

# Total knee arthroplasty using subvastus approach in stiff knee

## A retrospective analysis of 110 cases

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### ABSTRACT

**Background:** Subvastus approach used in total knee arthroplasty (TKA) is known to produce an earlier recovery but is not commonly utilized for TKA when the preoperative range of motion (ROM) of the knee is limited. Subvastus approach is known for its ability to give earlier recovery due to less postoperative pain and early mobilization (due to rapid quadriceps recovery). Subvastus approach is considered as a relative contraindication for TKA in knees with limited ROM due to difficulty in exposure which can increase risk of complications such as patellar tendon avulsion or medial collateral injury. Short stature and obesity are also relative contraindications. Tarabichi successfully used subvastus approach in knees with limited preoperative ROM. However, there are no large series in literature with the experience of the subvastus approach in knees with limited preoperative ROM. We are presenting our experience of the subvastus approach for TKA in knees with limited ROM.

**Materials and Methods:** We conducted retrospective analysis of patients with limited preoperative ROM (flexion  $\leq 90^\circ$ ) of the knee who underwent TKA using subvastus approach and presenting the 2 years results. There were a total 84 patients (110 knees) with mean age 64 (range 49–79 years) years. The mean preoperative flexion was  $72^\circ$  (range  $40^\circ$ – $90^\circ$ ) with a total ROM of  $64^\circ$  (range  $36^\circ$ – $90^\circ$ ).

**Results:** Postoperatively knee flexion improved by mean  $38^\circ$  ( $P < 0.05$ ) which was significant as assessed by Student's *t*-test. The mean knee society score improved from 36 (range 20–60) to 80 (range 70–90) postoperatively ( $P < 0.05$ ). There was one case of partial avulsion of patellar tendon from the tibial tubercle.

**Conclusions:** We concluded that satisfactory results of TKA can be obtained in knees with limited preoperative ROM using subvastus approach maintaining the advantages of early mobilization.

**Key words:** Limited preoperative range of motion, subvastus approach, total knee arthroplasty

**MeSH terms:** Knee replacement, osteoarthritis, arthroplasty replacement, knee

### INTRODUCTION

Total knee arthroplasty (TKA) is a well proven successful procedure due to its ability to achieve quality of life early. The range of motion (ROM) of the knee is an important contributory factor for the success of TKA apart from the relief of pain.<sup>1,2</sup> Deep flexion is important for certain populations for cultural and

religious activities. It is a well-known fact that preoperative ROM is one of the major factors determining ROM post TKA.<sup>3-5</sup> The technical problem in the knees with limited ROM lies in the difficulty of exposing the knee. The TKA can provide a significant benefit in these cases, but the associated complication rate is high.<sup>6,7</sup> Subvastus approach is known for its ability to give earlier recovery due to less postoperative pain and early mobilization (due to rapid quadriceps recovery).<sup>8-11</sup> Subvastus approach is considered as a relative contraindication for TKA in knees with limited ROM due to difficulty in exposure which can increase

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risk of complications such as patellar tendon avulsion or medial collateral injury.<sup>12-14</sup> Short stature and obesity are also relative contraindications. Tarabichi successfully used subvastus approach in knees with limited preoperative ROM.<sup>15</sup> However; there are no large series in literature with the experience of the subvastus approach in knees with limited preoperative ROM. We are presenting our experience of the subvastus approach for TKA in knees with limited ROM. Our hypothesis was that satisfactory results of TKA can be obtained in knees with limited preoperative ROM using subvastus approach.

## MATERIALS AND METHODS

84 patients (110 knees) with preoperative flexion  $\leq 90.0^\circ$  (stiff knee), operated by subvastus approach for TKA between 2008 and 2011 constitute this retrospective study. All the demographic data (such as age, height, weight, and body mass index [BMI]), radiographs, deformity and knee society scores (KSS) were collected prospectively for these patients. The patients with preoperative knee flexion  $\leq 90^\circ$  (which was confirmed on the table under anesthesia) who had given consent and were ready for followup were included in the study. Hospital Ethical Committee permission was taken. All the surgeries were performed by senior author (NAS). The mean age was 64 years (range 49–79 years). 6 patients were male and 78 were females. Average weight was 88 Kg (range 63–113 Kg). The average height was 156 cm (range 139–173 cm). Average BMI was 28 kg/m<sup>2</sup> (range 22–48 kg/m<sup>2</sup>). The cause for arthritis was osteoarthritis ( $n = 71$ ) and rheumatoid arthritis ( $n = 13$ ). One hundred and four knees had varus deformity, and 6 knees had a valgus deformity.

Same implant design (NexGen, Zimmer, Mumbai, India) was used (only difference was cruciate retaining [CR] and posterior stabilized [PS] which was decided intraoperatively) in all knees. Tourniquet was not used. Tranexamic acid in a dose of 15 mg/kg was given 30 min prior to surgery and two doses of 10 mg/kg were given 3 h and 6 h postsurgery.<sup>16</sup> The knee was evaluated under anesthesia as follows: Thigh was held vertical and the knee was allowed to flex by gravity (Drop and Dangle test)<sup>9</sup> and ROM was noted.

### Operative procedure

An adequate skin incision was made slightly medial to the midline of the knee, extending from slightly above superior pole of patella to the tibial tubercle with the knee in flexion. The deep fascia was invariably found thickened in stiff knees. This fascia was incised and released along the length of the incision. A small Langenbeck retractor was inserted in the line of the incision underneath the proximal edge of the wound and a finger was inserted to feel the tightness of the deep fascia. If found to be tight, with the help of a scissors

deep fascia was further divided until the midhigh (like an anterior fasciotomy over the quadriceps). This exposed the extensor apparatus. Saline with adrenaline (1:300,000) was infiltrated underneath the fascia medially and blunt dissection was carried out to expose inferior border of vastus medialis. With the knee in extension, a plane was created underneath the vastus medialis such that a small Langenbeck retractor could be introduced underneath the vastus medialis retracting it laterally. Another Langenbeck retractor was placed retracting the medial skin flap to expose the extensor apparatus. Tibial tubercle and medial border of patella were identified. Inverted L-shaped capsulotomy was made; the vertical limb of the incision was taken along the medial edge of the patellar tendon from the tibial tubercle until a point where a line along the inferior margin of vastus medialis would intersect it and then the horizontal limb of the incision was made along the inferior margin of the vastus medialis. A bent Hohmann retractor was placed in the lateral gutter retracting the quadriceps laterally which exposed the suprapatellar pouch. The suprapatellar pouch was invariably found thickened and fibrotic in knees with limited preoperative ROM and was excised. A periosteal elevator was placed on the anterior surface of the femur and was slid along the anterior surface as far as possible to release any adhesions between quadriceps and the anterior surface of the femoral shaft. With the bent Hohmann retractor in lateral gutter trochlear osteophytes if present were exposed and removed with the help of an osteotome. This allowed the patella to be tilted slightly so that prominent patellar osteophytes if present could be removed. After this, the patella was relocated in its groove and the knee was flexed as far as possible. The anterior horn of the medial meniscus was divided and the medial periosteum from the proximal tibia was raised until the midcoronal point.

In varus knees, prominent osteophytes were generally present on the medial femoral articular surface and these were removed with the help of an osteotome. Subligamentous osteophytes from underneath the medial collateral ligament (MCL) attachment on the femur, if present, were removed. The knee was placed in 'figure of 4' position and a bent Hohmann was placed around the medial shaft of the tibia revealing the medial tibial osteophytes, if present. These were removed with the help of bone nibblers or an osteotome. The tibia was externally rotated and the deep MCL was released from the proximal tibia by sharp dissection, if required. The prominent osteophytes underneath this ligament, if present, were also removed.

In valgus knees, the exposure of the medial tibia was limited only until the midcoronal point, and the deep MCL was not released. Lateral femoral osteophytes and the osteophytes from the lateral facet of the patella were removed, if present. The posterolateral capsule was released circumferentially

from the tibia as required. The IT band if appeared tight, was also released. Generally, the lateral collateral ligament and the popliteus tendon did not require a release.

For both the varus and valgus knees, with the Hohmann retractor around the lateral femoral surface the knee was gently bent while simultaneously externally rotating the leg. If a sufficient exposure of the distal femur was obtained, then further procedure was routine with an intramedullary guide for the femur and extramedullary guide for the tibia for the resection. If sufficient exposure was still not possible, then the knee was extended and the quadriceps was released further from the medial intermuscular septum such that the patella could be subluxed laterally even further. If there were prominent osteophytes in the intercondylar region of the femur or in the proximal tibia these were also removed. Rest of the procedure was routine.

Knees with limited preoperative ROM invariably had prominent femoral and tibial osteophytes posteriorly; these were carefully removed during surgery. If the knee was still too tight and the posterior cruciate ligament appeared contracted, it was either released or substituted. Patella was selectively resurfaced depending upon the state of patellar cartilage and presence of trochlear disease. An attempt was made to create symmetrical and equal flexion extension gap with resection of femur and tibia perpendicular to the mechanical axis. After the final cementation of the components, a drop and dangle test was carried out to confirm that flexion range had increased postsurgery. If the flexion range appeared to be inadequate the quadriceps was palpated to look for fibrous bands, if present these were pie crusted to improve the ROM. Care was taken not to close the fascia during closure.

Postoperatively, static quadriceps exercises and straight leg raising exercises were started as soon as the patient was out of the effect of anesthesia. Active ROM exercises were started from day 1. The patients were discharged when they were able to walk to the bathroom and sit on a chair. They were encouraged to exercise at home to maintain and improve the ROM of the knee. Patients were reassessed after surgery at 2 weeks, 6 weeks and 6 months then at the end of 1 year and 2 years when final ROM assessed and final KSS was calculated. We also noted the type and frequency of complications. All results were collected prospectively and analyzed retrospectively. Preoperative and postoperative values are compared using Student's *t*-test with a significant threshold defined at 0.05 ( $P < 0.05$ ).

## RESULTS

Subvastus approach provided satisfactory exposure in all knees.

40 knees had CR implants and 70 knees had cruciate sacrificing implants. The quadriceps was required to be elevated from the anterior surface of the femur in 95 cases. We were able to achieve improvement in flexion on addressing all the etiological factors; however, pie crusting of the quadriceps was required in one case.

The mean preoperative flexion was 72° (range 40°–90°) with a total ROM of 64° (range 36°–90°). Postoperatively, knee flexion improved mean 38° ( $P < 0.05$ ) which was significant as assessed by Student's *t*-test [Figures 1 and 2].

The mean KSS improved from 36 (range 20–60) to 80 (range 70–90) postoperatively ( $P < 0.05$ ). The improvement in the ROM and KSS for the knees having CR implants and for the knees having cruciate substituting implants is compared in Table 1. We encountered partial avulsion of patellar tendon in one knee which was identified on table and patellar tendon resutured by taking transosseous suture through tibia. Postoperatively, no extensor lag was noted in the same patient when assessed at the end of 6 months. None of the knees had radiographic signs of loosening at the end of 2 years and in none of the patient revision procedure was required.

## DISCUSSION

Results of TKA in knees with limited preoperative ROM are generally suboptimal in terms of total improvement in ROM<sup>17,18</sup> and there is a higher incidence of complications. The difficulty in the surgical approach for these knees lies in the fact that routine patellar mobility and adequate knee exposure cannot be easily achieved.<sup>19</sup> The common surgical options available to achieve sufficient exposure in stiff knee such as quadriceps snip, modified V-Y plasty, and tibial tubercle osteotomy can also be associated with complications.<sup>20-22</sup>

Biomechanical studies have shown that the satisfactory flexion required for various activities of daily living is as follows: 67° for the swing phase of gait, 83° for climbing up stairs, 90° for descending stairs, and 93° for rising up from

**Table 1: Comparison of results using CR and PS knees**

Clinical data	CR knees (40)	PS knees (70)	All the knees
The mean preoperative flexion	74° (range 44°-90°)	70° (range 40°-90°)	72° (range 40°-90°)
The mean improvement in the knee flexion postoperatively	36	40	38°
The mean preoperative KSS	38	34	36 (range 20-60)
The mean postoperative KSS	80	80	80 (range 70-90)

KSS=Knee society scores, CR=Cruciate retaining, PS=Posterior stabilized





**Figure 1:** (a) X-ray of knee joint anteroposterior and lateral views showing severe osteoarthritis (b) Preoperative clinical photograph showing drop and dangle test under anaesthesia and available flexion (c) X-ray anteroposterior and lateral views showing postoperative x-ray with TKR implant *in situ* (d) Clinical photographs showing flexion at end of surgery (e) Clinical photograph showing flexion at end of 2 years



**Figure 2:** (a) X-ray of knee joint anteroposterior and lateral views showing severe osteoarthritis (b) Preoperative clinical photograph showing drop and dangle test under anaesthesia and available flexion (c) X-ray anteroposterior and lateral views showing postoperative x-ray with TKR implant *in situ* (d) Clinical photographs showing flexion at end of surgery (e) Clinical photograph showing flexion at end of 2 years

a chair.<sup>23,24</sup> Knee flexion  $\leq 90^\circ$  were chosen as inclusion criteria because this would provide adequate motion for patients to perform activities of daily living.

The etiological factors for the limited ROM in osteoarthritic knees vary from tight quadriceps mechanism to prominent osteophytes and contracted ligaments and capsule.<sup>15,25</sup> The surgeon should identify these factors in each case and address them accordingly. Tarabichi in his study of

42 knees ( $n = 24$ ) was able to achieve immediate and significant improvement in ROM by releasing only the quadriceps muscle from its tethering adhesions (modified quadricepsplasty) by the subvastus approach and keeping other pathological changes such as large osteophytes, severe knee deformities and irregular articular surfaces intact.<sup>15</sup> The author concluded that inadequate excursion of the quadriceps muscle and tendon was the main limiting factor for the knee flexion. However, no other author has

Table 2: Literature review

Authors	Total knees/approach	Mean followup (years)	KSS		Preoperative ROM (degrees)	Postoperative improvement flexion/ROM (degrees)
			Preoperative	Postoperative		
Debette et al. 2014 <sup>27</sup>	239/medial parapatellar	5	33	86	<90	Flexion 39
Hsu et al. 2012 <sup>29</sup>	39/medial parapatellar	4.8	-	-	<50	ROM 59
Winemaker et al. 2012 <sup>27</sup>	134/medial parapatellar	1	-	-	<80	ROM 30.8°±18.8
McAuley et al. 2002 <sup>30</sup>	27/medial parapatellar	6	-	-	<50	ROM 44
Tarabichi and Tarabichi 2010 <sup>15</sup>	42/subvastus	-	-	-	<90	Flexion 34
Aglietti et al. 1989 <sup>31</sup>	20/medial parapatellar	4.5	34	74	<50	Flexion 25
Bhan et al. 2006 <sup>6</sup>	64/medial parapatellar	6.2	34.5	89.5	<50	Flexion 25
Montgomery et al. 1998 <sup>28</sup>	82/medial parapatellar	5.3	38	80	<50	Flexion 36
Spicer et al. 2002 <sup>32</sup>	22/medial parapatellar	4.3	24.6	77	<60	ROM 46
Current study	110/subvastus	2	40	80	<90	Flexion 38

KSS=Knee society scores, ROM=Range of motion

duplicated similar work. The subvastus approach requires the quadriceps to be mobilized from the intermuscular septum and fascia which in itself can address the pathology for the arthritic knees with limited ROM i.e., a tight quadriceps mechanism. When these knees are operated by the parapatellar approach, the tight quadriceps mechanism which is incised and resutured at the same level heals by fibrosis which may add to the limitation to the flexion even further. However, in the subvastus approach there is no resuturing of the quadriceps to the septum and fascia which maintain the advantage of the release and avoid fibrosis. Additionally, in the subvastus approach the quadriceps mechanism is intact which results in early quadriceps recovery and allows early mobilization of the patient. The results of our analysis of our series allow us to conclude that TKR performed in the setting of knees with limited ROM via subvastus approach can give satisfactory results in terms of mobility as evidenced by improvement in preoperative flexion ( $P < 0.05$ ).

We found only one study in literature about TKA in knees with limited preoperative ROM using subvastus approach. Tarabichi<sup>15</sup> (2001) used subvastus approach and modified quadriceps release (only the distal portion of the quadriceps muscle is bluntly released from any adhesions to the femur and surrounding tissue) in 42 stiff arthritic knees (ROM <90°). The mean improvement in the ROM was 34° (38° in our study). They concluded that adhesions of the quadriceps muscle to the underlying femur, which prevent the distal excursion of the quadriceps tendon, as the restrictive pathology preventing deep flexion in patients with osteoarthritis.

Debette et al.<sup>26</sup> (2014) retrospectively analyzed 239 patients with limited knee flexion (<90) who underwent TKA. The mean preoperative flexion was 83°. They got significant improvement in ROM i.e. 39°. The KSS improved from 33 to 86. The rate of intraoperative complications was relatively high in their series in the flexion deficit group (11 cases

or 4.6%) with six fractures of the tibia, two ruptures of the patellar tendon, one division of the popliteus tendon, one anterior tibial tuberosity fracture and one case of impingement between the polyethylene and the patella after surgery. Winemaker et al.<sup>27</sup> (2012) evaluated 1 year TKA outcomes among 134 preoperative stiff knees, with ROM 80° or less and compared with 134 nonstiff preoperative knees, with ROM 100° or greater. The mean improvement in ROM from baseline to 1 year was 30.8° ±18.8° in stiff knees. Bhan et al.<sup>6</sup> (2006) retrospectively reviewed 64 TKA with minimum 2 years followup who had less than a 50° arc of flexion preoperatively. The mean improvement in the arc of flexion was 25°. The KSS improved from 34.5 to 89.5. There were major complications in two patients. Montgomery et al.<sup>28</sup> (1998) reviewed 71 patients with a total preoperative arc of motion of ≤50° who underwent 82 TKA between 1974 and 1987. The average improvement in the flexion was 36°. The KSS improved from 38 to 80. Two knees had a decreased ROM postoperatively. Two knees with severe flexion-valgus deformities developed peroneal nerve palsies that both resolved. Regarding the knee flexion and KSS, the improvement observed in our series is comparable to these large series in literature using routine parapatellar approach [Table 2].

This study is admittedly limited in that it is a retrospective analysis. All cases were operated by a single senior surgeon experienced in subvastus approach. The study population is diverse as both CR and PS knees were included. In addition, the accuracy of measurement of ROM of the knee with a clinical goniometer would be less than that compared with using an electrogoniometer or fluoroscopically guided radiographic measurements. However, this study is unique of its kind as except Tarabichi et al. (2010) no one has reported the use of subvastus approach in knees with limited preoperative ROM. The strength of our study is that we were able to achieve improvement in preoperative ROM using subvastus approach ( $P < 0.05$ ), which is comparable to other series in literature.

To conclude satisfactory results of TKA can be obtained in knees with limited preoperative ROM using subvastus approach maintaining the advantages of early mobilization.

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### Conflicts of interest

There are no conflicts of interest.

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