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Original Research Article

Age wise comparative analysis of patients undergoing total knee arthroplasty: a multicenter indigenous experience

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ABSTRACT

Background: This study assesses the mid-term clinical and functional outcomes, implant survivorship and impact of age on patients implanted with either cruciate retaining/posterior stabilized (CR/PS) total knee system (TKS).
Method: This is an ongoing, prospective, multicentre, real-world study enrolling 300 patients: younger adults (<55 years; n=69), older adults (55 years to <65 years; n=92) and elders (≥65 years; n=139). Primary safety endpoints: implant survivorship and cumulative revision rate. Secondary endpoints: Knee Society Score (KSS), Western Ontario and McMaster universities osteoarthritis (WOMAC) score, range of motion (ROM), SF-36 questionnaire for assessment of quality of life (QoL), radiographic analysis, and any adverse events at 6 weeks, 6 months, 1-3 years.
Results: Primary endpoint demonstrated absence of any revision across all age categories during the 3 years study period. Secondary outcomes KSS (clinical and functional) showed non-significant difference among elderly (91.13±7.90 and 98.18±4.62, respectively) in comparison to young adults (91.03±8.61 and 98.91±3.75, respectively). All three age-groups showed significant improvement in ROM ($p<0.001$) till 3 years 121.05°±7.74°, 123.22°±4.26°, and 122.43°±5.8° respectively, with no differences among the age groups. We observed that WOMAC and SF-36 QoL scores improved with each follow-up ($p<0.001$) across all age groups. Radiographs showed no implant wear or osteolysis during the investigation.
Conclusions: Age seems to play no notable role on the post-TKA outcomes. Over a 3-year period, we observed marked enhancements in patient measures such as ROM, KSS, WOMAC, and QoL indicating and strongly affirming the safety and efficacy of CR/PS TKS prostheses.

Keywords: Age-related outcomes, Younger and older adults, OA, Total knee arthroplasty

INTRODUCTION

Fast-paced and changing lifestyles have boosted the demand for total knee arthroplasty (TKA) in younger people, long reserved for geriatrics with end-stage osteoarthritis (OA). This demand is dramatically rising among patients under 55 years, over the past decade.[1,2] Even with advancement in technology and surgical techniques, patient satisfaction remains between 75% to 80% with reasonable patient population still dissatisfied with post-op TKA functional outcomes.[3-6] Several studies have evaluated the patient's demographic characteristics

such as age of patient during TKA procedure, which significantly contributes to successful outcome measures.[7-10] Younger and active patients have poor long-term results and has a major concern for implant survivorship compared to their older counterparts.[11]

Joint replacement surgeries like TKA lessen chronic pain, improve patient related outcome measures (PROMs), and QoL however, in the elderly, comorbidity, complications, and death rates are high.[12] There is a controversy with age-related TKA outcomes as few studies suggests significant effect of age on post-TKA results such as, lower PROMs rates, length of hospital stay, mortality being prominent in older patients than the younger individuals.[15-17] While in younger group, higher rates of revision TKA caused by implant longevity and wear, aseptic loosing, etc. affect the QoL in long-term is noticed.[12] In a comprehensive review involving 39-articles by Lee et al.[11] PROMs rates were better in patients over 70 years old and mortality rates increased in patients over 80 years old, while revision TKA was more common in younger patients. In another study of 11,602 unilateral TKA, younger patients (<55 years) had higher knee injury and OA outcome score (KOOS) and lower post-operative pain (1 year follow-up), while overall satisfaction increased with age (55-64 years, 65-74 years, and ≥75 years).[7]

To examine and evaluate the aforementioned concerns, our objective is to provide a prospective evaluation of mid-term follow-up for patients aged <55 years to >65 years, who underwent TKA with a CR/ PS TKS. We hypothesized that age influences overall post-TKA outcomes, such as an increased rate of revision with increased pain, and diminished QoL.

METHODS

Study device

The CR/PS TKS (Maxx Orthopaedics Inc. Plymouth Meeting, Pennsylvania, USA) is an artificial prosthetic TKA device. Femoral components are made of cobalt-chromium-molybdenum (CoCrMo) alloy and offer choice of a femoral component CR/PS, a tibial component (metal backed and all-poly designs) and an all-poly patellar component.[18] The systems are approved by DCGI, cleared under 510k by US FDA and carry Conformité Européene (CE) mark. The thin anterior flange and 6° patellar groove assure smooth patellar tracking and efficient bone preservation. Both the left and right femoral components offer various sizes and complement the tibial sizes. The CR/PS TKS is designed to provide greater flexion while allowing bone-conservation. Furthermore, the femoral component sizing of the implant has been optimized to provide anthropomorphic fit as per the patient's size and stature.[18]

At sites that adopted the CR method, CR components were implanted and those who used PS method, PS components were implanted.

Population and methods

This is a prospective, multi-centre assessment of the available CR/PS TKS, a multi radii knee conducted between November 2016 and January 2019. It is a part of the ongoing Freedom 400 study (CTRI No: CTRI/2016/11/007455) held at various esteemed institutions in India such as MS Ramaiah Medical College and Hospital and MS Ramaiah Memorial Hospital in Bengaluru, Karnataka, India; Apollo hospital, Hyderabad, SVS medical college in Mahbubnagar, Telangana, India; Wockhardt hospitals, Mumbai Central, India; Max Superspeciality hospital, Shalimar Bagh, Delhi, and Naveda healthcare Centre, Delhi, India. Prior to study enrolment, the local review board at each site approved the research. Every patient included in the study gave their prior, signed, informed consent and study was performed in accordance with the principles listed under the declaration of Helsinki and international conference on harmonization (ICH) good clinical practice (GCP).

Endpoints

Implant survivorship and cumulative revision rate were primary safety goals. Secondary endpoints: 1. KSS; 2. WOMAC pain; 3. ROM, (this evaluation will show the long-term effect of the CR/PS TKS on joint ROM); 4. short form health survey questionnaire (SF-36); 5. standard anteroposterior and lateral x-rays. independent observers assessed radiolucent lines, osteolysis of the femoral and tibial bone stock, and implant placement; 6. adverse events. All primary and secondary objectives were assessed from baseline to 6 weeks, 6 months, 1-, 3 years post-operatively, including radiographic analysis.

Inclusion criteria

Patients suffering from primary OA, rheumatoid arthritis, advanced degenerative disease of either knee. Male or non-pregnant female aged 18 years or older (maximum 85 years) at the time of study and is willing and able to provide written informed consent. Patients willing and able to comply with postoperative scheduled clinical and radiographic evaluations were included.

Exclusion criteria

Exclusion criteria for the study: (i) Subject with a BMI greater than or equal to 40, (ii) patient with an active infection within the affected knee joint, (iii) patients needing bilateral TKA, (iv) patients needing patellar re-surfacing, (v) with neuromuscular or neurosensory deficiency that limited the ability of the patient to evaluate the safety and efficacy of the device, (vi) subject with a known sensitivity to device materials.

Statistical analysis

The statistical analysis was performed on an intent-to-treat basis. Implant failure was defined as revision of the femoral, tibial, or patellar component attributable to any

reason. Changes in KSS, ROM, and WOMAC scores between the baseline and follow-up periods were analysed and results are reported as mean±standard deviation for continuous variables and as number (%) for categorical variables. Continuous variables with a normal distribution are compared using paired t test for dependent samples or the Wilcoxon signed rank test if a normal distribution cannot be assumed. Result is significant at $p<0.05$.

RESULTS

Baseline characteristics

A total of 300 patients underwent TKA using CR/PS TKS and were randomized into younger adult aged <55 years (n=69), older adults aged between 55 years to <65 years (n=92) and elders ≥65 years (n=139). Of the total patients, 293 patients (98%) completed 3 years follow-up with lost to follow-up (LTF) and consent withdrawal reported in older adults (2 LTF and 4 consent withdrawal) and 1 consent withdrawal in elders' group. In such case last follow-up observation was carried forward and is presented in result (Table 1).

The mean age of patients in young adults was 49.80±6.53 years (youngest patient aged: 26.7 years and oldest patient aged 54.9 years) in older adults, 60.46±2.8 years (youngest patient aged: 55.3 years, oldest patient aged 64.8 years) and in elder group was 71.21±4.25 years (youngest patient aged: 65 years and oldest patient aged 85.2 years) (Table 1). Groups were women populated as shown in Figure 1.

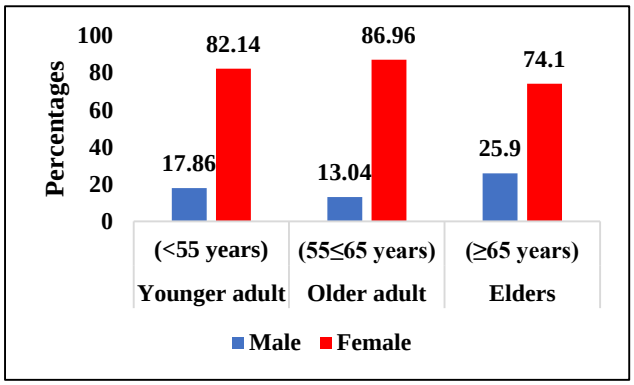

Figure 1: Percentage distribution of male and female population in different groups.

Among 3 groups 89.3%, 98.9% and 97.8%, respectively suffered from end-stage OA, 7.14% (younger adults) and 1.4% (elders) suffered from rheumatoid arthritis (Table 1). Co-morbidity included diabetes mellitus (14% and 20.9% in older adults and elder groups, respectively), hypertension (21%, 56.5%, 48%, respectively), and previous joint surgery was reported in 1 adult in younger cohort, in 8-older adults and in 29 in elder group. Medical history is shown in Table 1, 100 CR knees (younger adults: 31, older adults: 24 and elders: 45) and 200 PS knees (younger adults: 38, older adults: 68 and elders: 94) were implanted (Figure 2).

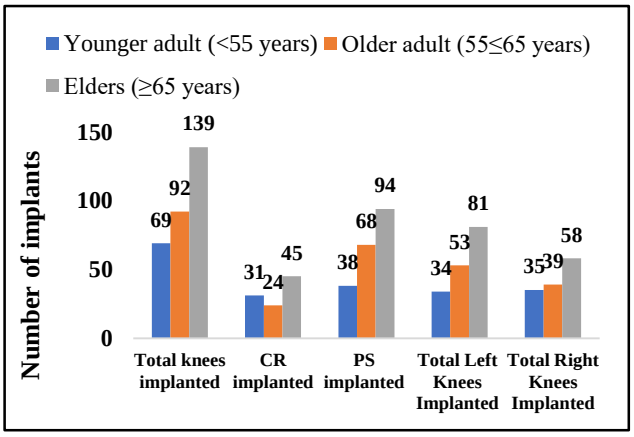

Figure 2: Total number of knees implanted in patients undergoing TKA.

Primary endpoints: implant survivorship and cumulative revision rates

No cases of removal or replacement of any components of study device were reported until the completion of the 3-year follow-up. Thus, implant survival was 100% up to the 3-year follow-up. In the anteroposterior view of the weight bearing knee of those who completed 3 years follow-up duration statistically significant improvements ($p<0.001$) were seen in the tibiofemoral angle, upper tibial varus, upper tibial bone loss and lateral view at all timepoints until the 3-year follow-up (Figure 3).

Figure 3 (A and B): Panel A represents pre-op X-ray showing medial proximal tibial angle (MPTA angle: 85°) and lateral distal femur angle (LDFA angle: 88°); Panel B represents full-length scanograms of post-op knee implanted with CR/PS knee system with improved MPTA angle: 88°, LDFA angle: 89° and hip-knee-axis (HKA) angle of 178°.

KSS stratified by age

Among objective performance indicators, patients showed a statistically significant improvement in mean clinical

KSS. There was no significant difference among the group for follow-up duration of 3 years despite having significant difference at baseline clinical KSS values (at baseline p=0.025) (Table 2). However, shown in Table 2, in younger adults KSS score significantly improved from pre-op 35.21±13.91 to 71.56±14.87 (6 weeks), 84.73±11.12 (1 year) and 91.17±10 at 3 years (p<0.001). Similar trend observed in older (baseline: 33.67±16.02 to 3 years: 93.17±6.43; p<0.001) and elders (baseline: 30.95±16.64 to 3 years: 91.83±8; p<0.001). Functional KSS at 3 years among 3 cohort was seen to significantly improve (Table 2) to 98.61±4.79 (younger adults), 98.90±3.62 (older adults) and 98.21±4.42 (elders) from their baseline scores 29.29±20.4 (younger adults), 28.15±21.26 (older adults) and 27.05±21.46 (elders) with p<0.001. At 1 year we observed a significant improvement and difference among groups with younger patients showing higher rates of functional scoring than those of older and elder patients (younger adults: 92.50±10.21; older adults: 85.42±14.55 and elders: 89.44±11.57) with p=0.003.

ROM stratified by age

There was a significant baseline difference in ROM among elderly and younger cohort (p=0.002) where elderly groups had poorer and restricted movement (93.42±20.23°) than their younger counterparts (97.26±12.20 and 98.82±16.85). For 3 years follow-up, we noticed uniform improvement among patients, irrespective of their age groups. However, significant improvement in patients with lower ROM at baseline among all 3 groups was noted. In younger adults: baseline ROM was 97.25°±12.74° which improved to 114.32°±12.66° at 1 year with further increase to 121.05°±7.74° at 3 years. Similar significant ROM improvements were noted among older adults 96.54°±18.53° (baseline) to 115.18°±10.51° (1 year) and 123.22°±4.26° (3 years). Among elders, increased trend in ROM was noted 95.60°±21.04° (baseline), 116.40°±11.32° (1 year) and 122.43°±5.8° (3 years). Figure 4 represents ROM at all time points in different groups showcasing improvement in ROM in patients undergoing TKA with CR/PSTKS.

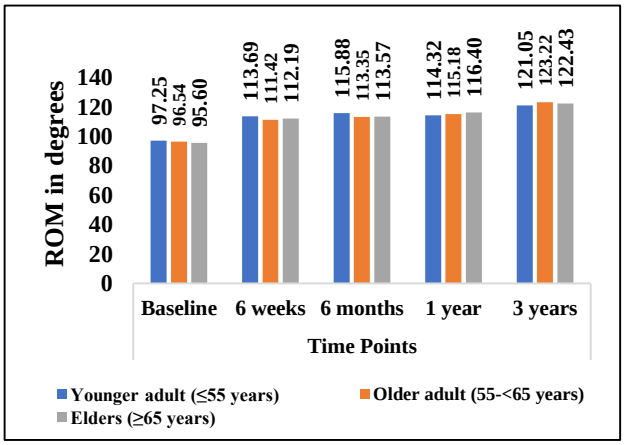

Figure 4: ROM at baseline and post-operative follow-up period in different age groups.

WOMAC scores stratified by age

Patients with greater satisfaction levels after TKA reported lower WOMAC scores components such as pain, stiffness, and degree of difficulty (Figure 5). Same trend of lower post-op scores but statistically significant differences between pre-op and post-op follow-up period was noticed which observed to be lowest at 3 years follow-up duration among all 3 cohorts (younger and older adults, and elders).

SF-36 questionnaire results stratified by age

Patient-oriented outcomes measures were analysed using SF-36 where physical functioning, role limitations due to physical health, pain (Figure 6); role limitations due to emotional problems, energy/fatigue, emotional well-being, social functioning, pain, general health, health change (Table 3) are reported and was observed to significantly improve with time, increasing the satisfaction levels and QoL pf patients.

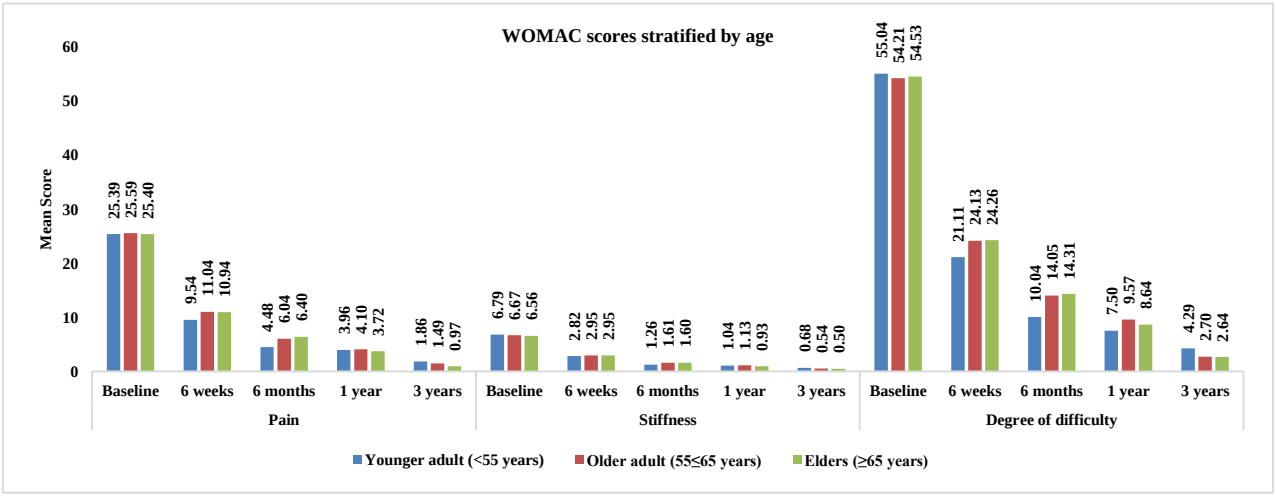

Figure 5: Post-operative and follow-up WOMAC scores of patients in different age groups.

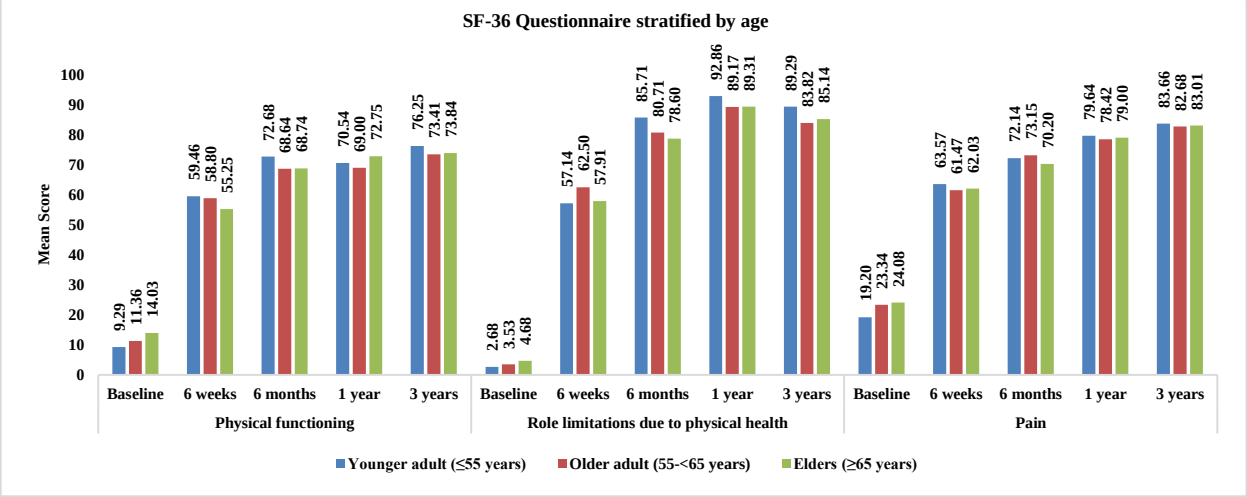

Figure 6: SF-36 scores showcasing the improved QoL with improved physical functioning, reduced pain and reduction in role limitation due to physical health.

Adverse events

At 3 years, 1 patient in older adult group died with no known reasons reported, while there was no death, or any other serious adverse events reported in other groups. Earlier follow-up periods of 6 weeks, 6 months and 1 year follow-up remained uneventful. There was 1 suture-line abscess reported in older adults at 1 year follow-up and patient was hospitalized for the same and debridement was done to remove unabsorbed vicryl and suture under local anaesthesia. Patient was successfully discharged, and no further complications was reported in this patient till the last follow-up period. No cases of deep vein thrombosis or wound-site infection were observed in any of the patients.

Table 1: Baseline and primary indications of patients.

Variables	Younger adult (<55 years)	Older adult (55≤65 years)	Elders (≥65 years)	P value
Total no. of patients, N	69	92	139	
Age (in years), mean±SD (min, max)	49.80±6.53 (26.74, 54.95)	60.46±2.8 (55.25, 64.80)	71.21±4.25 (65.00, 85.24)	<0.001
BMI (kg/m^2)				
Mean±SD	27.18±4.08	27.90±4.85	26.47±4.58	0.014
<30	54 (78.57)	57 (61.96)	110 (79.14)	
30-35	12 (17.86)	27 (29.35)	22 (15.82)	0.081
>35	3 (3.57)	8 (8.69)	7 (5.04)	
Heart rate (bpm)	81.54±10.58	82.92±11.82	81.65±11.68	0.148
Systolic blood pressure (mmHg)	128.00±15.57	131.18±15.49	133.96±14.72	0.007
Diastolic blood pressure (mmHg)	78.18±6.95	79.5±9.07	79.72±8.45	0.432
Primary diagnosis, N (%)				
OA	62 (89.29)	91 (98.91)	136 (97.84)	
Rheumatoid arthritis	5 (7.14)	0 (0.00)	2 (1.44)	0.214
Others	2 (3.57)	1 (1.09)	1 (0.72)	
Advanced degenerative joint disease left knee	2 (3.57)	0 (0.00)	0 (0.00)	-
Advanced degenerative disease right knee	0 (0.00)	1 (1.09)	1 (0.72)	-
Medical history, N (%)				
Diabetes mellitus	0 (0.00)	13 (14.13)	29 (20.86)	
Hypertension	17 (24.63)	52 (56.52)	67 (48.20)	
Smokers	20 (28.98)	1 (1.09)	1 (0.72)	
Dyslipidemia	0 (0.00)	5 (5.43)	2 (1.44)	
Chronic renal insufficiency	1 (3.57)	2 (2.17)	1 (0.72)	
Pulmonary edema	0 (0.00)	1 (1.09)	1 (0.72)	
Ischemic heart disease	0 (0.00)	4 (4.35)	6 (4.32)	

Table 2: KSS stratified by age groups.

Study endpoints	Time	Younger adult	Older adult	Elders
Clinical KSS, (mean±SD)	Baseline	35.21±13.91	33.67±16.02	30.95±16.64
	6 weeks	71.56±14.87	69.65±15.03	73.37±15.82
	P value (Baseline vs 6 weeks)	<0.001	<0.001	<0.001
	6 months	81.58±13.50	77.05±14.44	77.68±14.04
	P value (Baseline vs 6 months)	<0.001	<0.001	<0.001
	1-year	84.73±11.12	83.50±11.30	83.18±11.90
	P value (Baseline vs 1 year)	<0.001	<0.001	<0.001
	3 years	91.17±10.00	93.17±6.43	91.83±8.1
	P value (Baseline vs 3 years)	<0.001	<0.001	<0.001
Functional KSS, (mean±SD)	Baseline	29.29±20.40	28.15±21.26	27.05±21.46
	6 weeks	80.60±16.60	72.29±21.72	77.12±19.25
	P value (Baseline vs 6 weeks)	<0.001	<0.001	<0.001
	6 months	85.63±14.54	79.80±18.02	81.59±15.92
	P value (Baseline vs 6 months)	<0.001	<0.001	<0.001
	1-year	92.50±10.21	85.42±14.55	89.44±11.57
	P value (Baseline vs 1 year)	<0.001	<0.001	<0.001
	3 year	98.61±4.79	98.90±3.62	98.21±4.42
	P value (Baseline vs 3 years)	<0.001	<0.001	<0.001

Table 3: SF-36 questionnaire results stratified by age.

Study endpoints	Time	Younger adult (<55 years)	Older adult (55≤65 years)	Elders (≥65 years)
Role limitations due to emotional problems, (mean ± SD), (n=subjects)	Baseline	8.33±26.64	26.81±42.29	21.34±38.91
	6 weeks	57.14±48.73	62.32±45.62	60.67±45.97
	P value (Baseline vs 6 weeks)	<0.001	<0.001	<0.001
	6 months	86.90±30.55	81.52±32.91	78.42±38.46
	P value (Baseline vs 6 months)	<0.001	<0.001	<0.001
	1-year	92.86±21.00	87.04±28.57	90.34±25.85
	P value (Baseline vs 1 year)	<0.001	<0.001	<0.001
	3 years	94.05±13.00	89.41±18.70	89.86±18.28
	P value (Baseline vs 3 year)	<0.001	<0.001	<0.001
Energy/fatigue, (mean±SD), (n=subjects)	Baseline	41.43±23.29	43.26±20.36	45.86±22.33
	6 weeks	66.43±14.90	63.37±16.86	64.17±14.90
	P value (Baseline vs 6 weeks)	<0.001	<0.001	<0.001
	6 Months	67.50±10.84	67.17±15.27	65.43±14.17
	P value (Baseline vs 6 months)	<0.001	<0.001	<0.001
	1-year	67.50±13.91	66.06±15.11	66.23±13.41
	P value (Baseline vs 1 year)	<0.001	<0.001	<0.001
	3 years	69.29±15.07	67.29±16.59	69.06±15.57
	P value (Baseline vs 3 years)	<0.001	<0.001	<0.001
Emotional well-being, (mean±SD), (n=subjects)	Baseline	59.71±26.28	58.52±22.66	61.35±23.86
	6 weeks	77.71±11.59	73.78±14.79	75.97±15.91
	P value (Baseline vs 6 weeks)	<0.001	<0.001	<0.001
	6 months	80.14±10.64	77.09±14.08	76.43±13.69
	P value (Baseline vs 6 months)	<0.001	<0.001	<0.001
	1-year	76.29±15.04	75.24±15.14	78.70±13.28
	P value (Baseline vs 1 year)	<0.001	<0.001	<0.001
	3 years	78.71±15.09	76.47±16.16	75.80±14.98
	P value (Baseline vs 3 years)	<0.001	<0.001	<0.001
Social functioning, (mean±SD), (n=subjects)	Baseline	28.57±22.27	38.04±24.72	34.80±25.84
	6 weeks	66.07±15.16	66.30±15.48	66.55±16.57
	P value (Baseline vs 6 weeks)	<0.001	<0.001	<0.001
	6 months	76.79±16.91	72.69±16.15	73.83±15.26
	P value (Baseline vs 6 months)	<0.001	<0.001	<0.001

Continued.

Study endpoints	Time	Younger adult (<55 years)	Older adult (55≤65 years)	Elders (≥65 years)
	1-year	78.13±17.22	76.81±18.12	78.62±18.01
	P value (Baseline vs 1 year)	<0.001	<0.001	<0.001
	3 years	84.82±16.44	82.94±15.17	83.33±14.03
	P value (Baseline vs 3 years)	<0.001	<0.001	<0.001
General health, (mean±SD), (n=subjects)	Baseline	44.11±17.90	47.01±17.27	45.79±17.40
	6 weeks	68.57±13.60	69.08±13.48	68.85±12.31
	P value (Baseline vs 6 weeks)	<0.001	<0.001	<0.001
	6 months	72.14±10.31	71.58±11.26	72.88±11.89
	P value (Baseline vs 6 months)	<0.001	<0.001	<0.001
	1-year	73.04±11.25	72.33±12.55	71.70±10.90
	P value (Baseline vs 1 year)	<0.001	<0.001	<0.001
	3 years	75.71±11.76	78.00±13.48	75.80±12.35
	P value (Baseline vs 3 years)	<0.001	<0.001	<0.001
Health change, (mean±SD), (n=subjects)	Baseline	20.54±19.31	21.47±19.11	25.00±21.91
	6 weeks	85.71±12.60	81.79±18.57	83.45±16.91
	P value (Baseline vs 6 weeks)	<0.001	<0.001	<0.001
	6 months	91.07±12.20	89.13±13.00	87.95±14.23
	P value (Baseline vs 6 months)	<0.001	<0.001	<0.001
	1-year	91.96±11.89	92.50±12.11	92.57±11.47
	P value (Baseline vs 1 year)	<0.001	<0.001	<0.001
	3 years	88.39±18.61	91.18±17.12	93.30±13.01
	P value (Baseline vs 3 years)	<0.001	<0.001	<0.001

DISCUSSION

Our 300-patient prospective multicentre study demonstrates that CR/PS TKS implantation is efficacious in patients with end-stage OA. Patients who presented with multiple comorbidities were treated with primary unilateral TKA. This article takes a significant posture regarding the impact of age on PROMs after TKA including their level of satisfaction, such as the KSS, WOMAC, and SF-36 questionnaire, which evaluate QoL, radiographic analysis, ROM, clinical and functional outcomes. Understanding and analysing the patient outcomes post-TKA in different age groups is an important criterion for not only patients but also surgeons. This study on CR/PS TKS outcomes might play the important role for determining the advantages and benefit-risk ratio of choice of implant and age-factor while assisting in setting the accurate and precise expectation levels post-TKA.

Generally, mechanical wear and tear are found to be higher in younger patients due to their high demands of daily activities. Many studies report high and early implant failure and revisional surgeries in younger population.[19,20] In our younger patient series, we found no such difference in implant failure, neither did we notice any complications related to implant, site abscess, wound infections, aseptic loosening, or any other complications leading to revision till 3 years of follow-up period across all age group. However, in most TKA cases, implant survival beyond 5 years seems to decrease and since the follow-up of these patients in ongoing, it would be interesting to observe the overall survivorship and rate of revision TKA in these cohorts.[21,22] In a retrospective analysis of patients grouped age-wise reported higher rates of revision and 23% revision rates at 5 years, significant higher readmission rates (within 90 days) in younger cohort (younger than 40, 40-49, 50-59).[19] However, in our prospective study, none of the patients younger than 55 or 55 to 65 were re-admitted to hospital for post-TKA related issues.

Prior reports on primary TKAs have shown high success rates in elderly in comparison to their younger counterparts with extreme or severe deformity.[23,24] In our group analysis we observed no such differences. Though elder groups had greater baseline stiffness, limited ROM, and poor QoL (role limitation due to functional, emotional well-being) but there was a significant post-TKA improvement in this age group, we found similar results in younger and older adults. Asian patients show less satisfaction level if flexion lesser than 120° is achieved as the need for daily activities such as squatting, sitting cross-legged, kneeling, or climbing stairs need a flexion of 105° and more. In our patient groups, preoperative flexion across groups was 97.25°±12.74° (younger adults), 96.54°±18.53° (older adults), 95.60°±21.04° (elders) which significantly improved to 121.05°±7.74°, 123.22°±4.26°, 122.43°±5.8°, respectively.

Asians are developing more comorbidities like diabetes, hypertension, and obesity, yet their rates are lower than those in the South Pacific, Western, and Europe.[25] Post-operative complications are prevalent in these comorbid population as reported by Jain et al and can act as separate conjunctures for post-TKA poor outcomes. However, Bin Abd Razak et al did not find these factors to be a significant contributor and evaluated only the number of comorbidities in their population pool and we find the significant similarities with our prospective study where

these comorbidities were evaluated as numbers and presented in Table 2 and we were unable to co-relate them to the factors for influencing the outcomes for our study.[25,26] Over the period of 3 years follow-up none of the operating sites reported any adverse events such as implant failure or revision or implant wear due to these multifactorial comorbidities in all the 3 age groups.

Despite being a multi centric study with surgeons operating at each site with different surgical techniques/ alignment strategies, no significant difference in the clinical and functional outcomes were observed. High-quality implant such as CR/PS TKS can be the major factor for positive and impeccable 3 years results. Most of the registries report the long-term of more than 6-10 years for implant failure, or other complications. According to the findings of Sharkey et al advancements in the design and material decreases the frequency of implant failure following TKA.[27] Efficacy of TKA is also measured by objective and subjective methods.[3] We found that KSS and WOMAC scores improved significantly in all age groups including younger population in which the significant improvement from their pre-operative pain score ($p<0.001$) was noted. The higher level of patient satisfaction reported by young adults concerning pain relief and functional restoration corresponds with earlier research. A large prospective study reported lower QoL and higher pain scores in U.S. patients younger than 55 years and mental health scores than older patients.[7] One year follow-up among these patients showed better clinical and functional outcomes. In contrast, our study of 300 prospectively enrolled patients showed lower pain scores, higher WOMAC scores and better QoL among patients younger than 55 years and it remained the same across all age groups in our study. The difference among these studies may be due to difference in type of implants used as well as demographic difference in patients (Asian population) enrolled in the study.

Limitations

The present investigation is subject to some limitations, one of which pertains to the relatively smaller sample size of younger patients in comparison to elderly group which may have introduced inherent biases and may have influenced the statistical power of the analysis. Further research is necessary to validate and enhance these findings through the use of bigger sample size that are equal and randomized. Moreover, conducting research on the influence of distinct patient attributes, such as BMI, coexisting medical conditions, and levels of physical activity, on TKA results has the potential to provide significant knowledge for the development of customized treatment strategies.

CONCLUSION

This comprehensive analysis comparing the 3 years primary TKA results in young and older patients to elderly patients with similar surgical and functional outcomes shows the safety and efficacy of CR/PS TKS. Younger patients had higher satisfaction levels, functional, and clinical results, and no revisions throughout the 3-year follow-up period, which is promising. Our study found significant post-operative recovery and improvement in elderly patients despite higher comorbidities and lower baseline ROM scores. Our extensive cohort analysis of individuals of various ages supports the efficacy and durability of the CR/PS TKS strategy. The 3-year follow-up showed no radiological implant failure and no implant-related long-term issues. These findings emphasize the importance of personalized treatment strategies for young adults and older patients undergoing TKA. Implant selection and surgical techniques should be carefully tailored to address the specific needs of the patients.

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