

Assessment of patellar height after total knee arthroplasty and its effect on postoperative range of motion

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ABSTRACT:

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**The Egyptian Orthopedic Journal; 2020
supplement (1), June, 55: 7-11**

Objective:

Assessment of patellar height changes after total knee arthroplasty (TKA) and their effects on the range of motion (ROM).

Background:

The success rate of TKA exceeds 95%. The joint line often undergoes relative elevation after TKA; that is known as pseudo-patella baja (PPB). Patella baja (PB) can cause limited ROM and Stiffness with an approximate incidence of 1.3%.

Patients and Methods:

An analytical prospective study involving 30 knees of 27 patients who underwent primary TKA for advanced osteoarthritis. We measured knee ROM and measured the patellar height by three indices of patellar height assessment: the mCDI, the Blackburne and Peel index (BPI), and the Insall and Salvati index (ISI) for each patient preoperatively, three months later, and six months after surgery.

Results:

With BPI, there is a statistically significant effect on postoperative ROM, as evidenced by the significant change in patellar height in the form of PB (increased progress). With ISI there is a significant change in patellar height after TKA represented by patella alta but with no effect on postoperative ROM. With mCDI there is no significant change in patellar height after TKA.

Conclusion:

Patellar height changes after TKA but this change is not the main factor that affects postoperative ROM.

Keywords:

Patellar height – Total knee arthroplasty – Range of motion

INTRODUCTION:

A procedure with a success rate exceeding 95% is total knee arthroplasty (TKA).

[1] To maintain the tensions in the knee's collateral ligaments, the surgeon frequently employs polyethylene of a higher thickness during this procedure, which frequently results in relative elevation of the joint line. [2]

Pseudo-patella baja (PPB) is the term used to describe the elevation of the joint line. PPB is frequently the consequence of the use of a thick polyethylene insert during excess distal femoral bone resection and excess soft tissue release, as the femorotibial joint line increases without a change in the length of the patellar tendon. [3]

The literature has extensively documented the occurrence of patella infra or baja following TKA.

[4] Patella baja (PB) can result in an alteration in the patella's typical biomechanics, which can lead to anterior knee pain and a restricted range of motion (ROM), [5] The patella's impingement on the tibia during flexion. [6]

To ensure that the patellar tendon was tensioned, Insall and Salvati sought a method that would not be influenced by the actual size of the knee, the radiographic magnification, or the degree of flexion (provided that there was a sufficient degree of flexion, which was believed to be 20°). In 1971, They introduced the significant and now-classic ratio of the patellar diagonal length to the patellar tendon length. [7] However, since there are inaccuracies in the Insall and Salvati index (ISI), Other authors have introduced other ratios that utilize distinct measurements, with varying degrees of acceptance. The Blackburne and Peel index (BPI) is one of these methods, [8] the Caton-Deschamps index (CDI), [9] the Modified Insall and Salvati index (MISI) [10] and the modified Caton-Deschamps index (mCDI) [11] and others.

We aim to evaluate the impact of patellar height variations on the ROM following TKA.

PATIENTS AND METHODS:

Patients:

The study met ethical standards. All patients under study received an information packet providing them all they needed to know about our study our goals, the benefits, and guarantee of their privacy protection and they were given ample time to ask any questions. The investigation was limited to subjects who provided informed consent.

In the period between January 2018 and April 2019, an analytical prospective study was conducted involving 30 knees of 27 patients. There were 25 female patients and 2 male ones. They underwent primary TKA for knee joint advanced osteoarthritis.

The overall patient's mean age was 57 years old at the time of surgery (range 44 - 65 years) 11 right knees replaced, and 19 left knees replaced. Three patients had bilateral total knee replacement.

Criteria of inclusion:

Patients meeting all of the following criteria will be considered for the study:

- Osteoarthritis knee.
- No previous knee injury or surgical interference that affected the patellar height.

Criteria of exclusion:

- Revision TKA.
- Intra-operative patellar tendon injury, lateral patellar release, and/or patellar resurfacing.
- Postoperative complications affecting ROM e.g. infection, instability.

Methods:

We measured the patellar height by three indices of patellar height assessment: the ISI, the BPI, and the mCDI for each patient preoperatively, 3 months, and 6 months postoperatively on lateral view radiographs at approximately 20° knee flexion (Figures 1 & 2 & 3).

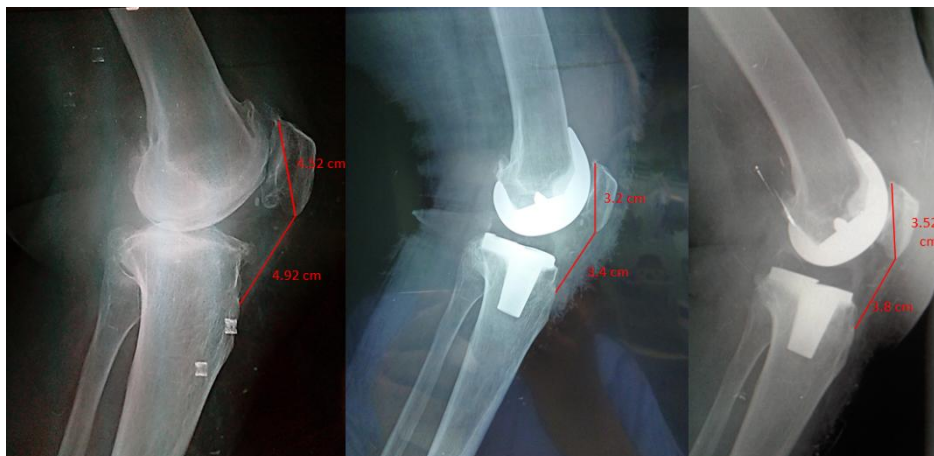


Figure 1: Insall and Salvatia index measurements on preoperative, 3-month, and 6-month postoperatively lateral radiographs of a left knee of one of the patients under the study.



Figure 2: Blackburne and Peel index measurements on preoperative, 3-month, and 6-month postoperatively lateral radiographs of the left knee of one of the patients under the study.

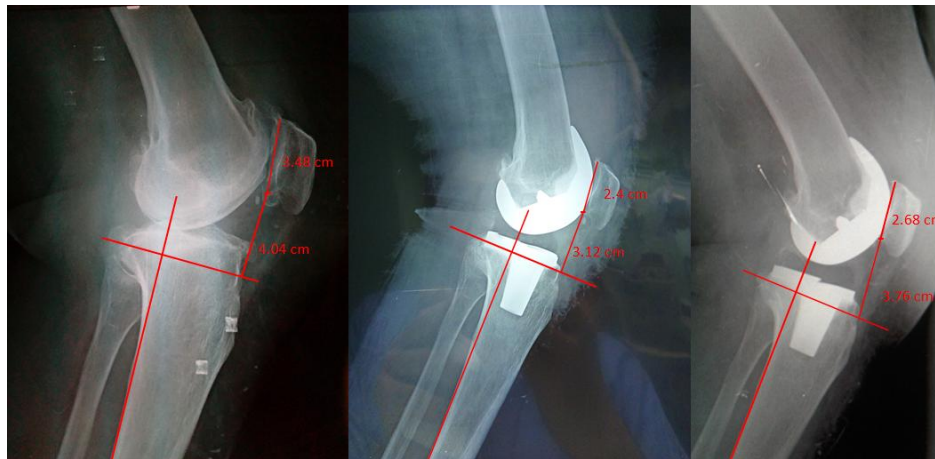


Figure 3: Modified Caton-Deschamps index measurements on preoperative, 3-month, and 6-month postoperatively lateral radiographs of a left knee of one of the patients under the study.

All measurements were obtained from digital lateral radiographs with 200% zoom, on slides in PowerPoint (Microsoft®), utilizing the Universal Desktop Ruler software (AVPSOft®) for measurement purposes.

The conventional goniometer was employed to determine the knee ROM for each patient before surgery, Routine physical examinations were conducted at three and six months postoperatively.

The Nex Gen® PCL substituting posterior stabilized prosthesis, manufactured by Zimmer® in Warsaw, Indiana, United States, was utilized by all patients.

Statistical analysis of the data

The IBM SPSS software program version 20.0 was employed to analyze the data that was inputted into the computer. (IBM Corp., Armonk, NY) Numbers and percentages were employed to characterize qualitative data. The normality of the distribution was confirmed using the Kolmogorov-Smirnov test. The range (minimum and maximum), mean, standard deviation, and median were employed to describe quantitative data. The significance of the results was assessed at the 5% level, and p-values were considered significant if they were less than 0.05.

RESULTS:

a. Insall and Salvati method:

There were 2 knees with patella alta preoperatively, they remained postoperatively and 2 more knees developed patella alta in 3 months postoperative follow-up that also remained with added another 2 knees developing patella alta in the 6 months follow up making them a total of 6 knees with patella alta of the 30 knees.

The other 24 knees had normal patellar height. No knees had PB (table 1).

Table 1: Comparison between the different periods studied according to Insall and Salvati index (n=30).

ISI	Pre-operative		Post-operative				p-value
	No	%	3 Months		6 Months		
			No	%	No	%	
Normal (0.8- 1.2)	28	93.3	26	86.7	24	80.0	0.049*
Patella alta	2	6.7	4	13.3	6	20.0	
Sig. bet. Periods	p ₁ =0.221, p ₂ =0.014*, p ₃ =0.221						

p: p-value for comparing the different studied periods p₁: p-value for comparing pre-operative and 3 months postoperative

p₂: p-value for comparing pre-operative and 6 months post-operative p₃: p-value for comparing 3 months and 6 months postoperative

*: Statistically significant at p ≤ 0.05

Those knees with postoperative patella alta did not have a significant difference in their ROM improvement from the postoperative normal patellar knees (P value equals 0.902) which is > 0.05 (table 2).

Table 2: Relation between Insall and Salvatia index and range of motion (n=30).

ROM	ISI		p-value
	Normal (0.8 – 1.2) (n= 24)	Patella alta (n= 6)	
Min. – Max.	79.0 – 161.0	98.0 – 130.0	0.902
Mean ± SD.	119.33 ± 18.08	118.33 ± 15.81	
Median	118.0	127.0	

p: p-value for the association between I.S and ROM

b. The Blackburne and Peel method:

There were no knees with patella alta or baja in the knees under study preoperatively when patellar height was assessed by BPI, and they were all within normal range. Postoperatively, 6 knees developed PB either in 3-month or 6-month follow-ups leaving 24 normal patellar height knees (table 3).

Table 3: Comparison between the different periods studied according to Blackburne and Peel index (n=30)

B&P	Pre-operative		Post-operative				p-value
	No	%	3 Months		6 Months		
			No	%	No	%	
Normal (0.54 – 1.06)	30	100.0	24	80.0	24	80.0	0.002*
Patella baja	0	0.0	6	20.0	6	20.0	
Sig. bet. periods	p ₁ =0.003*, p ₂ =0.003*, p ₃ =1.000						

p: p-value for comparing the different studied periods

p₁: p-value for comparing pre-operative and 3 months postoperative

p₂: p-value for comparing pre-operative and 6 months postoperative

p₃: p-value for comparing 3 months and 6 months postoperative

*: Statistically significant at p ≤ 0.05

Those knees that developed PB had a significant difference in their ROM improvement from the normal patellar height knees (table 4).

Table 4: Relation between Blackburne and Peel index changes from preoperative to 6 months postoperative and range of motion change in the same periods (n=30).

ROM	BPI		p-value
	Normal (0.54 – 1.06) (n= 24)	Knees developed patella baja (n= 6)	
Pre-operative			0.801
Min. – Max.	75.0 – 132.0	76.0 – 123.0	
Mean ± SD.	104.50 ± 18.03	102.33 ± 21.47	
Median	106.0	108.0	
6 months			0.016*
Min. – Max.	79.0 – 130.0	114.0 – 161.0	
Mean ± SD.	115.42 ± 14.38	134.0 ± 21.71	
Median	118.0	127.0	
% of Change			0.021*
Min. – Max.	-15.05 – 52.0	17.59 – 50.0	
Mean ± SD.	12.65 ± 19.40	32.83 ± 14.57	
Median	5.04	30.89	

p: p-value for the association between BPI and ROM *: Statistically significant at p ≤ 0.05

c. The modified Caton-Deschamps method:

As this method is rather comparative, it was applied preoperatively, 3-month, and 6-month postoperatively and results compared to each other. There was no significant change in the patellar height (table 5).

Table 5: Comparison between the different periods studied according to the modified Caton-Deschamps index (n=30).

mCDI	Pre-operative	Post-operative		p-value
		3 Months	6 Months	
Min. – Max.	1.02 – 1.98	0.70 – 1.62	0.78 – 1.82	0.615
Mean ± SD.	1.25 ± 0.25	1.21 ± 0.23	1.22 ± 0.24	
Median	1.16 (1.08 –	1.24 (1.08 –	1.17 (1.10 –	
(IQR)	1.26)	1.31)	1.37)	

p: p-value for comparing the different studied periods

DISCUSSION:

In the current study, it was determined that the Insall and Salvati method has numerous

drawbacks, including the challenge of accurately identifying the patellar tendon insertion on lateral knee radiographs and its affinity for various patellar morphologies.

The Insall and Salvati results in this study were the presence of 2 knees with patella alta preoperatively and the emergence of the other 4 post-operatively. Although this is a quite significant percentage of cases, those cases had no other symptoms or complaints that usually relate to patella alta neither pre- nor postoperatively. The 4 cases that developed patella alta postoperatively didn't have any significant difference in their ROM improvement postoperatively than the other cases that remained with normal patellar height.

Jawhar et al. also found the same presence of patella alta pre- and post-operative when using Insall and Salvati that changed when they used the modified Insall and Salvati method. [12]

Blackburne and Peel's method has been the most reliable method in our measurements it is easily reproducible, and not affected by different degrees of flexion as long as it is more than 25°. It is not even affected if there is some rotation, and certainly not affected by image magnification, and it is not affected by different morphology of the patella. Also, its landmarks are stable and easily identified. All that made it the most reliable method that is only affected by changes in the articular surface level and patellar height changes. By using the Blackburne and Peel method in this study, It was discovered that 20% of the cases are statistically significant for a change in patellar height following TKA. Those cases developed PB postoperatively.

The ROM enhancement of these cases, which developed PB postoperatively, was statistically significantly different from those who maintained a normal patellar height postoperatively.

This difference was an increase in the improvement of the ROM which could be due to a better preoperative ROM in cases that developed PB than in cases that remained within normal range. Also, it could be due to personal variation of some cases of PB being more responsive to physiotherapy and more active.

That difference also is in the mean of the ROM of the whole group of 6 cases of PB from which there are 4 cases. Their change in ROM is just like normal patellar height cases and the remaining 2 have a wider change that caused the mean of the whole group to increase. The better postoperative ROM in these two cases was likely the result of their superior preoperative ROM, their improved response to physiotherapy, and their lifestyle.

Behrend et al. also discovered that the mean

Blackburne and Peel (0.8–0.6) decreased from preoperative to 1-year follow-up. The mean joint-line shift in the cranial direction was 2 mm following the implantation of TKA. Patients with PPB exhibited significantly reduced flexion ($p < 0.001$). However, At the one-year follow-up, multiple regressions demonstrated that BPI was a significant positive independent predictor of flexion ($p < 0.001$). [13]

On the other hand, *Cabral et al.* discovered that, although patellar height was generally lower in their cases when measured postoperatively, this difference was not statistically significant for any of the methods examined. [14]

But *Gaillard et al.* also found PB statistically decreased the maximal flexion. [15]

Using the modified Caton-Deschamps index, no statistically significant change in the patellar height was encountered between preoperative and postoperative periods.

Applying that method also encountered some difficulties as the inability to precisely define the line parallel to the posterior tibial cortex with major changes in the index values with just little differences in that line. Also, a change in the degree of flexion changes the ratio significantly together with no specified range of flexion to apply the method making its reproducibility less applicable. In cases with larger tibial cuts, the perpendicular line might not be able to intersect with the anterior cortex.

Prudhon et al. The average difference between pre-operative and post-operative mCD was 0.19 in their series. The patella was reduced in 81.7% of the cases. The patients were categorized into three categories based on the reduction in patella height. The ROM of these three groups did not exhibit any significant statistical differences. [16]

They were unable to identify any significant differences between these three groups when they compared the IKS score, knee function, flexion, and extension deficit.

CONCLUSION:

With ISI there is a significant change in patellar height after TKA in the form of patella alta but with no effect on postoperative ROM.

With BPI there is a significant change in patellar height after TKA in the form of PB with a

statistically significant effect on postoperative ROM represented by increased improvement, but most probably due to individual factors and variations.

There is no substantial alteration in patellar height following TKA with the modified Caton-Deschamps index.

In conclusion, our findings indicate that patellar height undergoes a change following TKA; however, this alteration is not the primary factor influencing postoperative ROM.

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