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# Numbness Following Total Knee Arthroplasty: Role of Incision Length And Position - A Randomized Study

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**Background:** One of the symptoms annoying patients after total knee replacement (TKR) is numbness around the operative scar. Some studies have shown that altering the incision in terms of placement or length may decrease the incidence of numbness. It still remains unknown whether numbness affects patient-reported outcomes.

**Methods:** We conducted a randomized study to compare a short-length incision (n = 50) and a lateral exit incision (n = 50) with a standard midline TKR incision (n = 50) in terms of the incidence of numbness and its progress over 1 year of follow-up. Our secondary objective was to look at the involved zone, area of numbness, and secondary symptoms. We also looked at patient-reported outcome in terms of satisfaction in all groups using a visual analog scale and Forgotten Joint Score.

**Results:** At 3 months postoperatively, the incidence of numbness was least in the lateral exit group: 46.2% as compared to midline (62%) and short (58.3%), but the difference was not significant ($p = 0.07$). At 6 months, the short incision group had a significantly lower incidence (8%) of residual numbness as compared to 30% in the other two groups ($p = 0.003$). At 1 year, most patients recovered sensation loss and had similar function.

**Conclusions:** Placement or length of an incision did not significantly affect the incidence of numbness; however, the short incision led to early recovery of numbness. At 1 year of follow-up, most patients did not complain of loss of sensation and had similar functional outcome.

**Keywords:** *Total knee replacement, Incision, Numbness, Incidence*

Total knee replacement (TKR) is an extremely successful surgical intervention. It provides life-altering outcomes for the patient and has tremendous socioeconomic impact on the community.[1-3] TKR optimally achieves its primary aim of pain relief and restoration of functions; however, overall patient-reported satisfaction has been the focus of attention in recent times.[4,5] With increasing use of this procedure across all age groups and disease types, it is observed that some proportion of them (15%–20%) have some residual symptoms, which hampers satisfaction.[6] Most of them have good functional outcomes, but few have low satisfaction scores.[6,7] Many researchers are now looking at various reasons for patient dissatisfaction. Presently known causes for low patient-reported satisfaction are residual symptoms.[7-9] One of the frequently reported complaints of patients undergoing TKR in the first year of

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follow-up is altered sensation over the knee, which might compromise patient-reported outcome. Altered sensation around the operative scar is reported in up to 50% of patients even at 1 year of follow-up.[10,11] It has been related to injury to infrapatellar branches of the saphenous nerve, which leads to dysesthesias and even anesthesia in its area of innervation.

The standard incision for TKR is a 15–20 cm vertical incision created in the midline centered over the patella and extending inferiorly till the tibial tuberosity. Its proximal extent varies depending on the difficulty of exposure. There is sufficient literature, which has tried to correlate placement and length of an incision and the occurrence of numbness and dysesthesias in TKR patients.[10-14] However, most studies have shown that it does not affect functional outcomes.[13,15,16] A recent prospective case control study by Hassaballa et al.[17] has advocated use of a shorter incision to minimize numbness. There has been some evidence that decreasing the length of the incision or placing it lateral to the patella may avoid skin numbness and dysesthesia. However, there are a few randomized studies done to date to compare the length and placement of skin incisions in terms of incision-related numbness. Our primary objective was to look at the effect of decreasing and lateralizing the skin incision of TKR as compared to the standard midline approach in terms of the incidence and area of numbness. Secondary objective was to look at differences in functional outcome depending on incision.

## METHODS

This study was carried out at Joint Replacement Centre of a multispecialty tertiary care military hospital as a randomized study after obtaining Ethical Committee approval (No. AFH/15/2706/Orth). Informed consent was obtained from all included patients.

### Sample Size Calculation

Based on literature review, the incidence of numbness after a standard midline skin incision can vary from 50% to 100%.[10-12] However, on average, 60% is the incidence of incision-related skin numbness after TKR. The same being our primary outcome was used to calculate the required sample size to be able to detect a reduction to 30%. Using Stata ver. 12 (StataCorp., College Station, TX, USA), we calculated that with a two-sided alpha error of 0.05 to give our study 80% power to look for any difference more than this, we would need 49 patients in each group if it were to be a random allocation. We planned to recruit 50 cases in each group; standard midline incision group (midline group), short midline incision group (short group), and lateral incision groups (lateral group).

### Patient Recruitment

From Feb 2016 to December 2017, all consenting patients who reported to our center requiring primary unilateral TKR underwent a standardized preoperative risk screening, followed by preanesthetic assessment. The patients were screened for cardiac, pulmonary, renal, delirium and transfusion risks. Based on the risk profile, they were optimized (Fig. 1). Following risk screening and optimization, patients underwent a preanesthetic assessment. Excluded were patients with (1) severe deformity, post traumatic arthritis in whom a short incision was not possible, (2) inflammatory arthritis predisposing to wound healing issues and a preexisting skin lesion, (3) any neurological condition compromising outcome assessment, (4) no compliance with 1-year follow-up. They were randomized by a study nurse (PS) into midline, short, and lateral groups using computer-generated block random sequence, instituted using opaque sealed envelopes.

### Arthroplasty Protocol

One fellowship-trained arthroplasty surgeon (VK) with 15 years of high-volume arthroplasty practice, performing close to 500 operations every year, led the surgical team. All operations were performed under spinal anesthesia. At induction, all patients received weight- and comorbidity- adjusted doses of Cefazolin injection and an aminoglycoside. In all cases, one dose of antibiotic was repeated 8 hours after surgery. All patients received an injection of tranexamic acid 1 gm at induction and one dose was repeated 3 hours after surgery. To minimize postoperative nausea and vomiting and improve pain control, an injection of dexamethasone 8 mg was given at induction and was repeated next day morning.[18] All operations in the midline group were performed using a standard midline skin incision, starting 8–10 cm above upper pole of the patella to the tibial tuberosity. In the short group, the length of the incision was restricted to less than a few centimeters above the patella, just 3–5 cm short of tibial tuberosity, restricting the total length to less than 15 cm. In the lateral group, the top of the incision was similar to midline, but at the level of the patella, it was turned laterally to finish lateral to the tibial tuberosity (Fig. 2). In all groups, the skin incision was followed by medial parapatellar arthrotomy. In the lateral group, as the lower end of the incision was lateral to tibial tuberosity, the surgeon was required to raise a small skin flap to start the arthrotomy medial to the tibial tuberosity unlike in the other two groups, which had

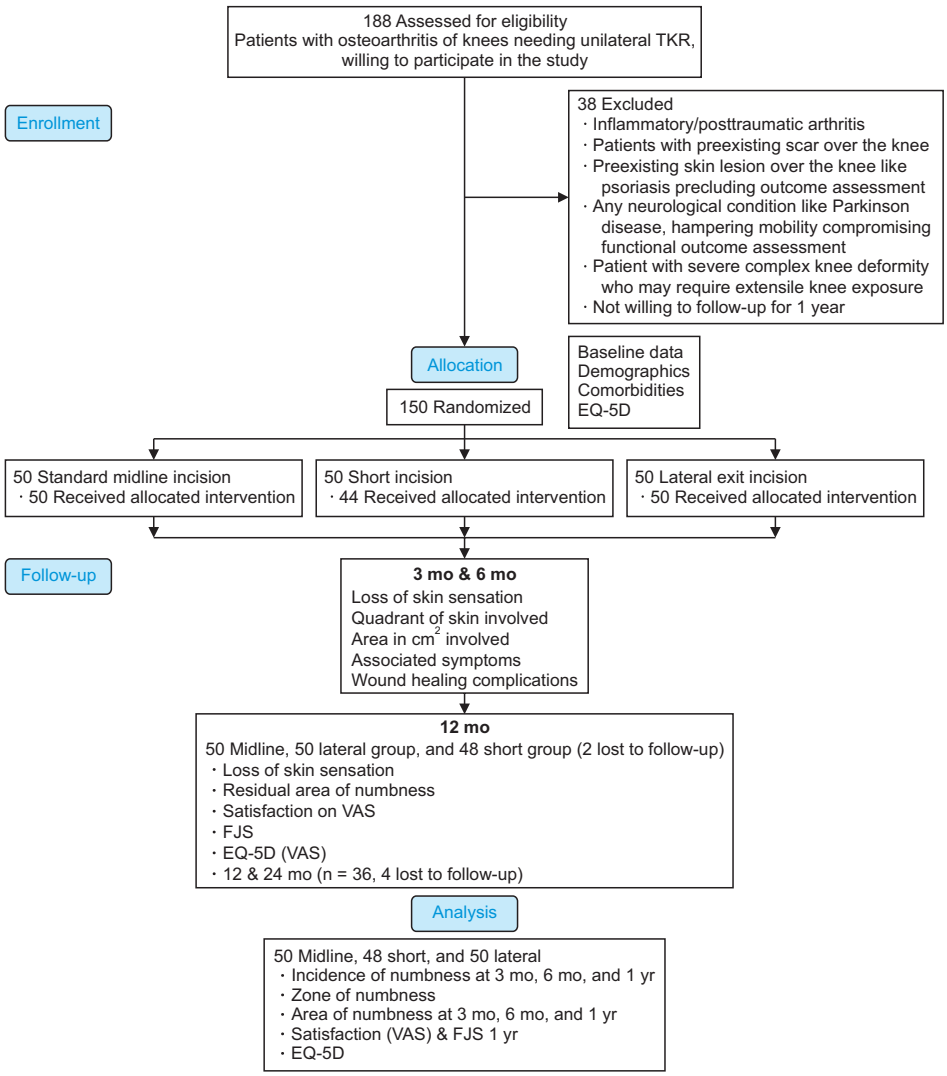



**Fig. 1.** Consolidated Standards of Reporting Trials (CONSROT) diagram of the study showing enrollment, allocation, follow-up, and analysis of the patients. TKR: total knee replacement, EQ-5D: EuroQol five-dimensional, VAS: visual analog scale, FJS: Forgotten Joint Score.

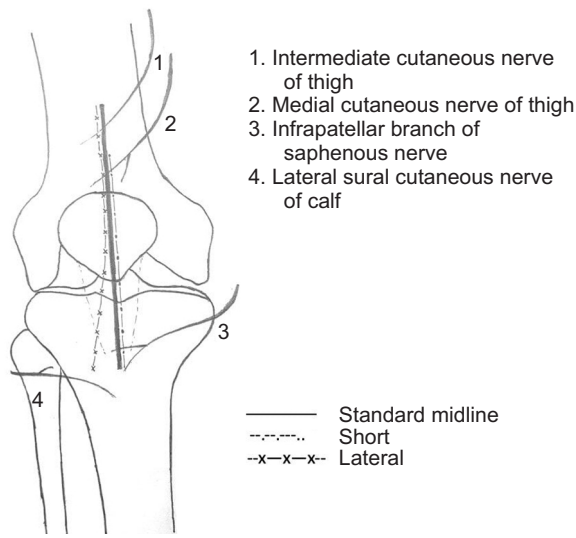



**Fig. 2.** Diagram showing placement of skin incisions and cutaneous nerve supply to the anterior aspect of the knee.

to be done carefully to avoid skin healing complications. In patients randomized to short group, all attempts were made to keep the incision short, but in some cases (n = 6), due to preoperative difficulty, it was extended to the standard length midline incision; yet, following the intention-to-treat principle, they were maintained and analyzed in the short incision group. Most operations were performed using a cruciate-substituting ultracongruent knee implant without patella resurfacing. Arthrotomy was closed using a barbed suture and all wounds were dressed using silver-impregnated hydrocolloid dressing. No drains were used and postoperatively the limb was elevated with the knee in flexed position for 24 hours.

All patients were risk screened for deep vein thrombosis as per risk score sheet[19] and selected for pure mechanical or mechanical and chemoprophylaxis. Patients were ambulated on the first postoperative day and put

on an accelerated rehabilitation protocol. Effective pain control was achieved by starting preemptive multimodal pain medication (oral, transcutaneous, and per rectal) preoperatively. Narcotics and injectable non-steroidal anti-inflammatory drugs were sparingly used as rescue analgesia. Most patients were discharged within 2–4 days of their surgery and all the included patients were followed up at 6 weeks, 3 months, 6 months, and 1 year following surgery as per planned schedule.

**Follow-up Assessment**

At each time point of follow-up, apart from looking for any medical or procedure-related complications, we specifically looked for any incision-related symptoms as per the proforma designed (Fig. 3). The primary information gathered was occurrence of numbness, site and extent of skin anesthesia or dysesthesia, related symptoms, and any skin changes. During follow-up, trained physiotherapists (SK and AS) and a nurse coordinator (PS) gathered information as per standardized postoperative follow-up proforma before evaluation by the surgeon (VK). To evaluate patient-reported outcome, we used Forgotten Joint Score (FJS) and satisfaction on a visual analog scale (VAS) at 1 year to compare recovery between the groups. EuroQoL five-dimensional instrument (EQ-5D) VAS score was used to evaluate general quality of life at 1 year.

**Statistical Analysis**

Statistical analysis was performed with Stata ver. 12 (Stata Corp.). The distributions of patient demographics including Functional Comorbidity Index were compared between study groups to identify any differences that might confound outcome comparisons. The mean, standard deviation, and range were presented for continuous parameters. Two-sample independent *t*-test or the nonparametric Mann-Whitney Wilcoxon test was used to compare continuous variables between the two groups according to the distribution of the variables. All the outcomes were discrete, hence frequency and percentage were calculated. Differences in discrete outcomes between the two groups were assessed by chi-square test or Fisher's exact test where appropriate. Given that this study had multiple related outcome parameters, statistical significance was only calculated for the primary outcome, which is occur-

**Post knee replacement numbness study**

| | | |
|---|---|---|
| **Name:** | **Age:** | **Sex:** Male/Female |
| **DOS:** | **Side:** Right/Left | |
| **Data of evaluation:** | | |

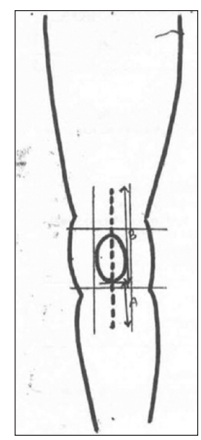
**Type of incision: Lateral lower exit TKA / Medial exit TKA / Medial UKA**

1. Please draw the scar on the picture on the reverse of this shoot.
2. Whether the patient complains about the numbness around the surgical scar: **Yes/No**
3. Whether the patient responds to leading questions about numbness around surgical scar: **Yes/No**

**If you answered "No", you do not need to proceed.**
**Thank you for your time**

4. When the numbness did starts? Immediately after TKR/after _____weeks.
5. Is it increasing or decreasing over time? Decreasing/Increasing/No change.
6. Numbness severity scale **0-1-2-3-4-5-6-7-8-9-10 (0 is normal and 10 is very severe)**
7. Please shade the area of numbness on the picture on the reserve of this shoot.
8. Does this numbness cause any discomfort to you? **Yes/No**
9. If you answered "**yes**". Please elaborate how it causes discomfort. **Yes/No**

10. Are you happy with your knee replacement? **Yes/No**
11. If you answered "**No**" is this due to numb patch? **Yes/No**
12. Please mark you level of satisfaction with surgery on this scale.
"0" are totally dissatisfied to "**10**" is totally satisfied.
0-1-2-3-4-5-6-7-8-9-10



**A =**
**B =**
**A + B =**
**Length of incision**

**Fig. 3.** Picture of the proforma used to collect patient data including follow-up. TKA: total knee arthroplasty, UKA: unicompartmental knee arthroplasty, TKR: total knee replacement.

rence of numbness. All estimates of management effect were provided with their 95% confidence intervals. We also used correlation coefficients to look for interaction of numbness with patient-reported outcomes.

## RESULTS

From February 2016 to December 2017, a total of 150 patients were enrolled in the study. Fifty patients each were randomized to standard midline incision (midline group), short incision (short group), and lateral exit incision (lateral group). The patients in all three groups were similar in respect of demographic profile and comorbidities (Table 1). The age of patients ranged from 40 to 87 years with the mean age varying from 61 to 64 years. Seventy percent of the patients in all groups were female.

The mean length of incision was 15.02 ± 2.68 cm (range, 9.2–26.5 cm) in the midline group, 10.28 ± 1.53 cm (range, 8–18 cm) in the short group, and 15.03 ± 2.43 cm (range, 8.8–19.9 cm) in the lateral group. Patients were followed up at 3 months, 6 months, and 12 months postoperatively. The numbness started 0 to 8 weeks from the date of surgery. The mean time before patients started experiencing numbness was 1.9 weeks in the midline group, 2.1 weeks in the short group, and 1.4 weeks in the lateral group. At 3 months, 33 patients (62%) in the midline group, 28 patients (58.3%) in the short group, and 24 patients (46.2%) in the lateral group complained of numbness (Table 2). If the anterior aspect of the knee is divided into four quadrants with midpoint being the center of patella, the most common zone of involvement was inferolateral, followed by superolateral in all groups. Some patients, especially those in the midline group experienced numbness more often in superomedial than inferomedial quadrant (Fig. 4). Total area of numbness measured was 47.0 $cm^2$ in the midline group, 42.3 $cm^2$ in the short group, and 56.2 $cm^2$ in the lateral group.

Over the next 6 months, many patients recovered sensation. However, 17 patients (32.1%) in the midline group, 4 patients (8.3%) in the short group, and 15 patients (30.8%) in the lateral group still had numbness (Fig. 5). A significantly smaller number of patients had numbness at 6 months in the short group ($p = 0.003$). Of those who had residual numbness at 6 months, the area of numbness was 17.8 $cm^2$ in the midline group, 2.7 $cm^2$ in the short group,

**Table 1.** Demographic Profile, Comorbidities, and Preoperative Evaluation

| Variable | Midline group (n = 50) | Short group (n = 48) | Lateral group(n = 50) | *p*-value | |
|---|---|---|---|---|---|
| | | | | Midline vs. short group | Midline vs. lateral group |
| Age (yr) | 63.3 ± 8.82 | 61.3 ± 8.44 | 64.1 ± 8.59 | 0.37 | 0.50 |
| Sex (male : female) | 15 : 35 | 15 : 33 | 14 : 36 | 0.55 | 0.35 |
| Side (Rt : Lt) | 27 : 23 | 24 : 24 | 25 : 25 | 0.54 | 0.53 |
| BMI ($kg/m^2$) | 28.02 ± 4.53 | 28.78 ± 4.49 | 28.01 ± 3.75 | 0.21 | 0.86 |
| Functional comorbidity index | 1.09 ± 1.09 | 1.06 ± 0.88 | 0.94 ± 0.87 | 0.76 | 0.74 |
| Hypertension | 30 | 28 | 30 | | |
| Diabetes mellitus | 15 | 16 | 10 | | |
| COPD | 4 | 2 | 2 | | |
| CKD | 2 | - | 1 | | |
| CAD | 3 | 2 | 1 | | |
| Miscellaneous | 4 | 3 | 2 | | |
| ASA score (I : II : III : IV) | 4 : 40 : 6 : 0 | 10 : 29 : 9 : 0 | 7 : 35 : 7 : 1 | 0.17 | 0.61 |
| Hemoglobin | 11.84 ± 0.83 (11.1–14.8) | 11.77 ± 0.93 (11–15) | 12.37 ± 1.27 (11–16.5) | 0.38 | 0.06 |
| Length of incision (cm) | 15.02 ± 2.68 | 10.28 ± 1.53 | 15.03 ± 2.43 | 0.0001 | 0.92 |

Values are presented as mean ± standard deviation (SD), number, or mean ± SD (range).
Rt: right, Lt: left, BMI: body mass index, COPD: chronic obstructive pulmonary disease, CKD: chronic kidney disease, CAD: coronary artery disease, ASA: American Society of Anesthesiologists (grading of anesthesia risks).

**Table 2.** Pattern of Numbness in Three Groups

| Variable | Midline group | Short group | Lateral group | *p*-value | |
|---|---|---|---|---|---|
| | | | | Midline vs. short group | Midline vs. lateral group |
| Numbness around scar at 3 months | 33 | 28 | 24 | 0.42 | 0.07 |
| Trend from 3 to 6 months | | | | 0.63 | 1.00 |
| Decreasing | 14 | 16 | 14 | | |
| Same | 37 | 31 | 37 | | |
| Increasing | 2 | 1 | 2 | | |
| Numbness around scar at 6 months | 17 | 4 | 15 | 0.003 | 0.83 |
| Numbness around scar at 12 months | 2 | 1 | 0 | 0.53 | 0.25 |
| Start of numbness in weeks, median (range) | 1.92 (0–6) | 2.13 (0–8) | 1.44 (0–8) | - | - |
| Site of numbness | | | | | |
| IL | 16 | 15 | 12 | | |
| IM | 5 | 6 | 0 | | |
| SL | 5 | 1 | 5 | | |
| SL–IL | 2 | 5 | 6 | | |
| SM–IM | 5 | 1 | 1 | | |
| Area of altered sensation ($cm^2$) | | | | | |
| 3 Months | 47.02 | 42.30 | 56.22 | 0.34 | 0.58 |
| 6 Months | 17.80 | 2.74 | 36.11 | 0.003 | 0.99 |
| 12 Months | 2.57 | 0.34 | - | 0.60 | 0.15 |
| Mean numbness severity (scale 0–10) | | | | | |
| 3 Months | 2.32 | 2.54 | 2.25 | 0.60 | 0.70 |
| 6 Months | 1.28 | 0.29 | 1.84 | 0.002 | 0.47 |
| 12 Months | 0.11 | 0.02 | - | 0.60 | 0.15 |
| Discomfort because of numbness | 5 | 7 | 0 | - | - |

IL: inferior-lateral, IM: inferior-medial, SL: superior-lateral, SL–IL: superior lateral–inferior lateral, SM–IM: superior medial–inferior medial.

and 36.1 $cm^2$ in the lateral group (Fig. 6). At final follow-up, 2 patients (3.2%) in the midline group, 1 patient (1.2%) in the short group, and none in the lateral group complained of numbness. Further, the mean area of numbness was 2.6 $cm^2$ in the midline group, 0.3 $cm^2$ in the short group, and 0 $mm^2$ in the lateral group. The area of numbness, as well as recovery period, was shorter in the short group.

The decreasing trend of numbness was seen at each follow-up. Also, the mean severity assessed on a scale of 0 to 10 was reduced: an approximate value of 2.30 at 3-month follow-up, 1 at 6 months, and 0.05 at the final follow-up. When patients were asked about any discomfort due to numbness, 3 patients in the midline group complained of associated pain and 2 patients complained of heaviness of knee joint associated with numbness. In the short group, 2 patients with numbness had associated pain, 2 had itching, and 2 had pain with swelling, while 1 patient was experiencing difficulty in ambulation with pain. There were no wound healing complications or prosthetic joint infections in any of the patients enrolled for the study at 1 year of follow-up. At the final follow-up, 2

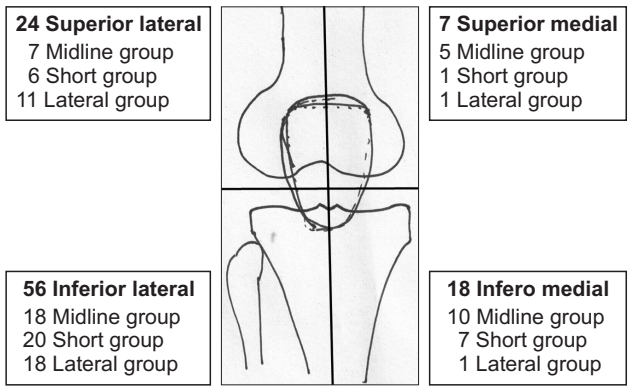



**Fig. 4.** Diagram showing four zones of numbness and the number of patients who had involvement of these zones. In some patients, more than one zone was involved.

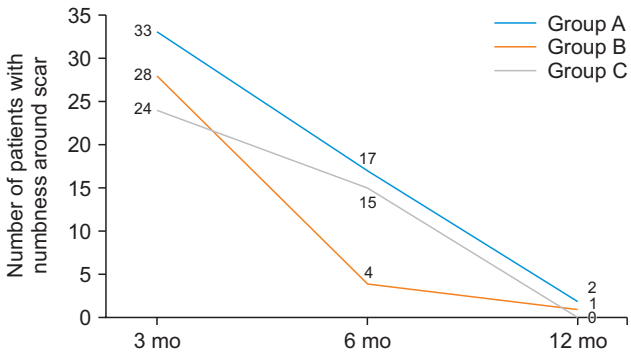



**Fig. 5.** Line diagram showing the incidence of numbness at each time point of follow-up.

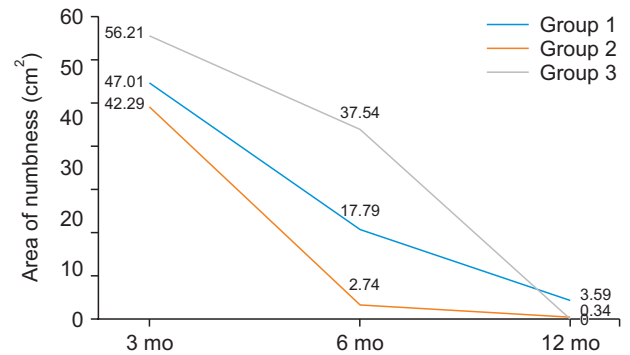



**Fig. 6.** Line diagram showing recovery of the area of numbness over 1 year of follow-up.

patients in the short incision group were lost to follow-up. The majority of patients were satisfied with knee replacement, with satisfaction level varying from 4 to 10. The mean satisfaction level was 8.2 in the midline group, 8.6 in the short group, and 8.4 in the lateral group (Fig. 7). The FJS level at the final follow-up varied from 40 to 100. The

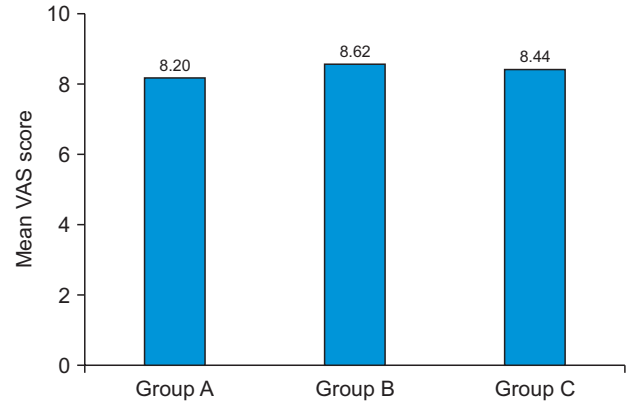



**Fig. 7.** Bar chart depicting 1-year patient-reported satisfaction on visual analog scale (VAS) in the three groups.

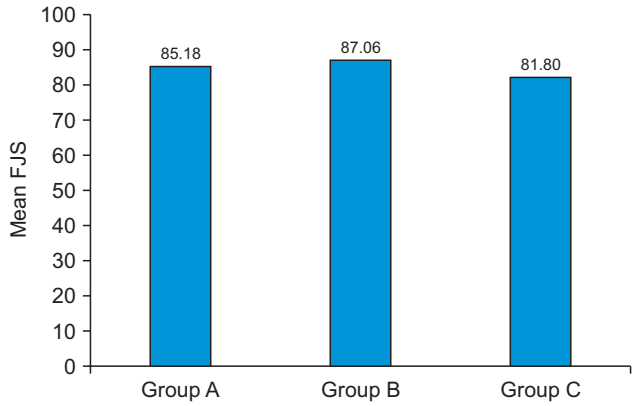



**Fig. 8.** Bar chart depicting 1-year Forgotten Joint Score (FJS) in the three patient groups.

mean FJS was 85.18 ± 14.4 in the midline group, 87.06 ± 11.1 in the short group, and 81.80 ± 13.9 in the lateral group (Fig. 8). Statistically, there was no significant difference in the extent of change while comparing the midline group to the lateral group ($p$ = 0.13) and short group ($p$ = 0.69). EQ-5D was similar in all groups (Table 3).

## DISCUSSION

Anatomical studies have shown that cutaneous supply to the anterior knee is by the inferior branch of the genicular nerve, 2 intermediate branches of the femoral cutaneous nerve, and a small lateral part by the posterior cutaneous nerve of the calf (Fig. 2). The proposed method to preserve these nerves during TKR could be shifting the incision laterally to prevent damage to the infrapatellar branch of the saphenous nerve (IPBSN) and/or decreasing the length above the patella to avoid injuring the lower femoral cuta-

**Table 3.** Patient-Reported Outcome Level of Satisfaction, EQ-5D, and Mean FJS at Final Follow-up

| Variable | Midline group (n = 50) | Short group (n = 48) | Lateral group (n = 50) | *p*-value | |
|---|---|---|---|---|---|
| | | | | Group midline vs. short | Group midline vs. lateral |
| Mean level of satisfaction on scale of 0–10 | 8.20 ± 1.56 | 8.6 ± 1.28 | 8.4 ± 1.14 | 0.23 | 0.82 |
| Level of satisfaction | | | | | |
| Yes | 50 | 47 | 50 | | |
| No | 0 | 1 | 0 | | |
| EQ-5D (max 100) | | | | | |
| Preoperative | 30.5 ± 10.2 | 33.6 ± 13.0 | 30.9 ± 11.7 | 0.19 | 0.85 |
| Final follow-up | 85.5 ± 14.2 | 85.4 ± 12.2 | 82.6 ± 13.1 | 0.97 | 0.29 |
| Mean FJS | 85.1 ± 14.3 | 87.1 ± 11.7 | 81.8 ± 13.8 | 0.69 | 0.13 |

Values are presented as mean ± standard deviation.
EQ-5D: EuroQoL five-dimensional instrument, FJS: Forgotten Joint Score.

neous branches.[11-14,20-22] Our study showed that irrespective of the approach, i.e., midline standard, short length, or lateral exit, there was no significant difference in the occurrence of perilesional numbness at 3 months of follow-up. However, at 6 months, in the short incision group, most of the patients recovered sensation (92%) and the difference was significant when compared to other groups. There was a significant improvement in return of sensations at 6 weeks irrespective of length or placement of an incision, with almost full recovery in the lateral exit group as compared to mere 3% and 1% of residual numbness in the midline group and short group, respectively. Randomized controlled trials (RCTs) by Laffosse et al.,[15] Maniar et al.,[16] and Shetty and Shetty[20] ascertained the advantage of anterolateral incisions over the standard midline incision in reducing lateral flap numbness by preventing injury to IPBSN. Hopton et al.[12] and Subramanian et al.[14]recognized the importance of keeping the length of an incision shorter to minimize the area of sensory disturbances (Table 4). Similarly, Subramanian et al.[14] showed full recovery in 71% of patients with small areas of numbness and 42% of patients with large areas of numbness at 2 years after surgery. Findings by Laffosse et al.[15] and Maniar et al.[16] had consensus on sensory recovery over time notwithstanding type of incisions. Injury to IPBSN is unavoidable irrespective of the incision as the nerve courses from the inferomedial quadrant to the mid-lateral quadrant of the knee; hence, as shown in our study, the incidence of numbness was similar in all groups.

Borley et al.[11] and Laffosse et al.[15] described the location of numb patch, which was most frequently noted on the superolateral or inferolateral side of the healed incision irrespective of the type of incision. In our study, the most frequent zone of involvement was inferolateral, followed by superolateral in all types of incision. However, in the midline incision group, up to 30% of the cases had numbness medial to the scar. Similar to recent RCTs,[15,16,20] our study also showed that at 1 year of follow-up, most patients recovered good function and there was no difference in patient-reported satisfaction and function between patients who received a midline, lateral, or short incision. Although lateral quadrant numbness is more frequently encountered and spoken about in the majority of the studies, a subset of patients especially in the midline incision group developed numbness in the medial quadrants. As in our study, in some patient's medial zone, numbness was seen by Hopton et al.[12] Unlike Hassaballa et al.[17] and Tsukada et al.,[23] we did not look into the effect of an incision on numbness and kneeling ability in our patients.

Our study compared the three groups with respect to the incidence of numbness, location, total area of numbness, recovery, and satisfaction. We found that the incidence of numbness at 3 months of follow-up was the least in the lateral group (48%) as compared to the midline group (62%) and the short group (58%). Although the difference between the lateral group and midline group was apparent, it did not reach the level of significance desired ($p = 0.07$). The difference seen could be due to sparing of some branches of the inferior geniculate nerve as the lower part of the incision was away from the main trunk

**Table 4.** Literature Review

| No. | Study | n | Follow-up (yr) | Incision | n | Length of incision | Numbness (%) | Area ($cm^2$) | Numbness at 6 months | Incidence at end of study | Conclusion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Retrospective study | | | | | | | | | | |
| 1 | Sundaram et al. (2007)[10] | 167 | 3 | ML<br>AM | 76<br>91 | 19.5<br>19.4 | NA | 28.9<br>23.8 | NA | 55 | No difference in two incisions |
| 2 | Borley et al. (1995)[11] | 25 | 2 | ML | 25 | 15.4 | 100 | 66 | NA | 78 | Numbness rate 100% |
| 3 | Hopton et al. (2004)[12] | 113 | 1 | ML | NA | NA | 48 | 69.3 | NA | 18 | Numbness area decreases with decrease in incision length (below 18 cm significant reduction). |
| 4 | Black et al. (2013)[22] | 103 | 5 | ML | NA | NA | NA | NA | NA | 27 | In almost one-third of patients, residual numbness remains even 1 year after surgery. |
| | Prospective nonrandomized study | | | | | | | | | | |
| 5 | Jariwala et al. (2017)[13] | 258 | 1 | ML<br>AM<br>Ob | 205<br>42<br>11 | NA | 49<br>62<br>91 | 90 | NA | 53 | The shorter the incision, the less the numbness. KSS did not correlate with the presence or area of numbness. |
| 6 | Hassaballa et al. (2012)[17] | 78 | 1.5 | ML<br>AM<br>S | 38<br>40 | 18<br>19<br>11 | NA<br>100<br>NA | 57<br>88<br>54 | NA | NA | Numbness area decreases as time progresses. |
| 7 | Subramanian et al. (2009)[14] | 32 | 2 | ML<br>AM | 26<br>6 | 20 | 81 | NA | NA | 40.5 | Laterally placed incision has significantly less numbness. |

**Table 4.** Continued

| No. | Study | n | Follow-up (yr) | Incision | n | Length of incision | Numbness (%) | Area ($cm^2$) | Numbness at 6 months | Incidence at end of study | Conclusion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Randomized control study | | | | | | | | | | | |
| 8 | Laffosse et al. (2011)[15] | 69 | 1 | ML<br>AL | 35<br>34 | 17.1<br>16.6 | 79<br>33 | 19.0<br>7 | 76.0<br>30 | 47<br>22 | Anterolateral incision has less numbness, WOMAC and KOOS scores correlated with smaller area of paraesthesia and better ROM. |
| 9 | Maniar et al. (2017)[16] | 40 | 1 | ML<br>AL | 20<br>20 | NA | NA | NA | NA | NA | Anterolateral incision has less numbness,functional scores did not show any differences with respect to WOMAC, SF-12, and the KSS in either group. |
| 10 | Tsukada et al. (2018)[23] | 162 | 1 | AM<br>AL | 86<br>76 | NA | NA | 10.6<br>3 | NA | NA | Anterolateral incision has less numbness and better kneeling ability. |
| 11 | Shetty and Shetty (2009)[20] | 49 | 1 | ML<br>AL | 25<br>20 | 21.8<br>24.7 | 41 | NA | NA | 41<br>NA | Anterolateral incision has less numbness. |
| 12 | This study | 148 | 1 | ML<br>S<br>LE | 50<br>48<br>50 | 15.2<br>10.3<br>15 | 62<br>56<br>48 | 17.8<br>2.7<br>36.1 | 31<br>8<br>30 | 3<br>1<br>NA | Short incision (< 15 cm) had significantly lower incidence of numbness and area involved and at 1 year, most recovered with similar function. |

ML: midline, AM: anteromedial, NA: not applicable, Ob: oblique, KSS: Knee Society Scores, S: short, AL: antero-lateral, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, KOOS: The Knee injury and Osteoarthritis Outcome Score, ROM: range of motion, SF-12: 12-item short form health survey, KSS: Knee Society Score, LE: lateral exit.

of the nerve, thus preserving some branches. However, the relatively larger average area of involvement in the lateral group could not be explained. At 6 months of follow-up, most patients in the short group (92%) had no residual numbness, which was significantly better than the midline group ($p$ = 0.003). Among those who had numbness in the short group at 6 months of follow-up (8%), the area involved was significantly smaller ($p$ = 0.002) than that in the midline group patients with numbness, indicating that the restoration of sensation was faster in the former group of patients. This could also be due to sparing of the anterior cutaneous branches of the femoral nerve, which may have innervated the numb patch taking over from the injured genicular branches of the saphenous nerve. When we looked at satisfaction from surgery on VAS and FJS, it was similar in all three groups thus indicating that peri-incisional numbness did not affect patient satisfaction and recovery.

The limitation of our study is that we could not blind the outcome assessment. To minimize the bias, the outcome assessment was done by a trained team of physiotherapists using a detailed numbness assessment proforma. Another limitation of our study is that we did not study the type of sensory loss, such as fine touch, crude touch, vibration, and deep pressure. We did not use any objective tool to assess hypesthesia. Our study demonstrated that by changing the placement of incision as compared to the standard midline approach, there was no significant decrease in the incidence of numbness. However, reduction in the suprapatellar length of an incision allowed early recovery of sensation (by 6 months) as compared to the standard incision (1 year). Peri-incisional numbness did not affect recovery of function or patient satisfaction after TKR at 1 year of assessment.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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