International Journal of Research in Orthopaedics
Gupta T et al. Int J Res Orthop. 2022 May;8(3):331-338
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20221121

A study to assess the clinical and functional outcome of sub-vastus approach for total knee arthroplasty

Tarun Gupta, Anuj Nigam*, Pramod P. Neema, Murtuza Rassiwala

Department of Orthopaedics, Unique Superspeciality Centre, Indore, Madhya Pradesh, India

Received: 02 February 2022
Revised: 28 March 2022
Accepted: 29 March 2022

***Correspondence:**
Dr. Anuj Nigam,
E-mail: dranujnigam@gmail.com

ABSTRACT

Background: Osteoarthritis and rheumatoid arthritis affects all patients of age more than 50 years, requiring total knee replacement. There are two major approaches to total knee replacement- sub-vastus approach and medial parapatellar approach. There is no common consensus on superiority of sub-vastus approach. So, we undertook the present study to evaluate the functional and clinical outcome of total knee replacement via sub-vastus approach in terms of knee society clinical and functional scores and visual analog scale along with monitoring of range of motion in the post-operative knee in the follow up period.
Methods: The present prospective and observational study was conducted in the Department of Orthopaedics, Unique Super Speciality Hospital, Indore, Madhya Pradesh for a period of 12 from June 2019-May 2020 with sample size of 30 patients undergoing total knee arthroplasty. All the patients had undergone total knee replacement via sub-vastus approach. The functional and clinical results of our study were compared with available literature.
Results: The mean KFS and KCS scores showed a statistically significant improvement over a period of 12 months ($p<0.05$), while the mean ROM showed an improvement till 6 months ($p<0.05$) and then it remained stable till 12 months in comparison to 6 months ($p>0.05$).
Conclusions: On comparing the results of sub-vastus approach with the available literature we found a significant improvement in functional and clinical outcome with a stable improvement in range of motion with very few complications.

Keywords: Osteoarthritis, Total knee arthroplasty, Sub-vastus approach, Knee society score, VAS

INTRODUCTION

Osteoarthritis (OA) is one of the most common conditions that causes impairment, especially among the elderly. OA is the most common articular disease in the industrialized world, and it is a source of chronic disability, primarily due to knee and hip OA.[1] The chronic rheumatic diseases, hip and knee joint OA are the leading cause of pain and disability in most countries of the world.[2] The articular cartilage of both the femur and tibia of the joint wears away in osteoarthritis of the knee. Trauma, rheumatoid synovitis, pigmented villonodular synovitis, and seronegative arthropathies such as gout, chondrocalcinosis, osteonecrosis, and idiopathic illnesses can all cause arthritis.[4] The knee is the commonly affected joint when it comes to osteoarthritis. Torn menisci, fractures, patellar instability, and loose bodies caused by chondromalacia or synovial chondromatosis are all post-traumatic causes. Total knee arthroplasty (TKA) is one of orthopaedic surgery's most cost-effective and consistently successful procedures.[5] In terms of pain reduction, functional restoration, and better quality of life, patient-reported results have demonstrated to increase considerably.[6] Patients suffering from end-stage, tri-compartmental, degenerative osteoarthritis can benefit from TKA (OA).[7] Symptomatic knee OA occurs in 10%

men and 13% in women aged 60 years or older. This incidence increases with the increase in the age.[3] The knee joint and its surrounding components can be approached surgically in a variety of ways for total knee arthroplasty.[8] The medial parapatellar arthrotomy, also known as the anteromedial approach, is the most common and widely utilized method for exposing the knee joint in total knee arthroplasty.[9] There is no common consensus as to which approach is the best. Hence, considering this lacuna in the review, the present study was conducted in our institution with an aim to evaluate the clinical and functional outcome in patients undergoing total knee Arthroplasty by subvastus approach.

Objectives

The objective of this study were (a) to evaluate the improvement in range of movement of the knee joint after total knee replacement by sub-vastus approach; (b) to evaluate the functional outcome using Knee society score in these patients; and (c) to evaluate the pain outcome in these patients using Visual analogue scale (VAS).

METHODS

The present prospective and observational study was conducted in the Department of Orthopaedics, Unique Super Speciality Center, Indore, Madhya Pradesh, for a period of 12 months from June 2019-May 2020. We had included 30 patients undergoing total knee Arthroplasty. The sample size was calculated According to the study done by Bhandarkar et al, sample size,

$$N = \frac{Nx}{[(N-1)E2 + x]}$$

Where, N is the population size, r is the fraction of responses, margin of error is E for which

$$E = \frac{Sqrt[(N-n)x}{n(N-1)}$$

Z is the critical value for the confidence level c. A constant of,

$$x = Z(c/100)2r(100-r)^{6}$$

By putting N=20000, r=4.23% and Z=1.96 in the above formula, we obtained a sample size of 63 at the confidence interval of 95%. Due to COVID pandemic, we could obtain 31 patients for the present study, but for convenience of calculation, we had finally included 30 patients in the present study and these were used for final analysis.

Ethical approval

An ethical approval for the conduct of this research was taken from the institutional ethics committee where the protocol with its corrections was reviewed and approved by the members of the ethics committee in a meeting held in June 2019.

Inclusion criteria

Patients with age between 50-75 years; with osteoarthritis Kellgren- Lawrence severity Grade 3 and 4; with rheumatic arthritis with varus and valgus deformity; with post traumatic arthritis; with types A and B according to Insall et al criteria; and patient and/or his/her legally acceptable representative willing to provide their voluntary written informed consent for participation in the study were included. Patients were grouped according to Insall et al criteria: (a) type A: unilateral arthritis with the other knee normal or with successful Replacement); (b) type B: unilateral arthritis with the other knee symptomatic; and (c) type C: with multiple joints involvement or medical infirmity.

Exclusion criteria

Patient with age less than 50 years and more than 75 years; with type C of Insall et al criteria; with other inflammatory knee pathology; with BMI more than 40 kg/m^2; who had undergone revision arthroplasty/any previous knee surgery; with present/past history of sepsis of the knee joint; with local skin lesions; who gave legal acceptable representative not willing to provide their voluntary written informed consent for participation in the study were excluded.

Methodology

The patient and/or his/her legally acceptable representative was explained about the study in detail including its risks/benefits, procedures, compliance, etc. in detail in their own language and informed consent was taken. A detailed history of each patient in the form of chief complaints, onset, duration and progression of the complaints. Past history related to medical illness or any surgical treatment were noted. History suggestive of rheumatoid arthritis or any other types of arthritis and neuropathic joint were assessed in detail. History of any previous surgery in the same knee like high tibial osteotomy, supracondylar osteotomy or fracture fixation were taken. Past history of any infection in the body were taken. Inquiry about anti-coagulant therapy was done. A detailed clinical examination was done to see presence or absence of tenderness, swelling and abnormal mobility in the concerned knee. Passive and active range of motion of affected knee joint were noted. Any flexion deformity or instability in knee were noted preoperatively. Knee circumference was taken at mid patellar level for all patients preoperatively. Amount of varus / valgus deformity, flexion contracture and range of movements of the joint was noted. Assessment of any distal neurovascular deficit in the particular limb was done. The condition of surrounding soft tissues was evaluated. Preoperatively the pain and functional assessment was

done using Knee Society Score. Radiologically, AP view (load bearing-standing), lateral view in 90 degrees of flexion of the affected limb and full-length extremity roentgenograms to know the mechanical and anatomical axis was taken. Pre-operative anesthetic and physician's fitness for surgery was obtained prior to the surgery. Patients were given thorough wash with soap and Microshield (at 8 hours' interval) for three times; last one was given a night prior to the surgery along with shaving of the parts. After completion of the third wash, the limb to be operated was covered with autoclaved sheet and kept as such till the surgery time. During preoperative period (approximately 12 hours prior to surgery) and during induction a dose of a third generation Cephalosporin with Sulbactum 1g IV+levofloxacin 500 mg IV was given. The surgical procedure was carried out under combined spinal and epidural anesthesia with patient in supine position and under tourniquet control.

Surgical details[10]

The patient in supine position, skin incision was made directly midline or slightly medial to midline according to the pathology. Pathology defines the length of the incision, it extended from the superior pole of the patella to the inferior aspect of the tibial tubercle. The incision was made in the subcutaneous tissue to reach the retinacular tissue. Under careful hemostasis, full-thickness medial and lateral flaps were created. So that the extensor mechanism lying deep to the subcutaneous tissue remain functional. The distal insertion of the vastus medialis obliquus (VMO) on the patella is identified and fascia overlying the VMO is released sharply, posteriorly towards the attachment of the VMO on the medial intermuscular septum, thereby exposing the distal part of VMO. Blunt dissection was done and inferior border of VMO was identified and retracted posteriorly and laterally, while maintaining its attachment to the patella. Retractor was inserted anterior to the distal femur and deep to the muscle to maintain the retraction. Two suture markings were made at the level of VMO attachment to the patella.

An oblique capsular incision is then made just distal to the VMO, beginning posteriorly at the level of intermuscular septum and extending laterally, parallel to the inferior border of the muscle, towards the medial border of the patella. The incision is made between the markings which then served as a guide for later repair. At the medial border of the patella, the arthrotomy is extended distally, taking care to leave a cuff of tissue attached to the patella for closure.

The arthrotomy incision was carried distally across the joint line and parallel to the medial border of the patellar tendon. The retropatellar bursa and fat pad was incised to gain additional exposure. To mobilize the extensor mechanism, the synovial capsular attachments of the quadriceps tendon was released fully from medial to lateral. Then patella was subluxed into the lateral gutter. lateral patellofemoral plicae release and release of adhesions was done. Knee again flexed, ACL along with anterior horn of both menisci was removed (posterior horn of menisci was removed after both bone cut made); Meniscus was removed leaving a 2 mm rim to prevent damage to the capsular sleeve. Now tibia was subluxated anteriorly and externally rotated. Further exposure and soft tissue balancing was done based on patient's preoperative deformity and soft tissue stability. Soft tissue balance was assessed and reassessed several times during the whole procedure. Since many of our patients had varus deformity, release of the medial structures (superficial and deep parts of medial collateral ligament, semimembranous tendon, pes anserinus and part of posterior capsule) as per demand of the individual case, was done. For every centimeter of release, the knee was stressed into valgus to see if varus has been fully corrected or not.

All osteophytes were removed. Bone cuts were made using appropriate jigs. Tibial preparations were followed by femoral. Three degrees of posterior slope was maintained while making tibial cut. The femoral bone cut was always maintained in 5 to 7 degrees of valgus. After this anterior and posterior Chamfer cuts were made by using jigs in both groups. Aim was to achieve a rectangular space between the femur and tibia (extension / flexion) after bone cuts, which was fulfilled in all cases. Final alignment was checked with spacer blocks with less than 5 degrees of varus/ valgus stress.

Special attention was paid to the removal of posterior osteophytes and elevation/release of posterior capsule. For final equalization of flexion and extension space, additional distal femoral resections were done (8-10 mm) if required. Following these resections not only the correction of the flexion contracture but also the mediolateral stability with spacer in place was ascertained. Patellar resurfacing was done in all cases following removal of peripheral osteophytes. Patellar tracking over the femoral component was noted and found. Trial components was then fixed. Stability and range of movement were rechecked in extension and flexion. Now trial component was removed and prosthesis were placed and fixed to bone. First the femoral and patellar component with help of one packet of cement (CMW III), then the tibial component using another packet of cement (CMW III) was fixed. Extra cement was removed with help of knife and curette. Tourniquet was deflated. Hemostasis was achieved. Wound washing with normal saline and closure was done in layers with knee in extension under negative suction drain. Appropriate noting, documentation as regards implant specification used, etc. was done.

In all these patients, same implant manufactured by Meril® Life (Destiknee Knee System) was used. The blood loss was assessed as the difference in weight of blood stained mop and that with new mop. The weight was calculated as mg of blood loss. As 1 mg of blood is equal to 1 ml of blood, the final blood loss was counted in ml. One gram of third generation Cephalosporin with Sulbactum IV twice a day+levofloxacin 500 mg IV once

daily for 5 days followed by oral antibiotics till suture removal was given during the post-operative period. Sutures were removed between 12 to 15 days after the surgery.

Post-operative rehabilitation and physiotherapy

Phase 1: Immediate postsurgical phase (day 0-3)

It included: (a) active/active assisted/passive (A/AA/PROM) exercises (seated and supine); (b) patella femoral and tibial femoral joint mobilization and soft tissue mobilization as indicated; (c) soft tissue massage; (d) isometric quadriceps, hamstring, and gluteal isometric exercises; (e) straight leg raises (SLR); (f) lower extremity range of motion (ROM) and strengthening as indicated based on evaluation findings; and (g) gait training on flat surfaces with full weight bearing with walker support

Phase 2a: Motion phase (week 1 to week 4)

It included (a) active/active assisted/passive ROM, stretching for flexion (>90 degrees) and extension; (b) functional training to promote independence in daily activities (e.g. toilet training); (c) patella femoral and tibial femoral joint mobilization; (d) continue isometric quadriceps, hamstring, and gluteal isometric exercises; and (e) SLR in 4 planes (flexion, abduction, adduction, extension).

Phase 2b: Motion phase (week 4 to week 6)

It includes: (a) continue above exercises; (b) continue patella femoral and tibial femoral joint mobilization as indicated; (c) use sit to stand and chair exercises to increase knee flexion during functional tasks; and (d) continue stationary bicycle for ROM

Phase III: Intermediate phase (week 7-12)

It includes (a) maximize post-operative ROM (0-115 degrees plus); (b) good patella femoral mobility; (c) good strength all lower extremity musculature; (d) return to most functional activities and begin light recreational activities (i.e. walking, pool program); (e) continue exercises listed in Phase II with progression including resistance and repetitions; (f) continue patella femoral and tibial femoral joint mobilization as indicated; (g) initiate endurance program, walking and/or pool; and (h) initiate and progress age-appropriate balance and proprioception exercises

Phase IV: Advanced strengthening and higher level function stage (week 12-16)

It includes (a) continue previous exercises with progression of resistance and repetitions; (b) increased duration of endurance activities; and (c) initiate return to specific recreational activity: progressive walking or biking program. Follow-up was done in 3rd month, 6th month and 12th month after the surgery. Clinical evaluation was done using Knee Society Score. VAS, Pain score and functional score were noted in all patients at regular follow-ups. Flexion at knee was measured using the goniometer. During post-operative and follow-up period, serial X-rays were taken.

RESULTS

The mean age of the patients was 65.00±5.29 years with an equal distribution of males and females. Predominantly right sided affection was seen. Osteoarthritis was the most common etiology for surgery. The mean KFS and KCS scores showed a statistically significant improvement over a period of 12 months ($p<0.05$), while the mean ROM showed an improvement till 6 months ($p<0.05$) and then it remained stable till 12 months in comparison to 6 months ($p>0.05$) The mean preoperative VAS was 4.40±1.49 and mean postoperative VAS was 3.17±1.46.

The difference was found to be statistically significant ($p=0.001$), showing a significantly lower VAS score postoperatively in comparison to the preoperative value. In the subvastus approach for total knee replacement, the VAS showed a statistically significant improvement till 6 months and improved VAS was stable from 6 months to 12 months. The mean blood loss in our study was 140.87±21.15 ml and duration of surgery was 83.10±7.73 minutes. Varus and fixed flexion deformities were most commonly seen. In our study, we found knee pain, superficial infection and knee stiffness in few of our patients.

Table 1: Comparison of mean ROM at different time interval (N=30).

Time interval	Number	ROM (mean±SD)	't' value	P value
Pre-operative	30	98.50±12.12	-5.464, df=29	0.001*
At 3 months	30	109.67±2.92		
At 3 months	30	109.6±2.92	-13.801, df=29	0.001*
At 6 months	30	118.67±4.14		
At 6 months	30	118.67±4.14	-1.000, df=29	0.326, NS
At 12 months	30	119.67±3.93		

Note: Paired 't' test applied. P value<0.05 was taken as statistically significant.

Table 2: Comparison of mean KFS score at different follow-ups (N=30).

Time interval	N	KFS (mean±SD)	't' value	P value
Pre-operative	30	21.37±6.72	-14.374, df=29	0.001*
At 3 months	30	38.00±5.96		
At 3 months	30	38.00±5.96	-18.429, df=29	0.001*
At 6 months	30	56.00±6.35		
At 6 months	30	56.00±6.35	-27.565, df=29	0.001*
At 12 months	30	80.67±5.83		

Note: Paired 't' test applied. P<0.05 was taken as statistically significant.

Table 3: Comparison of mean KCS score at different follow-ups (N=30).

Time interval	Number	KCS (mean±SD)	't' value	P value
Pre-operative	30	27.33±6.11	-16.335, df=29	0.001*
At 3 months	30	47.77±4.90		
At 3 months	30	47.77±4.90	-33.394, df=29	0.001*
At 6 months	30	68.73±4.29		
At 6 months	30	68.73±4.29	-24.553, df=29	0.001*
At 12 months	30	81.23±5.66		

Note: Paired 't' test applied. P value<0.05 was taken as statistically significant.

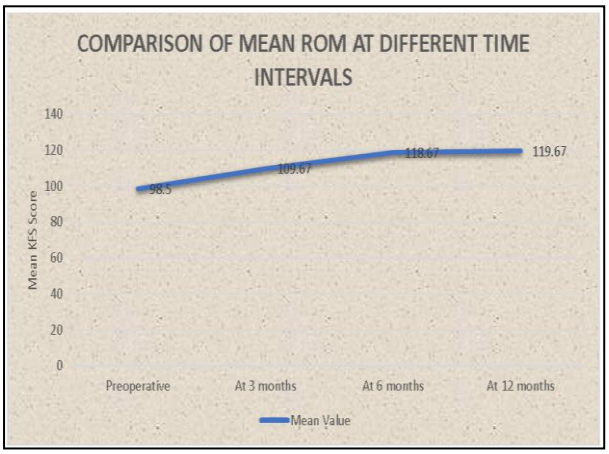

Figure 1: Comparison of mean ROM at different time interval.

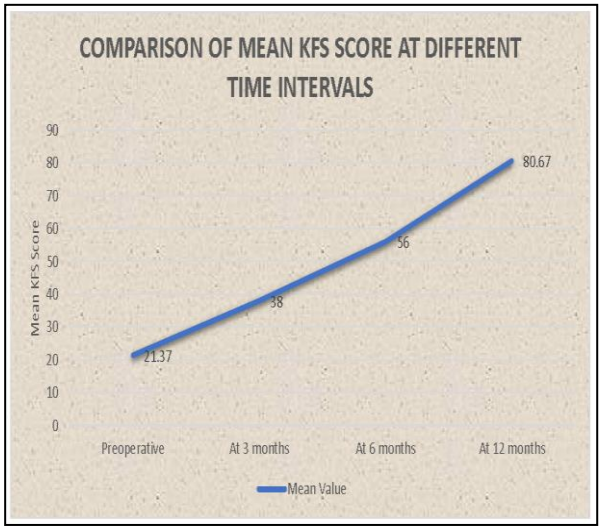

Figure 2: Comparison of mean KFS at different follow-ups.

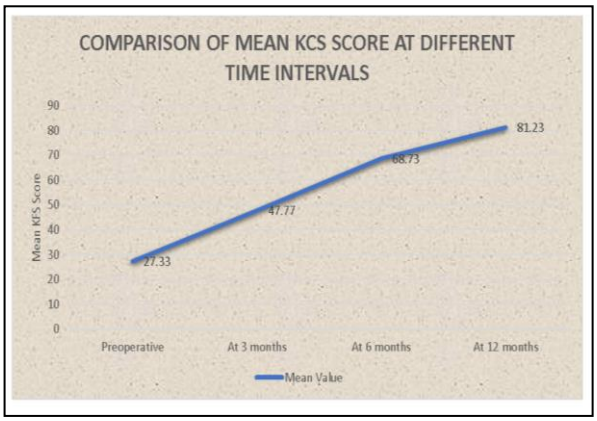

Figure 3: Comparison of mean KCS at different follow-ups.

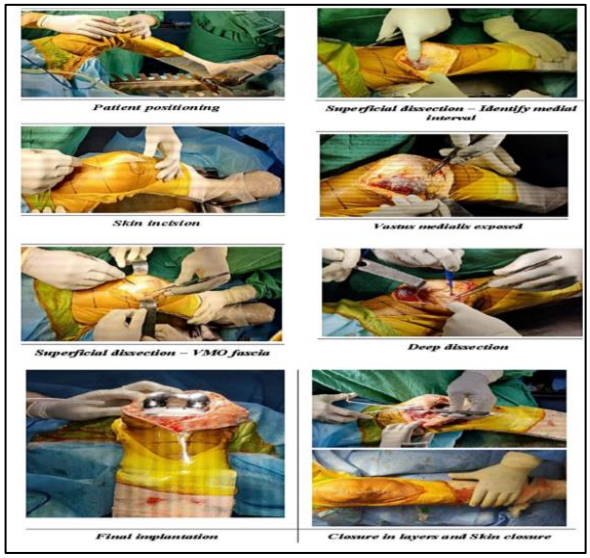

Figure 4: Intra-operative images showing total knee arthroplasty by sub-vastus approach.

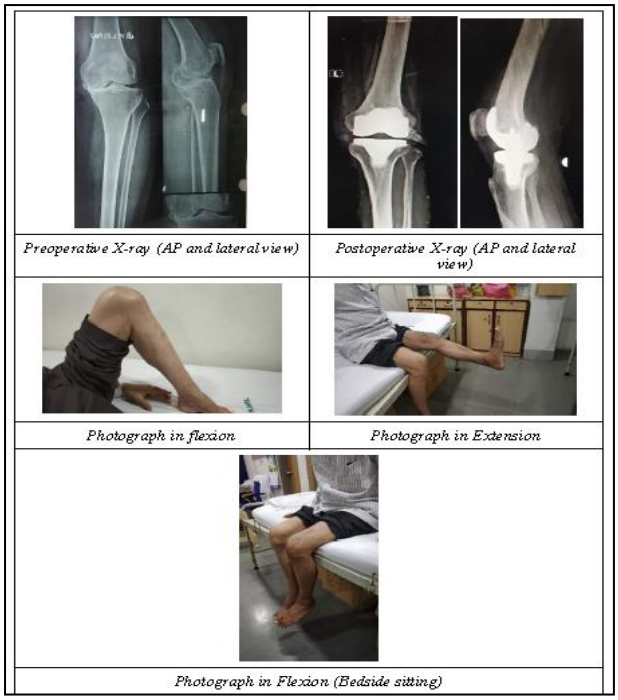

Figure 5: Pre-operative and post-operative results of study sample case 1.

Figure 6: Pre-operative and post-operative results of study sample case 2.

DISCUSSION

The present study was carried out to evaluate the clinical and functional outcomes of total knee replacement (TKR) carried out using subvastus approach. In the published literature, some authors were of the view that subvastus is better than the conventional medial parapatellar approach, while others had the opinion that subvastus approach is equivalent to the conventional parapatellar approach.[11] Faure et al in their study reported that subvastus approach showed greater strength initially, through after 3 months interval, the strength differences were not there.[4] There was a greater patient preference over the paramedian knee. Matsueda et al reported that fewer of their patients required retinacular release and this approach led to improved patellar tracking and stability.[13]

Roysam et al in their study reported that patients of subvastus approach group had earlier return of straight-leg raise, with lower consumption of opiates, less blood loss and greater knee flexion at 1 week in comparison to medial parapatellar approach.[13] Cila et al in their study reported greater quadriceps strength in the subvastus group patients earlier, but overall there was no advantage over the medial parapatellar approach.[2] Weinhardt et al like Cila et al reported that subvastus approach was comparable to medial parapatellar approach in terms of pain, blood loss, blood substitution and complications.[2,15] There is differing opinions regarding the subvastus approach. So we conducted the present study to evaluate the clinical and functional outcome of total knee replacement by subvastus approach. We had included 30 patients undergoing total knee replacement using subvastus approach in our institution during the study period. Our study showed similar results regarding straight leg raise and patella tracking as above mentioned studies. The mean age of the patients was 65.00 ± 5.29 years with a range between 52 to 75 years. Majority of the patients are in the age group 61-70 years. Masjudin et al in their study had included 23 patients of age between 55-76 years who underwent total knee replacement by either subvastus or midvastus approach.[18] Shah et al in their study had included 110 knees (84 patients) with a mean age of 64 years ranging from 49 to 79 years undergoing total knee replacement by subvastus approach.[20] The age group is comparable to our study age group, showing that majority of the patients of age more than 50 years require total knee replacement. The patients were comparable with respect to gender. Right side involvement was more predominantly seen in our study in comparison to the left side.

Osteoarthritis was the major cause of total knee replacement in our study. Varus deformity and fixed flexion deformity were the most common deformities seen in our study, with only 1 case have valgus deformity. The mean blood loss in our study was 140.87±21.15 ml and duration of surgery was 83.10±7.73 minutes. Maestro et al, Weinhardt et al, Teng et al and Bonutti et al in their studies reported no significant difference in the blood loss and operative time between classic medial parapatellar arthrotomy and medial vastus approach.[12,15,16,19] While the study done by Roysam et al and Liu et al found a significantly lower blood loss in subvastus approach group in comparison to parapatellar approach group.[14,17] Knee pain, superficial infection and knee stiffness were seen in few of our patients. Shah et al reported one case of partial avulsion of patellar tendon tubercle. We did not find any patellar tendon avulsion in our study.[20] Sukeik et al in their

study compared the subvastus and standard medial parapatellar approach and reported that complication rate were comparable between the two groups.[23] 43.3% patients achieved excellent and 56.7% achieved good KFS grading at the end of 12 months. The mean KFS score at baseline was 21.37±6.72, which significantly and persistently showed improvement till the end of 12 months period. 40% patients achieved. excellent and 60% achieved good KCS grading at the end of 12 months. The mean KCS score at baseline was 27.33±6.11, which significantly and persistently showed improvement till the end of 12 months period. Teng et al reported that the studies used in their meta-analysis had used Knee Society Score for evaluating the functional outcome and the results were in favor of subvastus approach to medial parapatellar approach.[19] Shah et al also reported a significant improvement in the mean Knee Society Score from 36 (preoperative) to 80 postoperatively ($p<0.05$).[20]

Our results also showed that the functional outcome showed a significant improvement in patients undergoing subvastus approach, which is similar to the findings of these authors. There was no statistically significant association between KFS and KCS at 12 months and age; sex and side involvement ($p>0.05$). The mean ROM at baseline was 98.50±12.12 which gradually improved till 6 months of follow-up (118.67±4.14) and then it remained stable till 12 months (119.67±3.93) followup. A study done by Shah et al which presented the results of subvastus approach showed a preoperative total ROM of 64° (range 36-90°) with a pre-operative flexion of 72° (range 40-90°).[20]

Post-operatively they reported a significant improvement in the knee flexion by a mean of 38° ($p<0.05$). The mean VAS at baseline was 4.40±1.49, which gradually decreased till 6 months of follow-up (2.20±1.09) and then remained stable till 12 months (1.97±1.03) follow-up. There was a significant improvement in the mean pain (VAS) immediately after the surgery. Berstock et al reported a significant improvement in pain score on day-one (0.8 out of 10) after subvastus approach.[21] Mohammad et al in their study had reported that subvastus approach had provided better pain relief postoperatively.[22]

Limitations

The limitations of our study are that the sample size is small and is lacking a comparative arm such as medial parapatellar approach, which would have provided a better comparison. Also the follow-up period was short, so could not evaluate the long-term implications of this approach.

CONCLUSION

On comparing the results of subvastus approach with the available literature we found a significant improvement in functional and clinical outcome with a stable improvement in range of motion with very few complications.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Grazio S, Balen D. Obesity: Risk factor and predictors of osteoarthritis. Lijec Vjesn. 2009;131:22-6.
2. Cila E, Güzel V, Ozalay M, Tan J, Simşek SA, Kanatli U et al. Subvastus versus medial parapatellar approach in total knee arthroplasty. Arch Orthop Trauma Surg. 2002;122(2):65-8.
3. Zhang Y, Jordan JM. Epidemiology of osteoarthritis. Clin Geriatr Med. 2010;26:355-69.
4. Fauré BT, Benjamin JB, Lindsey B, Volz RG, Schutte D. Comparison of the subvastus and paramedian surgical approaches in bilateral knee arthroplasty. J Arthroplasty. 1993;8:511-6.
5. Varacallo M, Luo TD, Johanson NA. Total Knee Arthroplasty Techniques. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2021.
6. Bourke MG, Jull GA, Buttrum PJ, Fitzpatrick PL, Dalton PA, Russell TG. Comparing outcomes of medial parapatellar and subvastus approaches in total knee arthroplasty: a randomized controlled trial. J Arthroplasty. 2012;27(3):347-353.e1.
7. Gidwani S, Fairbank A. The orthopaedic approach to managing osteoarthritis of the knee. BMJ. 2004;329(7476):1220-4.
8. Morrison W. Knee Replacement: Your Surgical Options, 2018. Available at: https://www.healthline.com/health/totalknreplacement-surgery/surgicaloptions. Accessed on 22 January 2022.
9. Sanna M, Sanna C, Caputo F, Piu G, Salvi M. Surgical approaches in total knee arthroplasty. Joints. 2013;1(2):34-44.
10. Endres NK, Minas T. Medial subvastus approach to the knee: surgical technique, 2021. Available at: http://www.orthojournalhms.org/volume10/manuscripts/PDF/V10_62.pdf. Accessed on 22 January 2022.
11. Keating EM, Faris PM, Meding JB, Ritter MA. Comparison of the midvastus muscle-splitting approach with the median parapatellar approach in total knee arthroplasty. J Arthroplasty. 1999;14(1):29-32.
12. Maestro A, Suarez MA, Rodriguez L, Guerra C, Murcia A. The midvastus surgical approach in total knee arthroplasty. Int Orthop. 2000;24(2):104-7.
13. Matsueda M, Gustilo RB. Subvastus and medial parapatellar approaches in total knee arthroplasty. Clincal Orthop Related Res. 2000;(371):161-8.
14. Roysam GS, Oakley MJ. Subvastus approach for total knee arthroplasty: a prospective, randomized, and observer-blinded trial. J Arthroplasty. 2001;16(4):454-7.
15. Weinhardt C, Barisic M, Bergmann EG, Heller KD. Early results of subvastus versus medial parapatellar

approach in primary total knee arthroplasty. Arch Orthop Trauma Surg. 2004;124(6):401-3.
16. Bonutti PM, Zywiel MG, Ulrich SD, Stroh DA, Seyler TM, Mont MA. A comparison of subvastus and midvastus approaches in minimally invasive total knee arthroplasty. J Bone Joint Surg Am. 2010;92(3):575-82.
17. Liu Z, Yang H. Comparison of the minimally invasive and standard medial parapatellar approaches for total knee arthroplasty: systematic review and metaanalysis. J Int Med Res. 2011;39(5):1607-17.
18. Masjudin T, Kamari Zh. A comparison between subvastus and midvastus approaches for staged bilateral total knee arthroplasty:a prospective, randomized study. Malays Orthop J. 2012;6(3):31-6.
19. Teng Y, Du W, Jiang J, Gao X, Pan S, Wang J et al. Subvastus versus medial parapatellar approach in total knee arthroplasty: meta-analysis. Orthopedics. 2012;35(12):e1722-31.
20. Shah NA, Patil HG, Vaishnav VO, Savale A. Total knee arthroplasty using subvastus approach in stiff knee: A retrospective analysis of 110 cases. Indian J Orthop. 2016;50(2):166-71.
21. Berstock JR, Murray JR, Whitehouse MR, Blom AW, Beswick AD. Medial subvastus versus the medial parapatellar approach for total knee replacement: A systematic review and meta-analysis of randomized controlled trials. EFORT Open Rev. 2018;3(3):78-84.
22. Mohammad KF, Santharam B, Girish B, Narayan P. A Prospective Study of Subvastus Approach vs. Medial Parapatellar Approach for Total Knee Arthroplasty. J. Evid. Based Med. Healthc. 2019;6:2349-562.
23. Sukeik M, Sohail MZ, Hossain FS, AlShryda S, Powell J. Comparing the Sub- Vastus and Medial Parapatellar Approaches in Total Knee Arthroplasty: A Meta- Analysis of Short-Term Outcomes. Dr. Sulaiman Al Habib Med J. 2021.

Cite this article as: Gupta T, Nigam A, Neema PP, Rassiwala M. A study to assess the clinical and functional outcome of subvastus approach for total knee arthroplasty. Int J Res Orthop 2022;8:331-8.