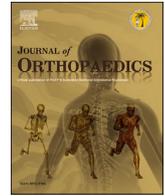


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# Lateral subvastus approach to total knee arthroplasty: A novel surgical technique and retrospective review of 931 consecutive cases

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## ABSTRACT

**Background:** The lateral muscle-sparing approach total knee arthroplasty (TKA) has been detailed and indicated selectively for severe valgus deformities. We present the largest, to date, consecutive series of lateral subvastus TKAs and we hypothesize that preoperative alignments would demonstrate no differences in range of motion (ROM), knee society scores (KSS), kneeling ability, patient satisfaction, or complications.

**Materials and methods:** This retrospective study examined 931 primary TKAs in 824 patients performed through the lateral subvastus approach with one to two years follow-up. All primary TKAs performed between July 2020 and February 2022 were included. We used descriptive statistics, chi-squares, and analysis of variance (ANOVA) to examine the cohort. Significance was set to  $p < .05$ .

**Results:** Patient's ROM significantly improved by six weeks, ( $1-117^\circ$ ,  $P < .05$ ) with continued improvement by one-year, ( $0-121$ ,  $P < .05$ ) with no significant differences in alignment in extension, ( $P = .142$ ) or flexion, ( $P = .253$ ). There were also no significant differences in alignment in KSS scores at six-weeks, ( $P = .635$ ), three-months, ( $P = .829$ ), six-months, ( $P = .836$ ), one-year, ( $P = .641$ ) or two-years, ( $P = .776$ ). There were no significant differences in kneeling ability, ( $P = .563$ ), and 85% of patients reported being able to kneel. There were no differences in patient satisfaction, ( $P = .436$ ), and 90% of patients reported being satisfied. There was a low 8% complication rate in this cohort. Neutral and varus knees were less likely than valgus knees to develop deep vein thrombosis (DVT;  $P < .05$ ) or have a medial collateral ligament (MCL) injury ( $P < .05$ ).

**Conclusions:** Patients with varus, valgus, and neutral knees had similar outcomes when using a lateral subvastus approach to TKA in ROM and KSS that were stable over two years with similar kneeling ability and satisfaction. There was a low incidence of complications with neutral and varus knees at the lowest risk. A lateral subvastus approach to TKA can be safe and effective for all knee deformities.

## 1. Introduction

Current advancements in total knee arthroplasty (TKA) include the utilization of assistive technologies such as navigation and robotics as well as the use of muscle-sparing approaches such as the medial subvastus and midvastus approaches.<sup>1-4</sup> Little in the literature shows that these advancements have the potential to improve postoperative pain, acute functional outcomes, or patient satisfaction at one year.<sup>2-7</sup>

Dr. Mont reported significant improvement in acute postoperative pain by sparing the quadriceps through a lateral approach and Dr. Lanting used a similar approach in a cadaveric study and found little intraoperative muscular or ligament damage with promise for extrapolating their findings in vivo.<sup>8,9</sup> Lateral approaches have been effective in knees with valgus deformity because it makes balancing contracted soft tissues on the lateral side easier, improves postoperative knee stability, uses conservative soft-tissue release, and results in fewer patellar complications, however, little is known about the outcomes in varus and neutral knees.<sup>10-12</sup> Currently, no centers we know of exclusively perform lateral subvastus approaches for TKAs regardless of

preoperative alignment. To date, we present the largest consecutive series of TKA prospectively treated with the lateral subvastus approach at a single center by three surgeons and the reported outcomes acutely, at one year, and two years follow-up.

The objective of this study is to detail a novel surgical technique and report its adverse events and potential benefits. We explored if there were differences in function, complications, or patient satisfaction among preoperative alignment groups in patients who had lateral subvastus TKA.

## 2. Materials and Methods

Institutional Review Board (IRB) approval was obtained for a case-series study using medical chart abstractions for patients who underwent primary TKA through a lateral subvastus approach using the Optimotion Implant system (Optimotion, Orlando, FL), a cruciate retaining implant design, performed between July 2020 and February 2022 by three board-certified orthopaedic surgeons within the same practice. A waiver of informed consent was approved by the IRB for

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retrospective review of medical charts. A within-subjects design was used to review 931 primary TKAs on 824 patients, between one and two years after their knee arthroplasty. All patients indicated for a TKA received a lateral subvastus approach.

The surgical technique is described in the video.<sup>13</sup> The lateral subvastus approach was performed without a parapatellar arthrotomy, and the capsulotomy was performed by splitting between the tibial tubercle and Gerdy's tubercle and curving along the IT band, sparing the vastus lateralis. Gerdy's tubercle was osteotomized creating a thin bone fragment (see Fig. 1). This thin fragment was approximated with a suture passed through it to fortify the thin fascia on the lateral aspect of the knee. The key technical components of the surgical technique involve placing a MCL protecting retractor from the lateral side over to medial side and cutting the tibia first in a semi extended position. The resected tibial plateau is removed, and the patella is flipped 90° to resect and be prepared. These two components of the surgical procedure must be done first, which then creates enough space to deliver the femur forward into a flexed position to be prepared with standard instrumentation.

Post operative protocol involved discharge to home with home physical therapy (PT) for 7–10 days with aspirin as deep vein thrombosis (DVT) prophylaxis. Patients were advised to use a walker for the first one to two weeks for balance purposes. Dressings were changed by home health post op day one. Patients received up to five weeks of outpatient PT after their home PT.

Preoperative and postoperative data was collected including sex, age, surgical facility, length of stay (LOS), preoperative comorbidities, ROM, KSS, alignment, postoperative complications, patient satisfaction, and patient reported kneeling ability. Alignment was determined through a physical exam and confirmed through radiographic findings. Some patients had missing data for one or more elements (e.g., telehealth visits could not include a full physical exam), however, patients were not removed from the study due to missing data. Analyses that required paired samples only included patients with complete data elements for the analysis. We defined and examined 20 of the most common complications (see Table 1).<sup>14</sup> We screened all patients at two weeks post-op for deep vein thrombosis (DVT) through ultrasound. Patients were required to demonstrate ambulation with assistance after surgery prior to discharge. Patients were asked to rank their satisfaction at their one-year follow-up appointment: one (very dissatisfied), two (dissatisfied), three (neutral), four (satisfied), five (very satisfied). Patients were considered dissatisfied if they indicated one or two. Patients were also asked if they could kneel from one (I cannot kneel), two (I can kneel with moderate discomfort), three (I can kneel with mild discomfort), four (I can kneel briefly without discomfort), five (I can kneel comfortably without restriction).

Complications were categorized into three groups. Complications uniquely related to the lateral approach itself which includes wound

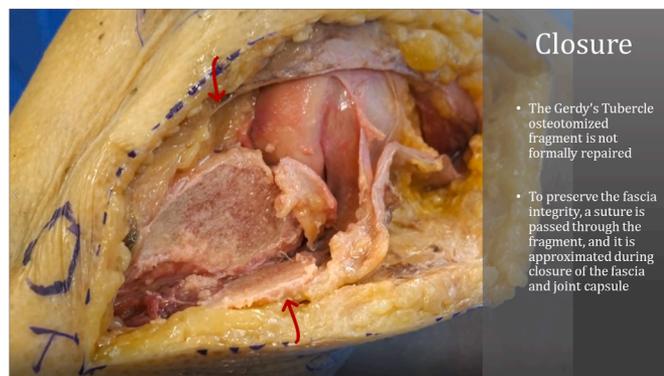


Fig. 1. Note. Osteotomized Gerdy's tubercle bone fragment is created and then approximated with a suture passed through it during wound closure to fortify thin fascia.

**Table 1**  
Definitions and criterion of complications.

Complication	Definition
1. Bleeding/Hemarthrosis	Postoperative bleeding requiring surgical treatment
2. Wound Complication	Failure of wound healing requiring reoperation or change in protocol within 90 days
3. Thromboembolic Disease	Symptomatic thromboembolic event requiring intensive, nonprophylactic anticoagulant within 3 months of TKA
4. Neural deficit	Postoperative neural deficit (sensory or motor) related to the index TKA
5. Vascular injury	Intraoperative vascular injury requiring surgical repair, bypass grafting, or stenting
6. Medial collateral ligament injury	Intraoperative or early postoperative medial collateral ligament injury requiring repair, change in prosthetic constraint, revision, or TKA protocol
7. Instability	Symptomatic instability reported by the patient and confirmed by laxity on physical examination as defined by the Knee Society Score
8. Malalignment	Symptomatic malalignment reported by the patient and confirmed radiographically with angular deformity in the coronal plane >10° from mechanical axis
9. Stiffness	Limited ROM as reported by the patient and demonstrated in a physical examination with extension limited to 15° short of full extension or flexion <90° (not applicable if preoperative arc of motion <75°) that required operative intervention (manipulation under anesthesia and/or liner exchange)
10. Acute deep periprosthetic infection	(Within 90 days of TKA) A sinus tract communicating with the prosthesis; or a pathogen is isolated by culture from at least two separate tissue or fluid samples obtained from the affected prosthetic joint; or 4 of the following 6 criteria exist: elevated ESR and serum CRP concentration; elevated synovial WBC count; elevated synovial PMN; presence of purulence in the affected joint; isolation of a microorganism in one culture of periprosthetic tissue or fluid; or > 5 neutrophils/high-power field in 5 high-power fields observed from histologic analysis of periprosthetic tissue at × 400 magnification
11. Periprosthetic fracture	Periprosthetic fracture of the distal femur, proximal tibia, or patella (operative or nonoperative treatment should be recorded)
12. Extensor mechanism disruption	Disruption of the extensor mechanism (surgical repair and/or extensor lag should be recorded)
13. Patellofemoral dislocation	Dislocation of the patella from the femoral trochlea (direction of instability should be recorded)
14. Tibiofemoral dislocation	Dislocation of the tibiofemoral joint (direction of instability should be recorded)
15. Bearing surface wear	Wear of the bearing surface symptomatic or requiring reoperation
16. Osteolysis	Expansile lytic lesion adjacent to one of the implants ≥1 cm in any one dimension or increasing in size on serial radiographs/CT scans
17. Implant loosening	Implant loosening confirmed intraoperatively or identified radiographically as a change in implant position or a progressive, radiolucent line at the bone-cement or bone-implant interface
18. Settling	Implant failure where tibial component sinks into tibial plateau
19. Implant fracture or tibial insert dissociation	Implant fracture or dissociation of the tibial insert from the tibial implant
20. Death	Patient deceased within 1 year of surgery

Note. TKA, Total Knee Arthroplasty; Citation for complications: Healy WL. Reply to the letter to the editor: Complications of Total knee arthroplasty: Standardized list and definitions of the Knee Society. *Clinical Orthopaedics & Related Research*. 2013; 471(11):3708-3708. <https://doi.org/10.1007/s11999-013-3237-7>.

dehiscence, MCL injury. General complications of TKA such as deep wound infections and stiffness requiring manipulation, post operative instability requiring revision surgery, failed implant such as subsidence. General medical complications such as DVT.

2.1. Data analysis

International Business Machines (IBM) Statistical Package for Social Science (SPSS) 29.0 was used for data analysis. Descriptive statistics were used to describe the cohort. One-way analyses of variance (ANOVA) were used to compare ROM and KSS to six-weeks, one-year, and two-year follow-up, as well as kneeling ability, and patient satisfaction across the three alignment groups (neutral, varus, and valgus). Chi-squares were used to examine complications in alignment groups, because the groups have unequal sizes (neutral = 164, varus = 624, valgus = 144), to compare the incidence of complications in each group. P-values were considered significant at less than 0.05.

2.2. Study cohort

The 931 surgeries had a minimum of one-year follow up, and 278 had two-year data for review. The average patient in this cohort was 69 ( ± 7.61; range, 43 to 88) years old, female (60%), with a BMI of 31.38 ( ± 5.89; range, 18.4 to 54.3; see Table 2). Of the 931 TKAs performed 846 (91%) were performed at an ambulatory surgery center and went home the same day. The remaining 85 (8%) patients had surgery at a hospital, 44 (4.7%) were discharged home day of surgery and 31 (3.3%) stayed overnight for observation, seven (0.01%) stayed for two days, two (<0.01%) patients stayed for three days, and one (<0.01%) patient was stayed for six days.

The average patient in the neutral group was 69.22 ( ± 7.84; range, 46 to 85) years old, female (66%), with a BMI of 29.79 ( ± 5.34; range, 18.4 to 44.0), and 93% had surgery at an ambulatory surgery center. The average patient in the varus group was 69.16 ( ± 7.69; range, 43 to 88) years old, female (65%), with a BMI of 32.00 ( ± 5.96; range, 20.5 to 54.25), and 90% were had surgery at an ambulatory surgery center. The average patient in the valgus group was 70.29 ( ± 6.91; range, 47 to 82) years old, female (75%), with a BMI of 30.50 ( ± 5.75; range, 19.6 to 46.7), and 93% had surgery at an ambulatory surgery center. Patients with valgus knees were significantly more likely to be female (P < .05), and patients with neutral knees had a significantly lower BMI 29.79 ( ± 5.34; range, 18.4 to 44.0) relative to patients with varus knees 32.00 ( ± 5.96; range, 20.5 to 54.25).

**Table 2**  
Cohort description (n = 1072) comparing preoperative conditions in current study (lateral subvastus approach) to nationally reported conditions for TKA (largely medial parapatellar approach).

Parameter	Results Lateral Subvastus Approach from Current Study	Results TKA from Literature	Reference
Age Mean (SD)	69 ( ± 8.06)	67.2 ( ± 9.4)	AJRR Annual Report 2022 <sup>22</sup>
Sex (male)	42%	39%	AJRR Annual Report 2022 <sup>22</sup>
BMI M(SD)	31.47 ( ± 6.04)	32.48 ( ± 6.6)	AJRR Annual Report 2022 <sup>22</sup>
Obesity	54%	62%	AJRR Annual Report 2022 <sup>22</sup>
Diabetic	16%	18%	Belmont et al., 2014 <sup>23</sup>
Rheumatoid Arthritis	2%	3%	Stundner et al., 2013 <sup>24</sup>
Immunosuppressants	7%	3%	Curtis et al., 2018 <sup>25</sup>

Abbreviations: TKA, total knee arthroplasty; SD, standard deviation; M, mean; BMI, body mass index.

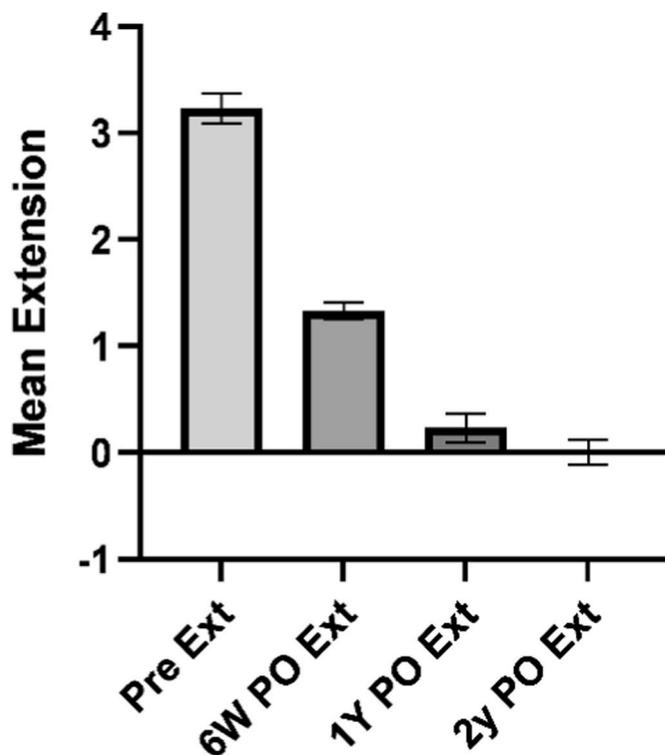
3. Results

Patients had a significant improvement in extension at six weeks follow-up (1.5, range, -4 to 20, P < .05) compared to preoperative extension (3.2, range, -5 to 30, P < .05), however, flexion at six-weeks follow-up (117.2, range, 85–135 P < .05) decreased from pre-op (121.3, range, 80–140), P < .05, (see Figs. 2 and 3). There were no significant differences in the alignment groups in six-week extension, (neutral = 1.21, varus = 1.55, valgus = 1.53, P = .389), six-week flexion, (neutral = 117.9, varus = 117.1 valgus = 117.2, P = .409), one-year extension, (neutral = 0.03, varus = 0.23, valgus = 0.34, P = .142), one-year flexion, (neutral = 121.7, varus = 121.1, valgus = 120.5, P = .253), or two-year extension, (neutral = -0.3, varus = 0.1, valgus = 0.0, P = .273), or two-year flexion, (neutral = 122.5, varus = 121.1, valgus = 121.6, P = .433) (see Table 4).

Patients with neutral knees had statistically higher KSS score pre-operatively (neutral = 61.9, range 38–80) relative to varus and valgus knees (varus = 59.2, range 8–95; valgus = 59.8, range 30–90: P < .05; see, Fig. 4). There were no significant differences between the three preoperative alignment groups in postoperative KSS scores at six-weeks, (neutral = 86.0, varus = 86.3, valgus = 87.3, P = .635), three-month (neutral = 88.8, varus = 89.3, valgus = 90.0, P = .720), six-month (neutral = 91.8, varus = 92.1, valgus = 92.4, P = .905), one-year follow-up, (neutral = 93.7, range; varus = 94.0, range; valgus = 93.1, range; P = .641) or two-year follow-up (neutral = 94.4, varus = 94.4, range; valgus = 95.8, range; P = .776 (see Table 3).

In this cohort, 85% of patients reported being able to kneel (see Fig. 5). There were no significant differences in the alignment groups in patient-reported kneeling ability (neutral = 3.0, varus = 2.9, valgus = 2.8, P = .372). Each alignment group averaged a response of three when asked if they could kneel, which indicates patients were able to kneel with mild discomfort.

Only 9.3% of patients reported being dissatisfied with their knee replacement and there were no significant differences in the alignment groups in patient satisfaction (neutral = 4.5, varus = 4.3, valgus = 4.4, P



**Fig. 2.** Paired samples T-Tests comparing preoperative, six-week, one-year, and two-year extension.

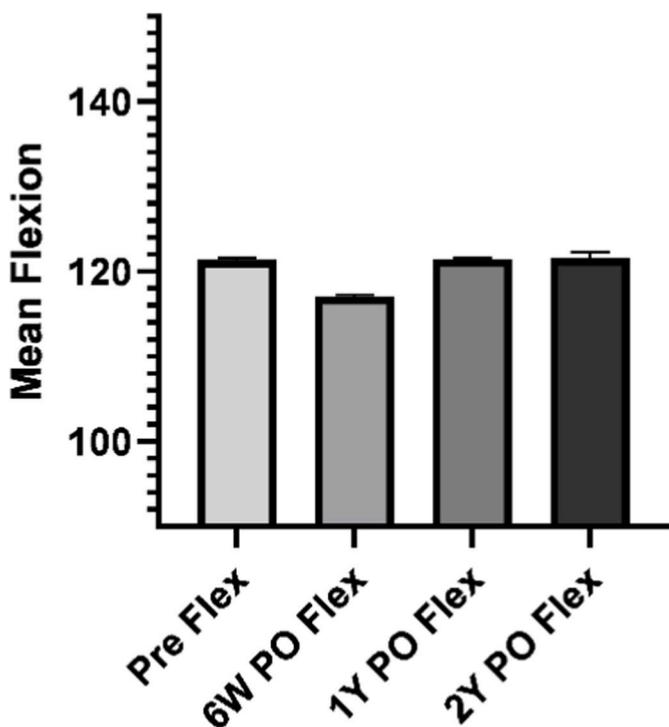


Fig. 3. Paired samples T-Tests comparing preoperative, six-week, one-year, and two-year flexion.

Table 3 Paired samples T-test comparing preoperative, six-week, one-year and two-year postoperative KSS scores.

Comparison	n	Mean	+/-	t(t-value)	p(p-value)
Pre KSS Function	1007	53.0	17.2	-27.8	<.001**
6w KSS Function	1007	72.2	19.7		
Pre KSS Assessment	952	60.1	10.8	-50.6	<.001**
6w KSS Assessment	952	86.7	12.2		
6w KSS Function	745	72.8	19.3	-14.0	<.001**
1y KSS Function	745	83.3	15.5		
6w KSS Assessment	697	86.9	12.2	-12.6	<.001**
1y KSS Assessment	697	94.1	10.4		
1y KSS Function	96	80.5	18.7	-3.1	.002*
2y KSS Function	96	85.8	13.4		
1y KSS Assessment	88	92.8	10.7	-0.9	.174
2y KSS Assessment	88	94.0	10.2		

Abbreviations. ROM, Range of Motion; PreExt, Preoperative Extension; 6wPOExt, 6 Week Postoperative Extension; 1yPOExt, 1 Year Postoperative Extension; 2yPOExt, 2 Year Postoperative Extension; PreFlex, Preoperative Flexion; 6wPOFlex, 6 Week Postoperative Flexion; 1yPOFlex, 1 Year Postoperative Flexion; 2yPOFlex, 2 Year Postoperative Flexion; KSS, Knee Society Score; \* $<0.05$ ; \*\* $<0.001$ .

= .499). All three alignment groups reported an average score greater than four which represents satisfied to very satisfied.

The lateral subvastus approach specific complications include deep wound dehiscence with drainage requiring surgical intervention was 0.5% (n = 5) and iatrogenic MCL injury 1.3% (N = 12). Iatrogenic MCL injuries were treated with conversion to a constrained insert and PS femur (Stryker Triathlon TS).

General complications common across all TKA approaches and not specific to a lateral subvastus approach includes deep wound infection requiring two-stage reimplantation 0.6% (n = 6), chronic stiffness treated with downsizing insert thickness 0.2% (n = 2), instability treated with increasing insert thickness 0.3% (n = 3), revision for subsidence of tibial components were 0.5% (n = 5), manipulation under anesthesia for stiffness 1.9% (n = 18), DVT 1.9% (n = 18) was based upon ultrasound

Table 4 Games-howell post hoc comparing preoperative alignment groups on KSS function and KSS assessment at six-weeks and one-year follow-up.

Parameter	Alignment Comparison	Mean Difference	SE	p	95% Confidence Intervals	
					Lower Bound	Upper Bound
<b>6-Week KSS Function</b>						
Neutral	Varus	0.3	1.7	.982	-3.76	4.39
Varus	Valgus	1.5	1.7	.646	-5.41	2.44
Valgus	Neutral	-1.8	2.2	.682	-6.88	3.28
<b>6-Week KSS Assessment</b>						
Neutral	Varus	-1.7	1.1	.255	-4.12	.81
Varus	Valgus	-0.9	1.0	.645	-3.38	1.52
Valgus	Neutral	2.6	1.3	.120	-.50	5.67
<b>1-Year KSS Function</b>						
Neutral	Varus	-0.9	1.5	.815	-4.50	2.65
Varus	Valgus	3.7	1.7	.067	-.20	7.62
Valgus	Neutral	-2.8	2.0	.358	-7.58	2.01
<b>1-Year KSS Assessment</b>						
Neutral	Varus	-0.9	1.1	.664	-3.40	1.58
Varus	Valgus	0.6	1.1	.854	-1.95	3.09
Valgus	Neutral	0.3	1.3	.965	-2.82	3.50

Note. Knee Society Score, KSS.

KSS From Preop to Two-Year Postop

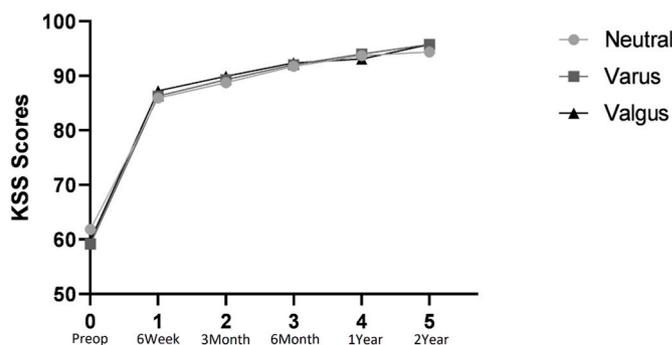


Fig. 4. Note. The improvement in Knee Society Scores (KSS) was similar among all knee alignments with a significant improvement seen by six-weeks follow-up, and a plateau effect thereafter.

performed at 10–14 days.

General complications unrelated to TKA included two readmissions within a 90-day period for diverticulitis and abnormal electrocardiogram (EKG) post op. One patient passed away from a cardiac event 408 days from surgery.

The only differences among alignment groups in complications were in iatrogenic MCL ruptures and DVTs. Valgus aligned knees were more likely to have intraoperative MCL injuries 3% (5/144) compared to varus knees 1% (7/623) and neutral aligned knees 0% (0/164),  $P = .022$ . Valgus aligned knees were more likely to have DVTs 5% (7/144), compared to neutral 0.006% (1/164), and varus 2% (10/623),  $P = .016$ .

#### 4. Discussion

This is the largest consecutive series of TKAs performed through a lateral subvastus approach, to date. Most (95%) of patients discharged as ambulatory with minimal readmissions and adverse events. KSS and ROM improves preoperative scores by six weeks and continues to improve during the first year at which point it normalizes with a high patient satisfaction rate. The complications associated with any TKA such as deep infection rates and DVT's, are as good if not better with a lateral subvastus approach than reported in the literature for other TKA techniques.<sup>15–17</sup> A lack of comparative cohort limits the conclusion of

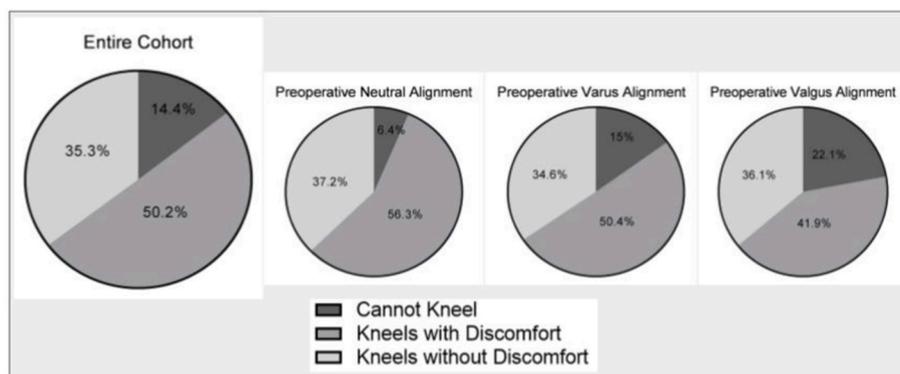


Fig. 5. Patient-reported kneeling ability one-year post-op.

these findings, nevertheless.

The primary benefit of a lateral subvastus approach is not splitting the quadriceps muscle allowing for less pain and early muscle recovery. A secondary benefit includes not damaging the medial saphenous sensory nerve with a direct anterior incision. Also, patellar tracking is improved due to the lateral release.

The downside of the lateral subvastus approach is its difficulty in execution. Surgical steps need to be performed in a very specific sequence to ensure that the surgery can be successfully completed. First is careful dissection of the lateral structures to allow for closure. An osteotomy of Gerdy's tubercle produces a thin bone fragment that a suture is passed through to fortify the closure of the joint capsule. Following dissection, tibial resection was performed which requires appropriate retractor placement to avoid cutting the MCL. Afterwards, the patella is flipped 90° (not fully everted) and resected accordingly. Only then the femur can be brought into flexion and completed with conventional instrumentation. Meticulous closure of the lateral deep extensor retinaculum and Gerdy's osteotomy to the lateral edge of the patella tendon is necessary to prevent drainage. Occasionally a dermal allograft flap is required in this area to minimize tension or reinforce the capsule during the primary closure. Closing with this modified technique resulted in a low incidence of wound complications (.5%) and periprosthetic joint infections (0.6%) in this cohort. It should be noted that a lateral subvastus approach is a fully extensible approach both proximally and distally as opposed to a medial subvastus approach which is limited in its proximal dissection.

MCL injury is another risk that is seen with this approach. Failure to properly place an MCL retractor may result in transection of the MCL with the saw. Using a precision saw blade mitigates some of this risk. Once the authors figured out how to appropriately place the retractor, the incidence of MCL injury from the saw was eliminated. There were 12 (1.3%) MCL injuries in this cohort, and valgus knees were significantly more likely to have this injury relative to the neutral and varus knees. This may be due to medial structures being weakened in valgus knees and that valgus knees often present as more difficult cases.<sup>18</sup>

All alignment groups achieved ROM 1–117° by six weeks follow-up and a flexion of 120° by one year follow-up that was stable over two years. All groups achieved similar benefits in KSS scores throughout two years of recovery. Patients (85%) reported being able to kneel at one year follow-up, while the literature on the medial parapatellar approach reports only 20–40% of patients report being able to kneel.<sup>19,20</sup> Improved kneeling ability may be related to an incision to the side, avoiding damage to the medial saphenous nerve, and any pain that would result in kneeling on an anterior incisional scar.

Patient dissatisfaction with TKA in the literature has hovered between 14 and 27%.<sup>2–4,21</sup> This study reduced patient dissatisfaction to 10%. All three alignment groups reported similarly high levels of satisfaction after surgery.

There was a 2% DVT rate in this cohort. All patients were screened

for DVT two weeks post-op. Patients with valgus knees were more likely than varus or neutral knees to develop an acute DVT. We were not able to measure all factors influential in DVT development (e.g., thromboembolic disease), therefore, we cannot rule out which factors increased the prevalence of DVT in the valgus group. A case-control study that controls for sex, comorbidities, type of anesthesia, and tourniquet time may provide greater insights on the relationship between alignment and risk of DVT.

## 5. Conclusions

The described lateral subvastus approach to TKA, in the authors hands, has demonstrated that it is a safe and effective approach for TKA regardless of preoperative alignment. Furthermore, the study shows that there may be some significant clinical benefits to the surgical approach with respect to early normalization of KSS score, improved patient satisfaction at one year and a greater ability to kneel. Patients with valgus deformity were at greater risk for iatrogenic MCL injury that resulted in a conversion to a constrained prosthesis, however, they did not encounter any subsequent complications. Valgus deformity can weaken the medial structures making these knees more susceptible to iatrogenic MCL injury and these findings are consistent with outcomes associated with the medial parapatellar approach to TKA. Patients with valgus knees were also more likely to develop DVT postoperatively, even though there were very few cases. The nature of this relationship is still unclear. While valgus knees were at greater risk for these complications, the overall complication rate in this cohort was still very low, and all three alignments demonstrated exceptional postoperative function.

## CRedit authorship contribution statement

**Steve Nguyen:** Conceptualization, Conceptualization of study, wrote the paper. **Eden Crowsey:** Formal analysis, Data analysis, data collection co-writer. **Nam Dinh:** Review edits. **Sergio Martinez:** Review edits. **Amanda Rogan:** Review edits, data collection. **Samantha Nguyen:** Data collection.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jor.2023.11.028>.

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