

Comparative Study of Minimal Invasive Subvastus Approach Versus Standard Medial Parapatellar Approach in Total Knee Arthroplasty

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Abstract

➤ *Background:*

For end stage degenerative arthritis or deformity of knee, Total Knee Arthroplasty (TKA) is the gold standard treatment. Our study compared the early functional results and complication rates of the minimal invasive subvastus (SV) approach to the standard medial para patellar (MPP) in primary TKA;

➤ *Materials and Methods:*

This study was a prospective, randomized and comparative study. Our study, consist of 20 patients in SV group and 20 patients in MPP group, randomly selected patients of either sex suffering from primary osteoarthritis of knee; treated with TKA. Assessment of the results was based on the clinical and functional knee society score at preoperative, two weeks and 3, 6, and 12 months post-operatively;

➤ *Results:*

Our study shows that Straight Leg Raise (SLR) was in a significantly shorter time in the SV group, indicating an earlier return of quadriceps function (SV group: 2.40 ± 0.68 days vs. MPP group: 4.30 ± 0.92 days; p-value = <0.0001). Hospital stay duration was shorter in the SV group (SV group: 6.3 ± 1.26 days vs. MPP group: 7.9 ± 1.25 days; p-value = 0.0003). On the other hand, SV group has slightly longer surgical time (SV group 80.75 ± 10.6 minutes vs. MPP group was 73.35 ± 10.87 minutes; p-value 0.0356). According to the overall clinical and functional knee society scoring system, there was improvement in the scores at different follow-up periods in both groups without any significant difference between the two groups. There was no increase in postoperative complications rate in SV group in comparison to MPP group;

➤ *Conclusions:*

SV approach is a good alternative approach for TKA with early functional results improvement and without increase in the overall complication rate within one year. Although, it provides good exposure to most of cases, but it is a little bit more technically difficult surgical approach and there is a learning curve for surgeons new to this technique.

Keywords:- Total Knee Arthroplasty, Subvastus, Medial Parapatellar, Knee Society Score, Straight Leg Raise, Learning Curve.

I. INTRODUCTION

Due to ongoing improvement in the surgical techniques and design of implant materials, Total Knee Arthroplasty (TKA) has become a very successful intervention in the treatment of end stage arthritis or deformity of the knee [1]. The most common TKA technique, as reported in national joint registries, is standard medial parapatellar (MPP) approach [2], as it provides excellent exposure. The main demerit of this approach is that it may cause the impairment of blood supply to the patella because the incision in the vicinity of the patella [3,4], that may leads to osteonecrosis of patella, fracture of patella or anterior knee pain. Lateral retinacular release further increases the risk of osteonecrosis of patella in this approach. Quadriceps-sparing technique, minimal invasive subvastus (SV) approach was introduced by Hoffman et al. [5]. This approach can conserve the blood supply to the patella, even if lateral retinacular release is required, and in addition, it provides an adequate surgical view. Furthermore, since it preserves the quadriceps muscle function, it reduces the problem of patellar tracking. However, subvastus technique can be more difficult in stiff knees or muscular patients, and there is a learning curve for surgeons new to the technique [1, 6].

II. AIMS AND OBJECTIVES

Our study is a prospective, and comparative study to compare the early functional results and complication rates of the SV approach to the MPP in primary TKA in primary osteoarthritic patients; to examine the effect of minimal invasive SV approach on operative time, blood loss, size of incision, duration of hospital stay, and postoperative well-being; to compare the knee society knee score and knee society functional score preoperatively and postoperatively at different follow-up periods and to systematically review current literature comparing the MPP approach and SV approach in TKA to determine whether one has superior outcomes over the other.

III. MATERIALS AND METHODS

This study was conducted in the department of Orthopaedics, Govt. Medical College and attached group of hospitals, Kota (Rajasthan). It was a comparative, prospective study done on 40 patients treated with primary TKA during the years 2015-2017. The study population was divided into two groups of patients who met with inclusion criteria, underwent TKA with the same surgical team: 20 cases in SV group and 20 cases in MPP group, following the same arthroplasty model and similar preoperative and postoperative procedures. The posterior cruciate ligament sacrificing type LCS design (DePuy, Zimmer, Stryker, and Maxx) was used. Written informed consent was taken from all patients involved in our study. Demographic, clinical, and radiographic data were collected preoperatively, and post-operatively at 2 weeks, 12 weeks, 6 months and at 1 year of follow-up as per the Knee Society Score and Knee Functional Scoring system.

➤ *Inclusion Criteria:*

Patient from either sex with primary severe osteoarthritis of knee.

➤ *Exclusion Criteria:*

Previous knee osteotomies; damage of the extensor mechanism of knee; recent or ongoing knee sepsis; flexion deformity of knee >15 degree; varus-valgus deformity > 15 degree; Body mass index (BMI) greater than 40 kg/m²; painless and well functioning knee arthrodesis; and recurvatum deformity secondary to muscular weakness.

➤ *Scoring System:*

The objective knee score, completed by the surgeon, includes a score of pain (includes while walking on level ground, on stairs or inclines), Range Of Motion (ROM), and stability (anteroposterior and mediolateral) as well as deductions for alignment, flexion contracture and extensor lag. The functional component of the score includes standard activities of daily living like walking, stairs use along with deduction for walking aids use. The postoperative version asks patients to compare their initial expectations with current reality for pain relief, range of motion and activities of daily living (squatting, kneeling, cross leg sitting etc). The range of movement of the knee was measured with a goniometer. The maximum Knee clinical Score is 100 points and the maximum Functional Score is 100 points.

➤ *Follow Up Evaluations:*

- *Case-1 (MPP Group): Clinical & radiological evaluation of knee at 12 weeks.*



Fig 1

- *Case-2 (MPP group): Clinical & radiological evaluation of knee at 6 months.*



Fig 2

- *Case-3 (MPP group): Clinical & radiological evaluation of knee at 1 year.*



Fig 3

*(SLR- Straight Leg Raising, ROM- Range Of Motion.

- *Case-1 (SV group): Clinical & radiological evaluation of knee at 12 weeks.*

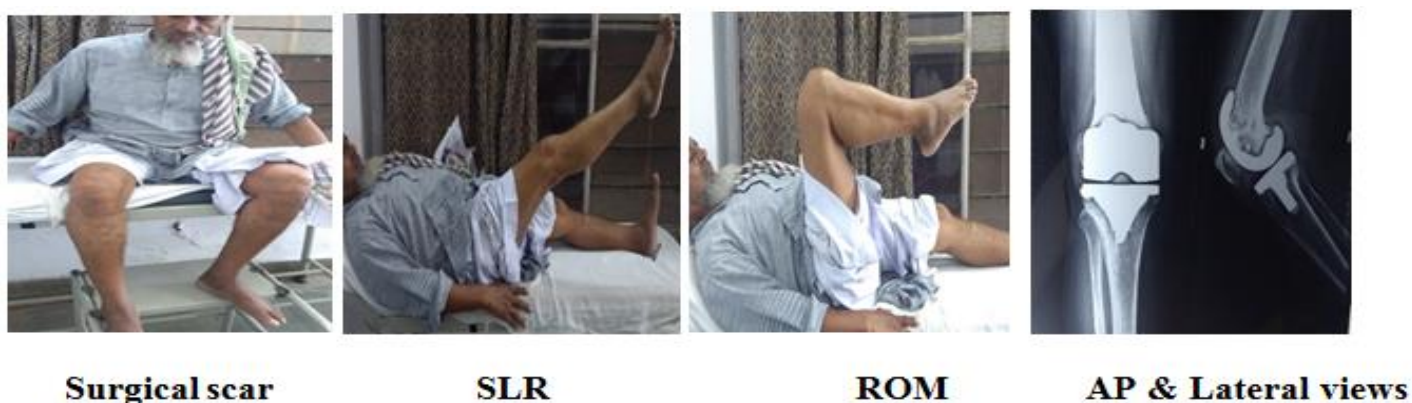


Fig 4

- *Case-2 (SV group): Clinical & radiological evaluation of knee at 6 months.*



Fig 5

- Case-3 (SV group): Clinical & radiological evaluation of knee at 1 year.



Fig 6

*(SLR- Straight Leg Raising, ROM- Range Of Motion).

IV. OBSERVATIONS AND RESULTS

All demographic data (age, sex, BMI, comorbidity) were comparable in both groups.

S.N.	Observations (mean)	MPP group [n=20]		SV group [n=20]		p-value
		Mean±SD	Min-Max	Mean±SD	Min-Max	
1.	Length of Cutaneous Incision (cm)	12.84 ± 0.61	11.8-13.8	12.66 ± 0.51	11.8-13.6	0.3222 (NS)
2.	Surgical Time (min)	73.35± 10.87	55-100	80.75 ± 10.60	59-102	0.0356 (S)
3.	Lateral Retinacular release (no. of cases)	2 (10%)	-	1 (5%)		-
4.	Blood Loss (ml)	597.75±57.95	490-700	586.75±59.43	475-675	0.5570 (NS)
5.	Straight Leg Raise (days)	4.30±0.92	3-6	2.40±0.68	2-4	<0.0001 (ES)
6.	Hospital stay (days)	7.9±1.25	6-10	6.3±1.26	4-8	0.0003 (ES)

Table 1:- Comparison of Various Observations between MPP Group and SV Group.

*NS= Not Significant, S= Significant, ES= Extremely Significant.

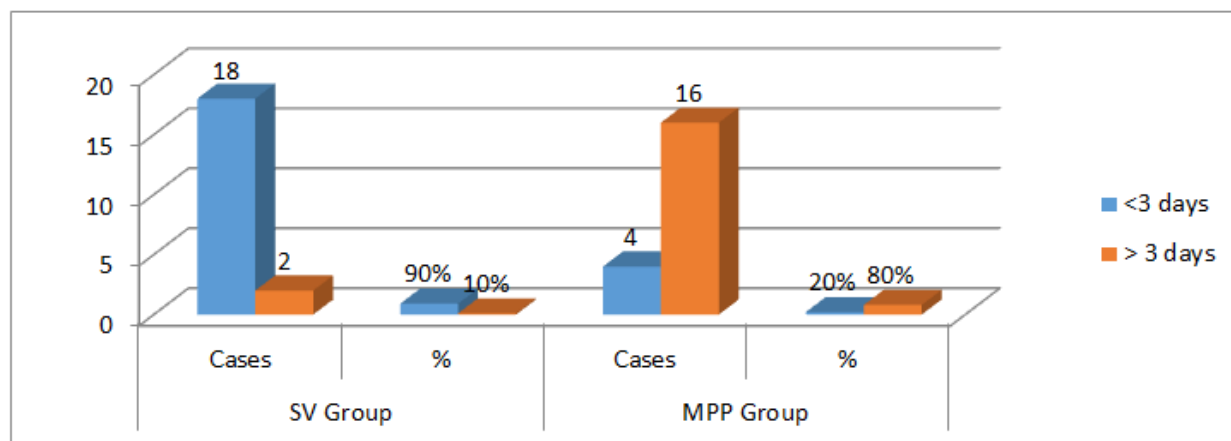


Fig 7:- Showing ‘Straight Leg Raise’ Duration between SV Group and MPP Group.

Quadriceps strength there was periodic improvement overtime on the two groups with no significant differences,

except on the 2nd week ($p=0.02$) where patients in SV group had stronger muscle.

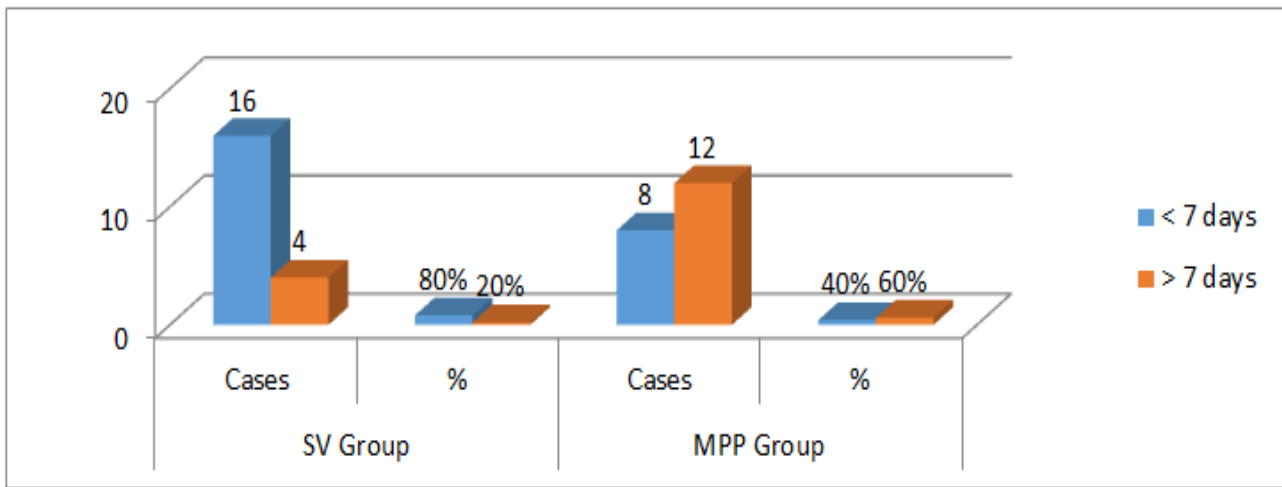


Fig 8:- Showing ‘Hospital Stay’ Duration between SV Group and MPP Group.

Knee Society Score: As regard the Knee Society Score (primary outcome), clinical evaluation which represented by: **Pain:** Pain improved significantly ($p<0.0001$) at different follow-up periods when compared to the previous time period in both groups except on the 2nd week for the group. No statistically significant difference between the two groups in periodic improvement at different follow-up periods. **Range Of Motion (ROM):** The knee range of motion (ROM) score improved significantly overtime in both groups ($p<0.0025$). No

statistically significant difference between the two groups regarding ROM points at different follow-up periods. Range of motion at 1 year was $118.75^{\circ}\pm 7.5$ for MPP group and it was $120.25^{\circ}\pm 4.5$ for SV group. Other points of Knee Society Score such as Knee Stability (Antero-posterior & medio-lateral), Flexion Contracture, Extension leg and Alignment (Varus & Valgus) considered accordingly and a cumulative Knee Society Score calculated for each case of both groups.

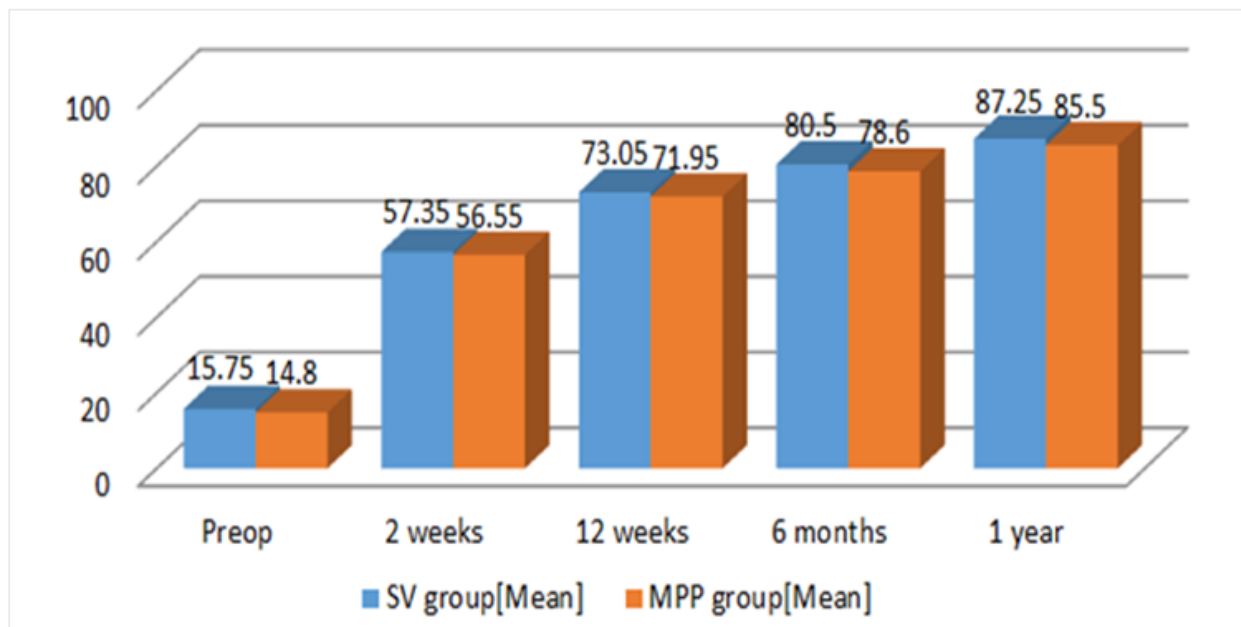


Fig 9:- Comparison of Knee Society Score (KSS) between MPP Group and SV Group.

Knee Functional Score: The Knee Function Score which represented by the overall function score [walking capacity, Stairs (up & down), with or without walking aids], there was periodic improvement at different follow-

up periods in function for both groups except in the 2nd week where, there was a significant deterioration in both groups. No statistically significant difference between the

two groups in periodic improvement at different follow-up periods.

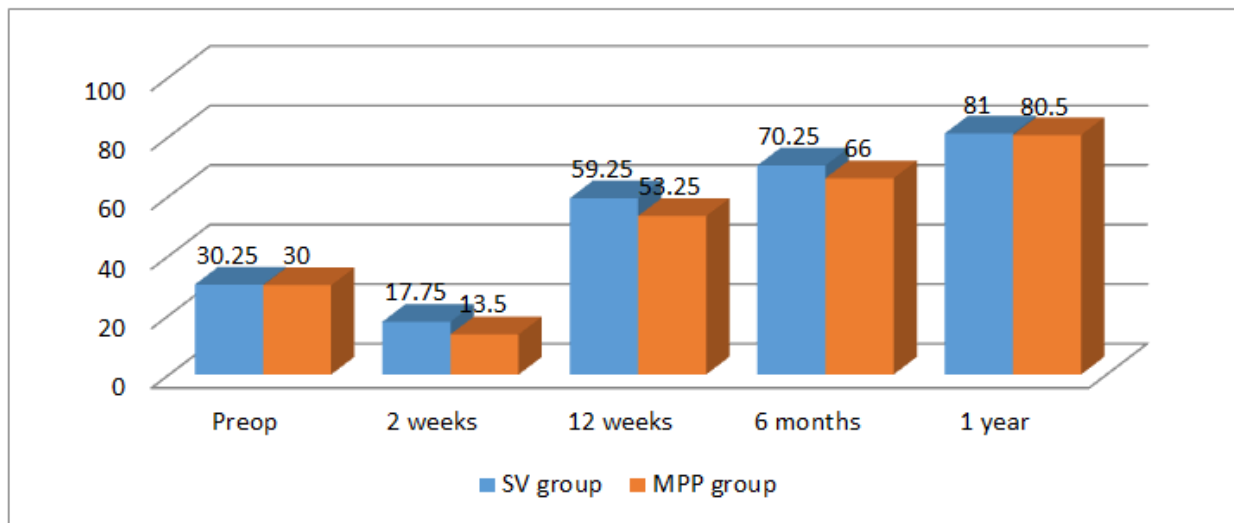


Fig 10:- Comparison of Knee Functional Score between MPP Group and SV Group.

V. DISCUSSION

In our study, mean surgical time for SV group is 80.75 minutes [range 59-102] and for MPP group is 73.35 minutes [range 55-100]. Here p -value [0.0356] is statistically significant between two groups. Van Hemert et al. 2010 found mean surgical time 74.7 minutes in SV group and 69 minutes in MPP group. Hongsen Chiang et al. (7) found mean surgical time 89.6 minutes in SV group and 66.9 minutes in MPP group. These findings correlate well with the observations of our study. While, Weinhardt et al. 2004 found less mean surgical time in SV group. They reported mean surgical time 75 minutes in SV group and 80 minutes in MPP group. Findings of this study, contrary our results.

In our study, the surgical time for the SV group was significantly longer in comparison to the MPP group, as this procedure is more technically difficult and may be explained by the learning curve to gain experience with this technique but is still well within the acceptable operative time of the surgeon.

In our study, mean size of cutaneous incision in SV group is 12.66 centimetre [range 11.8-13.6] and in MPP group is 12.84 centimetre [range 11.8-13.8]. No statistically significant difference found (p -value= 0.3222) between both groups. Hongsen Chiang et al. 2011 (7) found length of surgical incision in SV group 12.2 ± 0.9 cm and in MPP group 12.9 ± 0.8 cm. Observations of our study correlate with these findings.

In our study, lateral retinacular release was done in 2 patients (10%) of MPP group while it was performed in only 1 patient (5%) of the SV group. It was statistically not significant (p -value=0.9753) similar to the observations of Bridgman et al. (2009) and Pan et al. (2010), while Roysam et al. (2001) and Van Hemert (2010) found no need of lateral retinaculum release in their studies. Although, lateral

release procedure would eliminate lateral pull on the patella that is produced by the vastus lateralis muscle, the patella-femoral ligaments, or the lateral retinaculum provided that normal rotation is maintained.

We found that, Straight Leg Rise (SLR) in a significantly shorter time in the SV group (MPP: 4.30 ± 0.92 vs. SV: 2.40 ± 0.68 , p -value= <0.0001). It shows that quadriceps function returns earlier in the SV group. In other comparative studies, Roysam et al. 2002 (8), Weinhardt et al. (2004), patients who had the SV approach, could elevate their legs on an average of 2.6-4 days earlier than those who had the MPP approach. Observations of our study correlate well with these studies.

In our study, mean estimated blood loss in SV group is 586.75 ml [range 475-675] and in MPP group is 597.75 ml [range 490-700]. It shows statistically insignificant difference (p -value= 0.5570) between both groups. Hongsen Chiang et al. (2011), found 633.4 ml blood loss in SV group and 657.4 ml blood loss in MPP group. Observations of our study correlate with these findings. While, Boerger et al. 2005 (9) detected 10% more bleeding in SV group. However, Zanasi et al. (2006) found no difference. These findings contrary results of our study. The higher bleeding in SV group could be due to difficulty of making a perfect hemostasis after the components have been definitively placed and by the collection of blood under the vastus medialis muscle. Although, there is no differences existed in the rate of transfusion in both groups.

We found statistically significant difference in length of hospital stay between the two groups, it was shorter in the SV group, (MPP: 7.9 ± 1.25 vs. SV: 6.3 ± 1.26 , p -value = 0.0003), similar findings correlate with study of Munenori et al. 2000 (10) and Varela-Egocheaga et al. (2010).

So, in our study the subvastus approach allows faster straight leg raising, earlier improvement of the quadriceps

strength, shorter length of hospital stay. This can be achieved without more complications than MPP approach, only the operative time became a somewhat longer especially in our early cases due to the learning curve.

Clinical evaluation was based on the knee society objective and functional rating scales, included the Knee Score (severity of pain, range of motion and stability of the knee) and the function score (functional capacity during walking and climbing stairs).

Based on analgesic consumption, Pain was improved significantly ($p < 0.0001$) at different follow-up periods when compared to the preoperative pain status in both groups. No statistically significant difference between the two groups in periodic improvement at different follow-up periods. Pain improved significantly overtime in both groups. These findings correlate with the observations of Bourke et al. (2012), and Ahmed M. Kholeif et al (11).

The knee range of motion (ROM) score improved significantly overtime in both groups ($p < 0.0025$), except on the 2nd week for both the groups. No statistically significant difference between the two groups regarding ROM points at different follow-up periods. These findings correlate with the observations of Dutka et al (2011), and Ahmed M. Kholeif et al (11).

According to the overall clinical knee society score there was improvement at different follow-up periods in both groups ($p < 0.0001$) without any significant difference between the two groups at any period of study. These findings correlate with the observations of Sastre et al (2009), and Ahmed M. Kholeif et al (2017).

The knee function score which represented by the overall function score there was periodic improvement ($p < 0.0006$) in both groups at different follow-up periods of study, except in the 2nd week where, there was a significant deterioration. These findings correlate with the observations of Sastre et al. (2009), and Ahmed M. Kholeif et al (2017).

➤ *Complication Rates:*

Our study doesn't show any major perioperative complications in either group. During surgery, being more careful with the soft tissues may have avoided the high number of cutaneous complications. Post-operative medial thigh hematoma developed into 2 knees [10%] of SV group. These were transient and did not influence eventual range of motion, rehabilitation, transfusion rates or pain levels. Close attention to excellent hemostasis with inspection after letting the tourniquet down is necessary. Perhaps a more tight or extensive deep fascial layer closure would have eliminated or minimized hematomas. Superficial wound infection that resolved with dressings and antibiotics for one week was noticed in MPP group in two cases [10%] and in SV group in one case [5%]. Flexion contracture (5-10 degree) was noticed in three cases [15%] of MPP group and two cases [10%] of SV group. A physiotherapy rehabilitation protocol was followed for 12 weeks to relieve this flexion contracture. There was no

clinical evidence of deep venous thrombosis in either group or other major complications. These findings correlate well with the study of Bridgman et al. 2009 (1), Sastre et al. (2009), Varela-Egocheaga et al. (2010) and Ahmed M. Kholeif et al 2017 (11).

➤ *Grading:*

Grading of the Knee Society Score and Knee Functional Score for each follow-up case was done according to INSALL et al. (1989). Score 80-100 considered excellent, 70-79 good, 60-69 fair and score below 60 considered poor grading. In our study, for Knee Society Score grading: 75% results were excellent, 20% results were good, 5% results were fair at 1 year post-operative follow-up in both groups. No one case was considered in poor grading. Knee Functional Score grading for SV group: 70% results were excellent, 25% results were good, 5% results were fair at 1 year post-operative follow-up. No one case was considered in poor grading. Knee Functional Score grading for MPP group: 65% results were excellent, 30% results were good, 5% results were fair at 1 year post-operative follow-up. No one case was considered in poor grading. These observations correlate with the study of Bridgman et al. 2009 (1), Varela-Egocheaga et al. (2010), Bourke et al. (2012) and Ahmed M. Kholeif et al (2017).

VI. CONCLUSION

Our study shows that the SV approach allowed earlier straight leg raising, earlier quadriceps strength improvement, shorter hospital stay and better function score when compared to the standard MPP approach. On the other hand, SV approach has slightly longer surgical time. Although, it provides good exposure to most of cases, but it is a little bit more technically difficult surgical approach and there is a learning curve for surgeons new to this technique. SV approach is a good alternative approach for TKA with early functional results improvement and without increase in the overall complication rate within one year.

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