared them between the two knees.
Methodology: Patients who underwent primary Bilateral sequential and staggered TKA between 1st January 2019 and 31st Dec 2019, were included and their functional outcomes were assessed at 6 weeks, 3 month, 6 months and 1 year intervals were evaluated in our study.
Results: With a mean age of 66.95 years (50-82), 142 primary bilateral total knee replacements were included. In the 142 patients observed a total of 17 patients had a difference in the left and right knees where 13 patients had right knee better than left and the other 4 had left better than right based on the KSS score. In conclusion, the differences between knees were not significant over 1 year period follow-up based on the KSS scores
Conclusion: In our study, we found that functional outcomes of knees based on KSS scores were different in the early follow ups at 6 weeks and 3months interval but at a long term follow up of 1 year the differences were not significant.

Keywords: Osteoarthritis knee, bilateral TKA, functional differences, sequential, staggered

Introduction
The incidence of osteoarthritis has increased globally because of increased life expectancy and better health care [1]. The total knee replacement (TKR) is worldwide most commonly performed surgery for pain relief and improved knee function in end stage knee osteoarthritis. [2] Although joint replacement surgery is widely considered to be one of the success stories of modern medicine, approximately up to 20% of patients with a knee replacement are to some extent dissatisfied with the outcome following TKR [3]. It is estimated that 80% of patients over the age of 65 years have knee osteoarthritis, and one-third of them present with symptoms of bilateral knee osteoarthritis [4]. Although several studies have evaluated and compared the outcomes of sequential versus staggered bilateral TKR [5-7] and they have found that bilateral staggered TKR and unilateral TKR is safer alternative compared to simultaneous TKR none of the studies have compared the functional outcomes between right and left knees in cases of Bilateral TKR patients [8]. We are planning to answer the above mentioned lacunae with the following study Hence, the aim of our study is to evaluate, that is there any significant differences between right and left knees after sequential versus staggered TKR.

Objective
1. The objective of this study is to find any functional differences between right and left knees in patients who underwent bilateral TKR.
2. To understand the effect of Age, BMI, gender, co-morbidities and postoperative time on the functional recovery in TKR patient's after 1 year follow up.

Materials and Methods

Our study is a retrospective study where the data was analysed in a prospective manner. 142 patients were evaluated for the inclusion that underwent bilateral elective primary TKR in our hospital between Jan 2019 and Dec 2019 for knee osteoarthritis. The cohort was divided into 2 subgroup- group-1 included those underwent sequential bilateral TKR on the same day in same anaesthesia, and group-2 included those underwent stage or staggered bilateral TKRs under two separate anaesthesia within 7days. Patients with cardiopulmonary comorbidities and systemic illness such as chronic obstructive pulmonary disease, cerebrovascular disease, peripheral vascular disease or active coronary artery disease were excluded.

A total of 142 patients were enrolled in single-centre study from our database out of which 106 patients underwent staggered bilateral TKR (212 knees) and 36 patients underwent sequential bilateral TKR (72 knees) The mean age of the patients was 64 years in group-1 and that in group -2 was 65 years. Body mass index was 27.89 and 29.9 respectively for group -1 and group-2. There were total 34 males and 108 females. The deformity which were considered were various degrees of varus ranging from 5 to 15 degrees and FFD ranging from 5 to 10 degrees.

All patients were operated through midline incision with a medial parapatellar approach. A cemented implant was used in all these patients were PFC sigma cruciate substituting. All these patients were evaluated for the knee outcomes in postoperative follow up at an interval of 6weeks, 3months, 6months and 1year via telephonic and video communication keeping in mind the COVID at each follow up patients were asked for knee function based on KSS (Knee society score) which included pain difference, instability and range of movements. An institutional review board approval was taken prior to study, and informed written consent was taken from all the patients.

Characteristics of TKR patients

The participant's characteristics:-

Table 1: Overall analysis

		Group			
		SE BTKR		ST BTKR	
		Count	%	Count	%
Age(years)	50 and below	0	0.0%	3	2.8%
	51 - 60	11	30.6%	21	19.8%
	61 - 70	20	55.6%	58	54.7%
	Above 80	5	13.9%	24	22.6%
BMI(kg/m2)	< 25	7	19.4%	0	0.0%
	25 - 30	23	63.9%	62	58.5%
	Above 30	6	16.7%	44	41.5%
Gender	F	30	83.3%	78	73.6%
	M	6	16.7%	28	25.5%
HTN	No	13	36.1%	32	30.2%
	Yes	23	63.9%	74	69.8%
DM	No	28	77.8%	67	63.2%
	Yes	8	22.2%	39	36.8%
Comorbidities	Yes	25	69.4%	81	76.4%
	No	11	30.6%	25	23.6%

Analysis of Age of undergoing TKR and functional outcome

As seen in Table 2, staggered BTKR patients tended to be younger, male and likely to have pre-existing comorbidities than staged BTKR patients. More than half (55.6%) of sequential patients were age 65 and older, compared with 54% of staggered BTKR patients. In the *sequential group* the analysis brought us to the observation that 30.6% patients in 51-60years age group, 55.6% patients in 61-70yrs and 13.9% of ages above 80 years underwent TKR and no patient was below 50 years of age (figure 1). In the *staggered group* 19.8% patients in 51-60years age group, 54.7% patients in 61-70yrs and 22.6% of ages above 80 years underwent TKR and 2.8% patient were below 50 years of age (figure 2).

Table 2: Age analysis

		Group			
		SE		ST	
		Count	Column N %	Count	Column N %
Age	50 and below	0	0.0%	3	2.8%
	51 – 60	11	30.6%	21	19.8%
	61 – 70	20	55.6%	58	54.7%
	Above 80	5	13.9%	24	22.6%

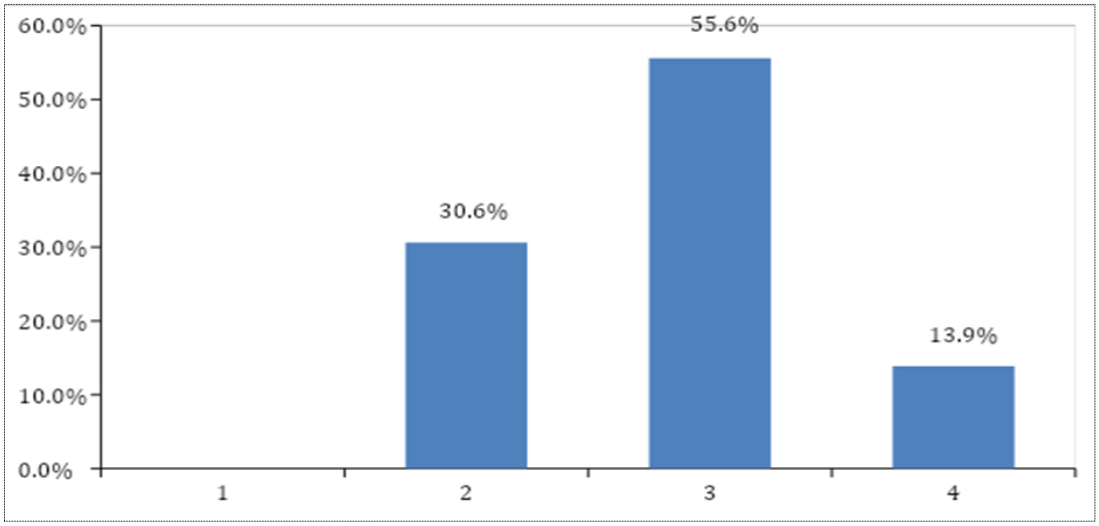

Fig 1: Age analysis in SE

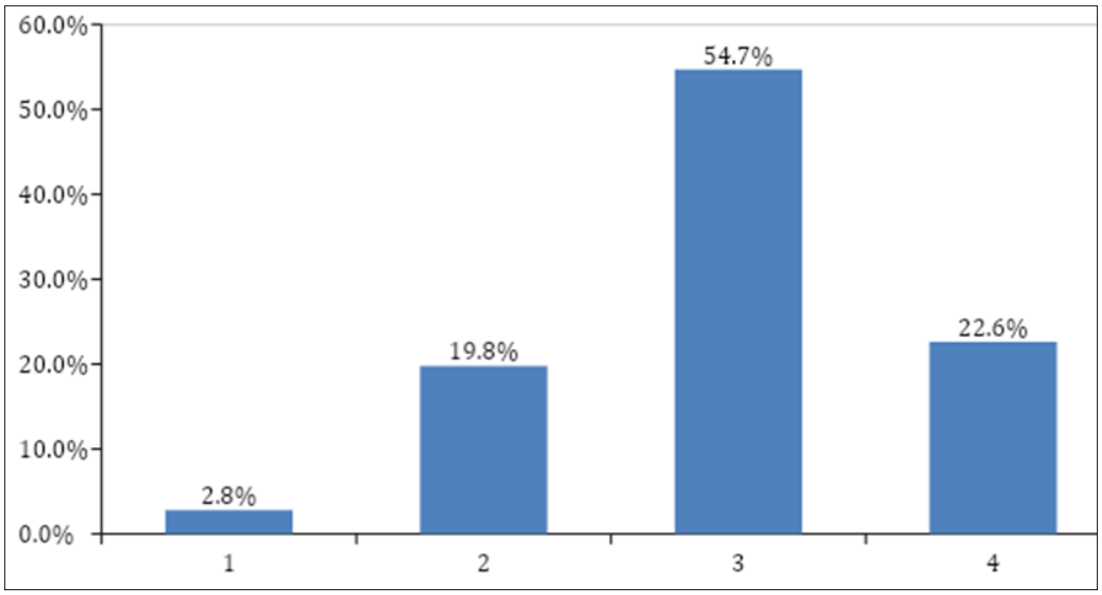

Fig 2: Age analysis in ST

Table 3: Correlation of Age on 1year KSS

	SE		ST	
	R	**L**	**R**	**L**
ANOVA /t- test p values	0.052	0.988	0.623	0.111

P values < 0.05 are highly significant, so according to above values the age has no significance on post-operative functional outcome over a one year follow up which is with accordance with other studies [9].

BMI analysis in TKR

As seen in Table 4, more patients were in the overweight category in both SE and ST group. In the *sequential group* 19.4% patients had a normal (BMI < 25), 63.9% were overweight (BMI 25-30) and 16.7% (BMI > 30) were in the obese category (Figure 3). In the staggered group_no patient had a normal (BMI < 25), 58.5% were overweight (BMI 25-30) and 41.5% (BMI > 30) were in the obese category (Figure 4).

Table 4: BMI analysis

		SE		ST	
		Count	**Column N**	**Count**	**Column N%**
BMI	< 25	7	19.4%	0	0.0%
	25-30	23	63.9%	62	58.5%
	Above 30	6	16.7%	44	41.5%

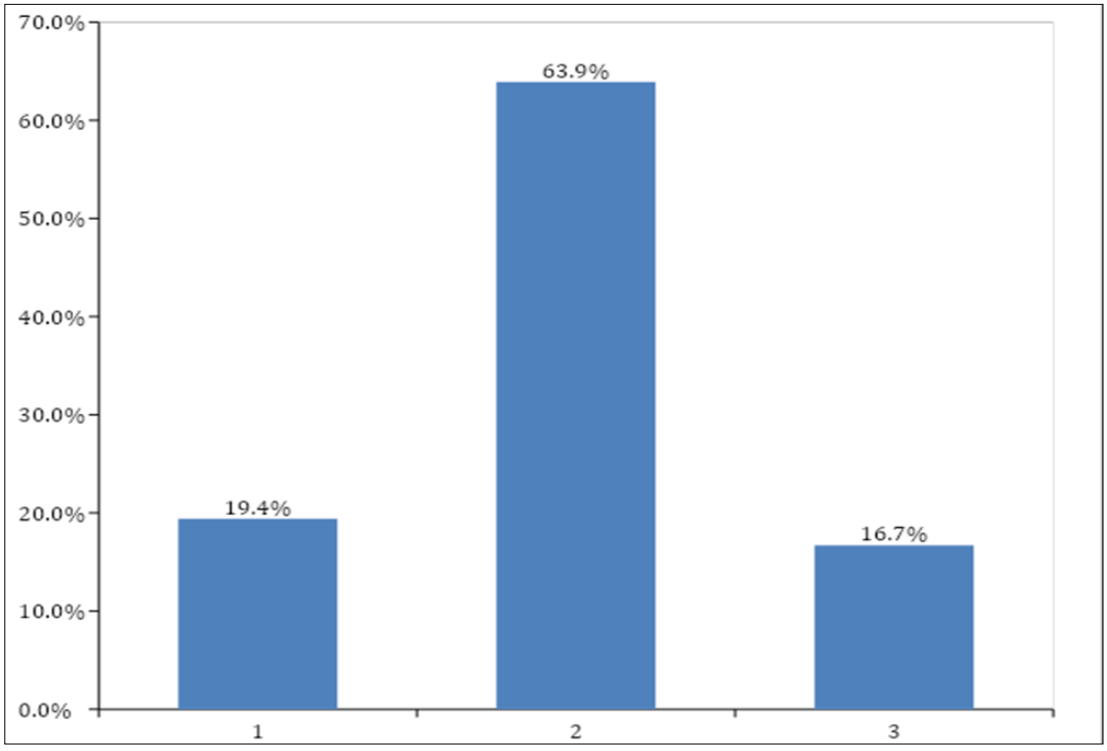

Fig 3: BMI analysis in SE

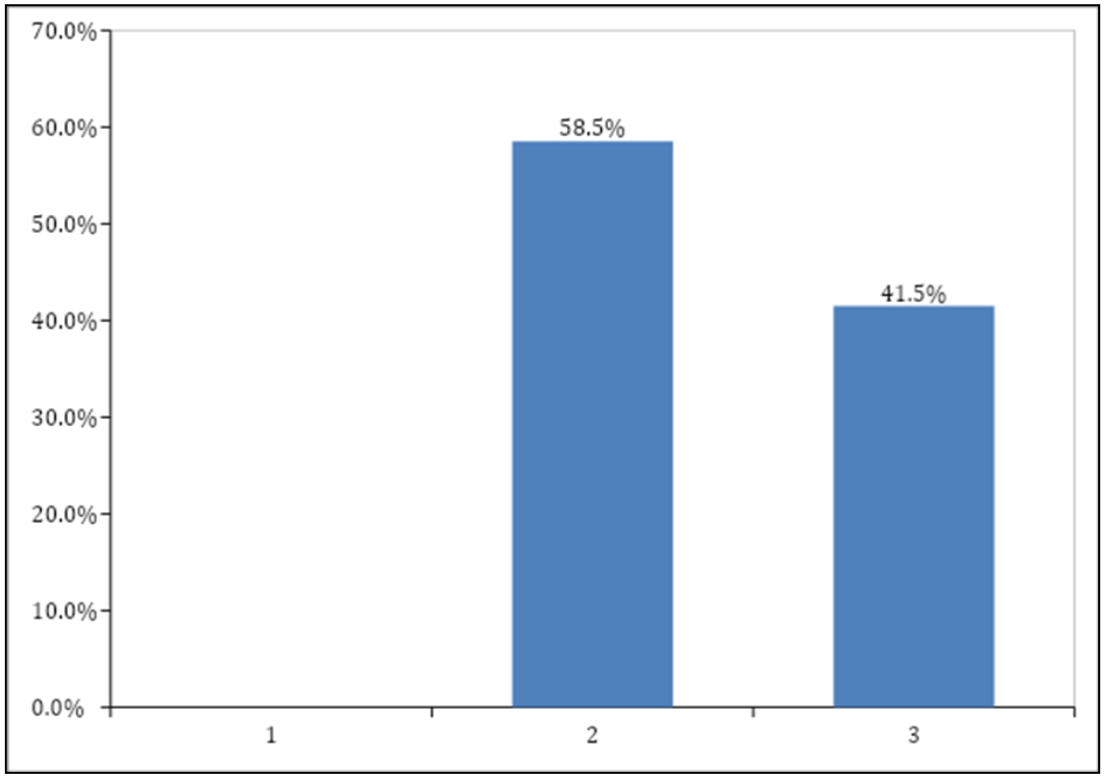

Fig 4: BMI analysis in ST

Table 5: Correlation of Age on 1year KSS

	SE		ST	
	RK	LK	RK	LK
ANOVA /T- test p values	0.187	0.171	0.320	0.491

P values <0.05 are highly significant, so according to above values that a higher BMI has no significance on post-operative functional outcome over a one year follow up which is with accordance with other studies [10].

Gender analysis

As per the table below we have come to the conclusion that female gender had a more preponderance for osteoarthritis but the postoperative functional outcome at 1 year follow up was excellent based on KSS scoring. In the sequential group 17% patients were males and 83% were females (BMI < 25) (Figure 5). In the staggered group 26% patients were males and 74% were females (Figure 6).

Table 6: Gender analysis

		SE BLTKR		ST BLTKR	
		SE		ST	
Gender	F	30	83.3%	78	73.6%
	M	6	16.7%	28	25.5%

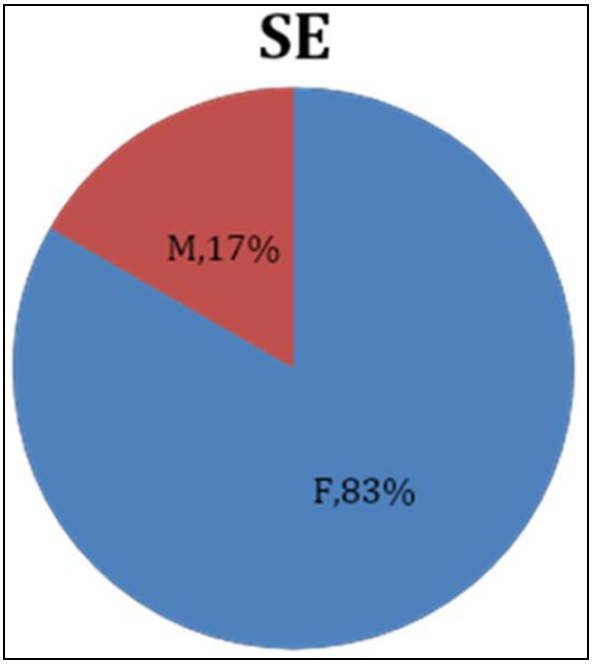

Fig 5: Percentage of Males and Females in sequential group

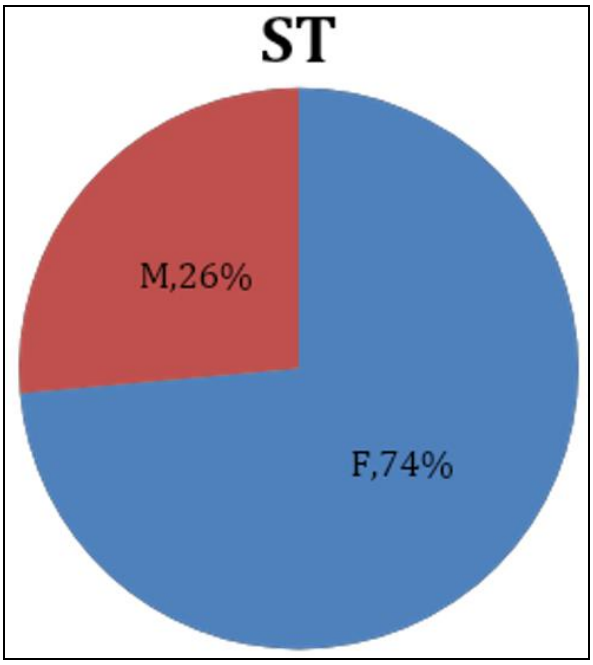

Fig 6: Percentage of Males and Females in staggered group

Table 7: Correlation of Gender on 1year KSS

	SE		ST	
	R	L	R	L
ANOVA /T- test p values	0.907	0.716	0.718	0.301

P values <0.05 are highly significant, so according to above values gender as seen in American population female had a poor post-operative score but in Asians had no significance on post-operative functional outcome over a one year follow up which is with accordance with other studies [11].

Co-morbidities analysis

In total TKR patients we found that in the sequential group 69% had pre operative comorbidities (figure 7) out of which 63.9% had HTN (figure 8) and 22% had DM (figure 9) and in the *staggered group* 76% had pre operative comorbidities (Figure 10) of which 69.8% had HTN (Figure 11) and 36.8% had DM (Figure12).

Table 8: Co-morbidities analysis

		SE BLTKR		ST BLTKR	
HTN	No	13	36.1%	32	30.2%
	Yes	23	63.9%	74	69.8%
DM	No	28	77.8%	67	63.2%
	Yes	8	22.2%	39	36.8%
Comorbidities	Yes	25	69.4%	81	76.4%
	No	11	30.6%	25	23.6%

Table 9: (Correlation of Co-morbidities on 1year KSS)

	SE		ST	
	R	L	R	L
ANOVA /t- test p values-HTN	0.714	0.940	0.718	0.198
DM	0.240	0.486	0.927	0.145
Co-morbidities	0.456	0.677	0.587	0.304

P values < 0.05 are highly significant, so according to above values DM and HTN in Asians had no significance on post-operative functional outcome over a one year follow up which is with accordance with other studies [11-13] and good postoperative functional score after TKR.

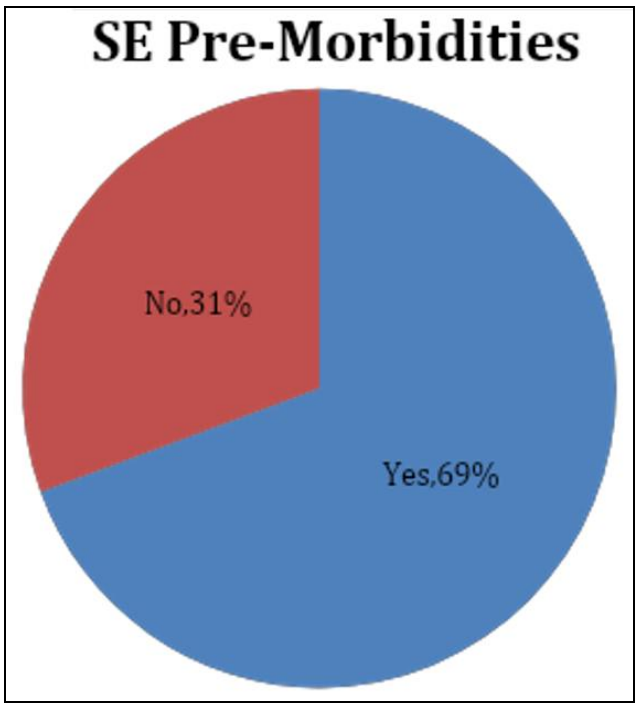

Fig 7: Percentage of people with and without comorbidities

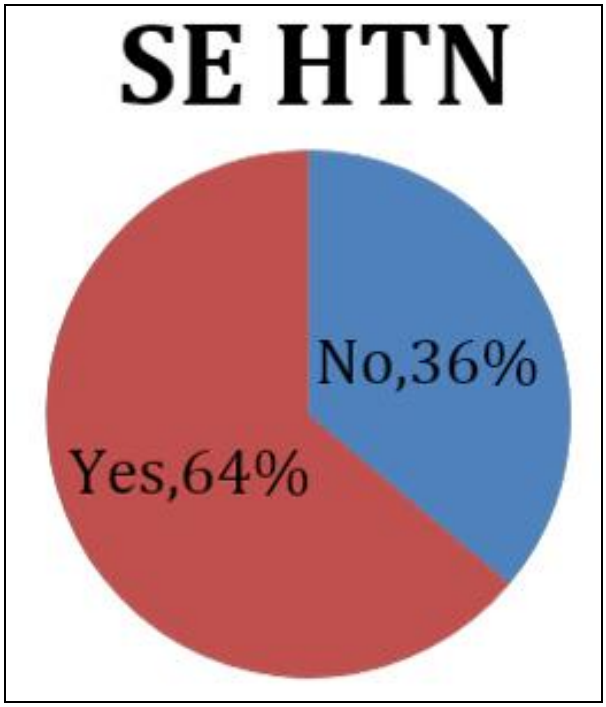

Fig 8: Percentage of people with and without hypertension in sequential group sequential group

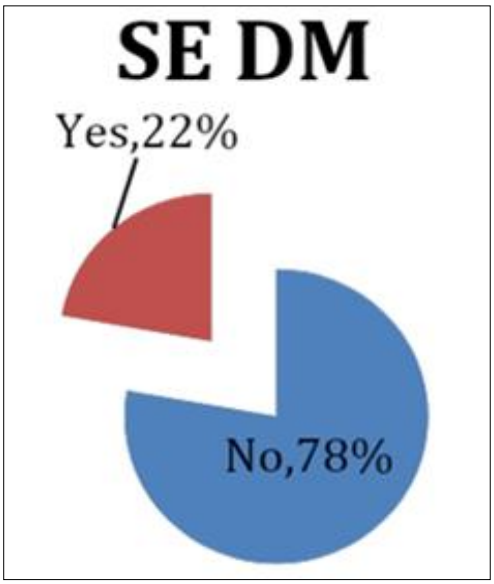

Fig 9: Percentage of people with and without Diabetes

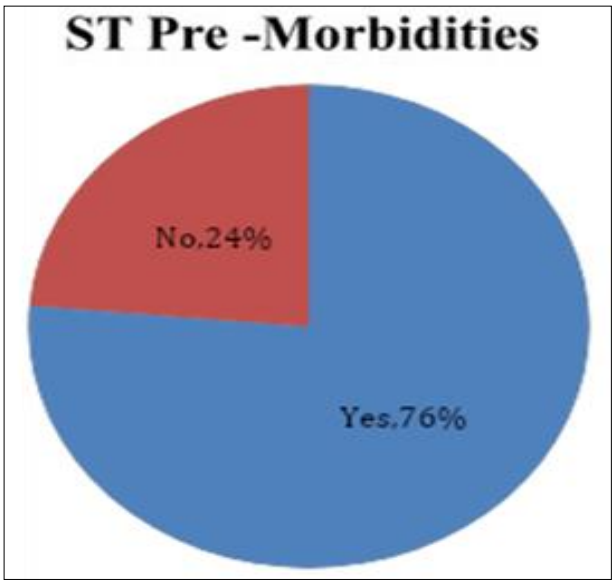

Fig 10: Percentage of people with and without comorbidities Mellitus in sequential group in staggered group

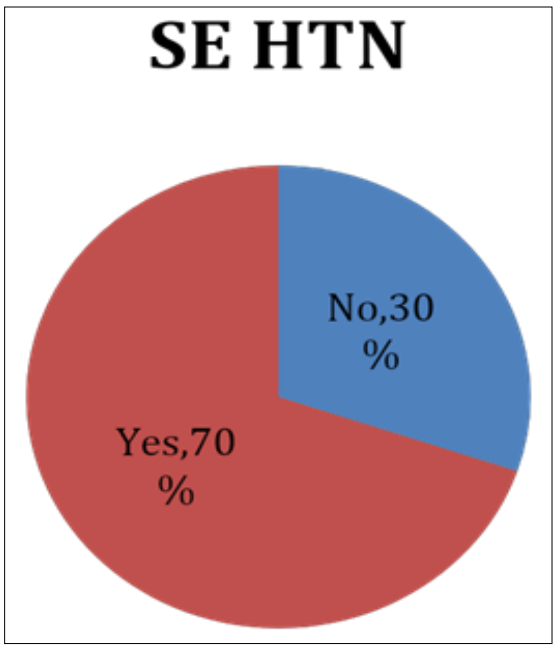

Fig 11: Percentage of people with and without hypertension

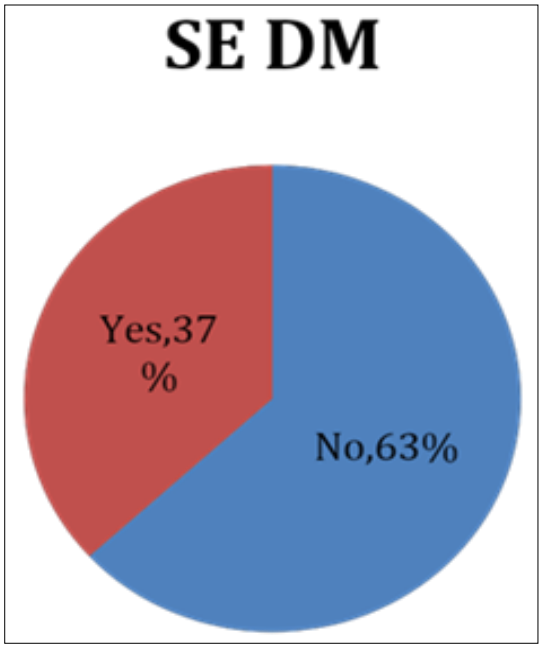

Fig 12: Percentage of people with or without diabetes mellitus in staggered group in staggered group

KSS score analysis and complaints

The KSS is a knee joint specific questionnaire originally developed and validated in 1989 for use in assessing the outcome of total knee replacement. The KSS has 2 components: a knee rating (0–100 points) and function (0–100 points) worth a total of 200 points. The knee rating is divided into pain (0–50 points) and a knee score which assesses range of motion, stability, and alignment (0–50 points). A higher score indicates a better outcome. The KSS includes range of motion and alignment measurements, and this may in part contribute to its popularity. The preoperative scores of right and left knees were individually measured pre-operatively and post operatively at 6wks, 3m, 6m and 1yr intervals and the following observations were made at the follow-up in sequential (Figure 13) and staggered (Figure 15) groups. In the sequential group 83% of the patients found no differences in functional outcome between right and left knees, 14% Right better then left and 3% left better then right (figure 14). In the *staggered group* 90% of the patients found no differences in functional outcome between right and left knees, 7% Right better then left and 3% left better then right (figure 16). Cut points for each of the 2 subscales are excellent (≥ 80), good (70–79), fair (60–69), and poor (< 60). The table below explains that during follow up staggered TKR patients improved better compared to sequential group.

Table 10: Kss Analysis

				SE BLTKR		ST BLTKR	
				Count	Column N %	Count	Column N %
Time	1 YR	RIGHT	Poor	0	0.0%	0	0.0%
			Fair	0	0.0%	0	0.0%
			Good	0	0.0%	0	0.0%
		Excellent		36	100.0%	106	100.0%
	LEFT	Poor		0	0.0%	0	0.0%
		Fair		0	0.0%	0	0.0%
		Good		0	0.0%	0	0.0%
		Excellent		36	100.0%	106	100.0%
6 MON	RIGHT	Poor		0	0.0%	0	0.0%
		Fair		0	0.0%	0	0.0%
		Good		3	8.3%	5	4.7%
		Excellent		33	91.7%	101	95.3%
	LEFT	Poor		0	0.0%	0	0.0%
		Fair		0	0.0%	0	0.0%
		Good		5	13.9%	12	11.3%
		Excellent		31	86.1%	94	88.7%
3 MON	RIGHT	Poor		0	0.0%	0	0.0%
		Fair		5	13.9%	11	10.4%
		Good		31	86.1%	95	89.6%
		Excellent		0	0.0%	0	0.0%
	LEFT	Poor		0	0.0%	0	0.0%
		Fair		3	8.3%	7	6.6%
		Good		33	91.7%	99	93.4%
		Excellent		0	0.0%	0	0.0%
6 WKS	RIGHT	Poor		4	11.1%	8	7.5%
		Fair		32	88.9%	98	92.5%
		Good		0	0.0%	0	0.0%
		Excellent		0	0.0%	0	0.0%
	LEFT	Poor		3	8.3%	11	10.4%
		Fair		33	91.7%	95	89.6%
		Good		0	0.0%	0	0.0%
		Excellent		0	0.0%	0	0.0%
PRE	RIGHT	Poor		36	100.0%	106	100.0%
		Fair		0	0.0%	0	0.0%
		Good		0	0.0%	0	0.0%
		Excellent		0	0.0%	0	0.0%
	LEFT	Poor		36	100.0%	106	100.0%
		Fair		0	0.0%	0	0.0%
		Good		0	0.0%	0	0.0%
		Excellent		0	0.0%	0	0.0%

We have inferred from the above table that preoperatively both SE BLTKR and ST BLTKR had a poor functional KSS score but at 6 weeks, 3month, 6month the ST group fared well compared to SE group but at the end of one year follow up all of them had an excellent functional KSS score.

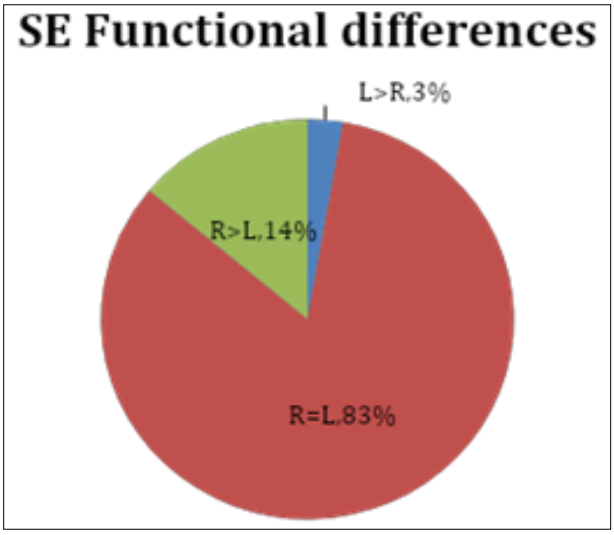

Fig 13: Analysis of functional differences between

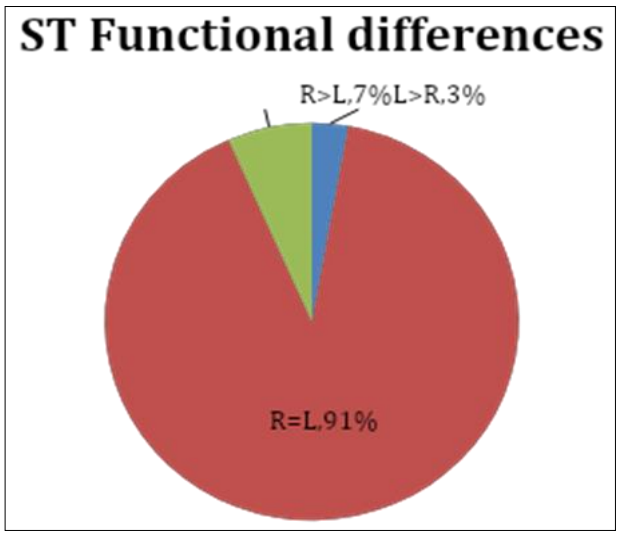

Fig 14: Analysis of functional differences between right and left knee in sequential group. And left knee in staggered group

3. Statistical analysis

All clinical outcome variables were analysed by an independent external statistician who was blinded to the surgical technique, using Statistical Analysis Software IPSS 21. The collected data were analysed using both descriptive and inferential statistical methods. Descriptive methods such as frequency, percentage a, mean and standard deviation were calculated to summarise the data. Tests such as Chi square/Fishers exact test, Wilcoxon signed rank test and ANOVA were used to assess the p Value which was used to identify any differences between the mean values in the two groups. Treatment comparisons for the continuous outcome variables were based on a marginal linear model. The pre-operative level was used as an explanatory variable.

Marginal linear models are an extension of the linear statistical class of models. In linear models, the independence of all observations is assumed. In marginal linear models, however, correlations between successive measurements of the same patient are accounted for.

4. Results

With a mean age of 66.956 (50-82), 142 primary bilateral total knee replacements were included. In the 142 patients. Observed a total of 17 patients had a difference in the left and right knees where 13 patients had right knee better than left and the other 4 had left better than right based on the KSS score. In conclusion, the differences between knees are not significant over 1 year period follow-up based on the KSS scores. The current study aimed to compare correlation of age, gender, BMI and co morbidities in bilateral TKR on functional outcome postoperatively at 1 year follow up as seen in the table below. Results of the current study indicated that both groups showed excellent functional outcome function after TKR at 1year post-operatively. There was no significant difference noted between sequential and staggered BLTKR.

TKR is most common and successful surgical intervention to reduce pain and improve function in patients with end stage osteoarthritis. There are many factors should be considered before deciding surgical intervention such as patient's age, severity, symptom duration, pre-operative medical condition, and unilateral or bilateral involvement. The commonest indications for TKR include OA, traumatic arthritis and rheumatoid arthritis. In the current study, all patients had a diagnosis of primary knee OA.

Table 11: Correlation of pre-operative KSS with Post-operative KSS at different intervals

Time			Mean	N	Std. Deviation	T test p value	Inference
PRE	SE	RIGHT	47.94	36	5.737	0.254	NS
		LEFT	46.47	36	6.026		
	ST	RIGHT	47.57	106	4.388	1.000	NS
		LEFT	47.57	106	4.393		
6 WKS	SE	RIGHT	64.86	36	2.860	1.000	NS
		LEFT	64.86	36	3.127		
	ST	RIGHT	64.61	106	2.870	0.684	NS
		LEFT	64.77	106	2.843		
3 MON	SE	RIGHT	74.50	36	3.010	1.000	NS
		LEFT	74.50	36	3.176		
	ST	RIGHT	74.70	106	2.812	0.145	NS
		LEFT	75.20	106	2.779		
6 MON	SE	RIGHT	84.81	36	2.906	0.246	NS
		LEFT	84.06	36	3.135		
	ST	RIGHT	85.27	106	3.078	0.337	NS
		LEFT	84.83	106	3.345		
1 YR	SE	RIGHT	87.33	36	1.912	0.322	NS
		LEFT	87.81	36	1.451		
	ST	RIGHT	87.46	106	1.816	0.651	NS
		LEFT	87.57	106	1.574		

The table 11 above gives us the inference that preoperative KSS scores have no correlation to postoperative KSS scores

5. Conclusion

While TKR (bicompartmental or tricompartmental) is the treatment of choice for advanced degenerative osteoarthritis with involvement of both tibiofemoral compartments with or without involvement of patellofemoral compartment, it is not very clear from the literature about the differences between the right and left side in replacement surgery of knee, for both TKR and UKR. Naeme R *et al.* [14], in a study about the distribution of radiographic osteoarthritis between the right and left side in hand, hip and knee have shown that the osteoarthritis of knee is more prevalent on the right side. The study also showed that at tibiofemoral joint, medial compartment was narrower and lateral compartment wider on right side, and knee joint osteophyte score was also greater on the right side. This discordance was attributed to biomechanical factors in the pathogenesis of side specific osteoarthritis. The exact clinical significance of this observation is not clear to us. Factors like difference in biomechanics in side-specific osteoarthritis, uneven distribution of osteoarthritis of knee between right and left side or either early or late presentation of either side of knee osteoarthritis may hold the key to the answer. The right sided dominance in majority of the population may also play some role.

6. Drawbacks of our study

More studies, including multi-centric, are needed in this regard and this may be quite valuable for implant makers to have an appropriate ratio of the implants for each side. In our study, it is established that functional outcomes after total knee replacement patients over a long-term follow-up are not significant and there are no significant differences in right and left knees after TKR. People who have a greater BMI, deformity may have a poor functional outcome at the beginning of follow-ups but over one year will have no significant differences in functional outcome. The current

study has several potential limitations. An objective outcome measure could be included to assess wide range of physical function. For instance, various performances based outcome measures such as timed up and go test and stair climbing test could be used to better understand functional recovery in these population. Additionally, the current study only assessed pain and function. Other important outcome measures such as ambulation, muscle strength, mobility, range of motion, and quality of life are warranted to consider in future study. The result of this study was restricted to bilateral TKR in patient with end stage OA, and therefore it might limit the generalizability of findings to other types of replacement surgeries. Additionally, the current study compared simultaneous bilateral TKR with a staged bilateral TKR and not unlilateral TKR. Therefore, randomized controlled studies are warranted to further identify the differences in the various outcomes between simultaneous and staged bilateral TKR. Moreover, future study may investigate the effect of physiotherapy intervention to reduce post-operative complications and improve functional outcomes after Bilateral TKR.

7. References

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