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

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ABSTRACT:

Objective:
Assessment of patellar height changes after total knee arthroplasty and their effects on the range of motion (ROM).
Background:
Total knee arthroplasty (TKA) is a procedure with a success rate over 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%.
Methods:
An analytical prospective study involving 30 knees of 27 patients which underwent primary TKA for advanced osteoarthritis. We measured knee ROM and measured the patellar height by three indices of patellar height assessment; the Insall and Salvatia index (ISI), the Blackburne and Peel index (BPI), and the modified Caton-Deschamps index (mCDI) for each patient preoperatively, 3 months and 6 months postoperatively.
Results:
With BPI, there is significant change in patellar height in the form of patella baja with statistically significant effect on postoperative ROM represented by increased improvement. With ISI there is 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 of patellar height after TKA.
Conclusion:
Patellar height changes after TKA but this change is not the main factor that affects postoperative ROM.
Key words:
Patellar height – Total knee arthroplasty – Range of motion

INTRODUCTION:

Total knee arthroplasty (TKA) is a procedure with a success rate over 95 %. **[1]** In this procedure the joint line often undergoes relative elevation because the surgeon has to use polyethylene of greater thickness in order to adequately maintain the tensions in the collateral ligaments of the knee. **[2]**

Such joint line elevation is known as pseudo-patella baja (PPB). PPB occurs when the femorotibial joint line rises without a change in the length of the patellar tendon, often as a result of the use of a thick polyethylene insert during excess distal femoral bone resection and excess soft tissue release. **[3]**

Occurrence of patella infera or baja after total knee arthroplasty has been well reported in the literature. **[4]** Patella baja (PB) can cause an alteration in the normal biomechanics of the patella and can give rise to anterior knee pain, limited range of movement, **[5]** impingement of the patella on the tibia in flexion. **[6]**

Insall and Salvatia sought a method that would be unaffected by the physical size of the knee, the radiographic magnification, and the degree of flexion (provided there was sufficient flexion [which was believed to be 20°] to assure tension of the patellar tendon). In 1971, they introduced the important and now-classic ratio of the patellar diagonal length to the length of the patellar tendon. **[7]** However, since there are inaccuracies in Insall and Salvatia index (ISI), other ratios that make use of different measurements have been introduced by other authors with different degrees of acceptance. These methods include the Blackburne and Peel index (BPI), **[8]** the Caton-Deschamps index (CDI), **[9]** the Modified Insall and Salvatia index (MISI) **[10]** and the modified Caton-Deschamps index (mCDI) **[11]** and others.

Our objective is assessment of patellar height changes after total knee arthroplasty and the effect of this change on the range of motion (ROM) after surgery.

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. Only the subjects who provided informed consent were enrolled in the study.

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 total knee arthroplasty for knee joint advanced osteoarthritis.

The overall patients 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 complication affecting range of motion 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 (Figure 1 & 2 & 3).

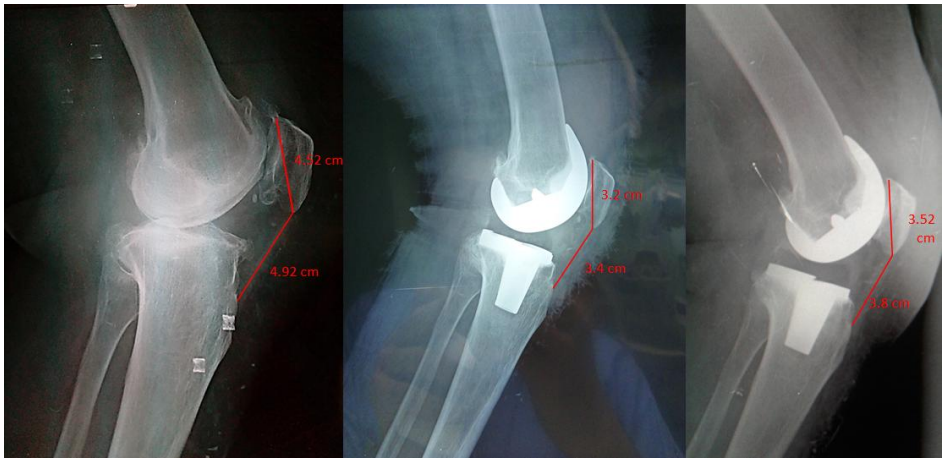

Figure 1: Insall and Salvatia index measurements on preoperative, 3month and 6 month postoperatively on lateral radiographs of a left knee of one of patients under the study.

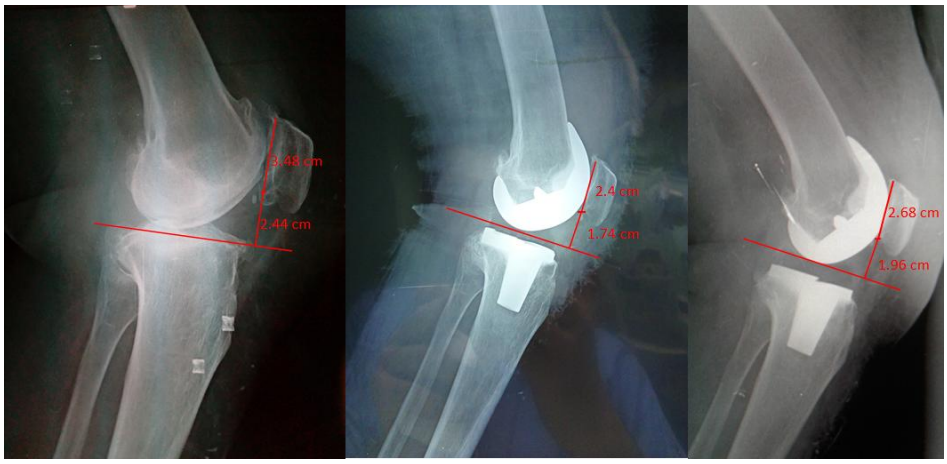

Figure 2: Blackburne and Peel index measurements on preoperative, 3month and 6 month postoperatively on lateral radiographs of a left knee of one of patients under the study.

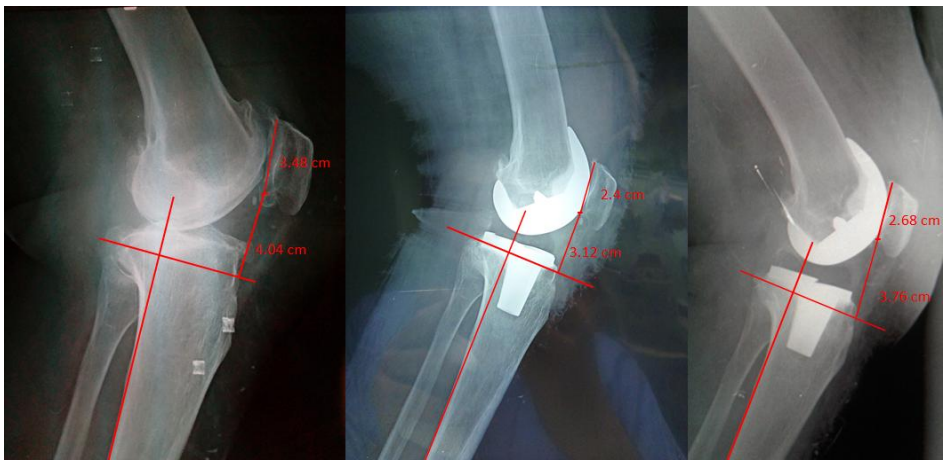

Figure 3: Modified Caton-Deschamps index measurements on preoperative, 3month and 6 month postoperatively on lateral radiographs of a left knee of one of patients under the study.

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

The knee range of motion was obtained by using a standard goniometer for each patient preoperatively, 3 month and 6 month postoperatively on routinely performed physical examination .

The prosthesis used for all the patients was the *Nex Gen*® PCL substituting posterior stablized, made by the company Zimmer® in Warsaw, Indiana, United States.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**.** **(**Armonk, NY: IBM Corp**)** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level and by p values that were taken to be significant when they were less than 0.05.

RESULTS:

a. Insall and Salvatia method:

There were 2 knees with patella alta preoperatively, they remained postoperatively and 2 more knees developed patella alta in 3 month postoperative follow up that also remained with added another 2 knees developing patella alta in the 6 month 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 patella baja (table 1).

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

ISI	Pre-operative		Post-operative				p-value
			3 Months		6 Months		
	No	%	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 between the different studied periods p_1: p value for comparing pre-operative and 3 months post-operative
p_2: p value for comparing pre-operative and 6 months post-operative p_3: p value for comparing 3 months and 6 months post-operative
**: Statistically significant at $p \leq 0.05$*

Those knees with postoperative patella alta did not have 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 association between I.S and ROM

b. The Blackburne and Peel method:

There was 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 studied periods according to Blackburne and Peel index (n=30)

B&P	Pre-operative		Post-operative				p-value
			3 Months		6 Months		
	No	%	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 between the different studied periods
p_1: p value for comparing pre-operative and 3 months post-operative
p_2: p value for comparing pre-operative and 6 months post-operative
p_3: p value for comparing 3 months and 6 months post-operative
**: 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 change from preoperative to 6 month 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			
Min. – Max.	75.0 – 132.0	76.0 – 123.0	
Mean ± SD.	104.50 ± 18.03	102.33 ± 21.47	0.801
Median	106.0	108.0	
6 months			
Min. – Max.	79.0 – 130.0	114.0 – 161.0	
Mean ± SD.	115.42 ± 14.38	134.0 ± 21.71	0.016*
Median	118.0	127.0	
% of Change			
Min. – Max.	-15.05 – 52.0	17.59 – 50.0	
Mean ± SD.	12.65 ± 19.40	32.83 ± 14.57	0.021*
Median	5.04	30.89	

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

c. The modified Caton-Deschamps method:

As this method is rather a comparative method, 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 studied periods according to 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 (IQR)	1.16 (1.08 – 1.26)	1.24 (1.08 – 1.31)	1.17 (1.10 – 1.37)	

p: p value for comparing between the different studied periods

DISCUSSION:

In the current study, it was found that Insall and Salvatia method indeed has many drawbacks related to its affection by different patellar morphology and the difficulty to precisely identify the patellar tendon insertion on the lateral knee radiographs.

The Insall and Salvatia results in this study was the presence of 2 knees with patella alta preoperatively and the emergence of other 4 post-operatively. Although this is a quite significant percentage of cases, but those cases had no other symptoms or complains that usually relates to patella alta neither pre nor postoperatively. The 4 cases that developed patella alta postoperatively didn't have any significant difference in their range of motion 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 Salvatia that changed when they used the modified Insall and Salvatia method. **[12]**

Blackburne and Peel method has been the most reliable method in our measurements it is easily reproducible, not affected by different degrees of flexion as long as it more than 25º. It is even not affected if there is some rotation, and for sure 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 Blackburne and Peel method in this study, it was found that there is a change in patellar height after TKA in 20% of the cases which is statistically significant. Those cases developed patella baja postoperatively.

There was a statistically significant difference in the improvement of the ROM of these cases - that developed patella baja postoperative – from those that remained with normal patellar height postoperatively.

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

That difference also is in the mean of the range of motion of the whole group of 6 cases of patella baja from which there are 4 cases that their change in range of motion is just like normal patellar height cases and the remaining 2 having a wider change that caused the mean of the whole group to increase. These 2 cases most probably had that better postoperative range of motion due to their much better preoperative range of motion

and their better response to physiotherapy and their style of life.

Behrend et al. also found that Mean Blackburne and Peel (0.8–0.6) decreased from preoperatively to 1 year follow-up. Mean joint-line shift in a cranial direction was 2 mm after TKA implantation. They showed significantly lower flexion in patients with PPB ($p < 0.001$). However, multiple regressions revealed that BPI was a significant positive independent predictor for flexion ($p < 0.001$) at 1 year follow-up. **[13]**

On the other hand ***Cabral et al.*** found that although patellar height in their cases tended to be lower when measured postoperatively, that difference was not significant for any of the methods studied. **[14]**

But ***Gaillard et al.*** also found patella baja 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 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 change in degree of flexion changes the ratio significantly together with no specified range of flexion to apply the method made 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. found that average difference between pre and post-operative mCD was 0.19 in their series. In 81.7% of their cases, patella was lowered. Patients were classified in three groups according to patella height lowering. These three groups had no significant statistical differences in range of motion. **[16]**

In these three groups they compared IKS score, knee function, flexion and extension lack, they could not find any significant differences between these three groups.

CONCLUSION:

With Insall and Salvatia index there is significant change in patellar height after TKA in the form of patella alta but with no effect on postoperative range of motion.

With Blackburne and Peel index there is significant change in patellar height after TKA in the form of patella baja with statistically significant effect on postoperative range of motion represented by increased improvement, but most probably due to individual factors and variations.

With modified Caton-Deschamps index there is no significant change of patellar height after TKA.

In conclusion we found that patellar height changes after TKA but this change is not the main factor that affects postoperative ROM.

REFERENCES:

1. Ortega M, Barco R, Rodrı´guez EC. Artroplastia total de rodilla. Rev. Esp. Cir. Ortop. Traumatol. 2002; 46(5):476–484.
2. Júnior LH, Soares LF, Gonçalves MB, Pereira ML, Lessa RR, Costa LP. Relationship between patellar height and range of motion after total knee arthroplasty. Rev. Bras. Ortop. 2015; 46(4):408-11.
3. Kazemi SM, Daftari Besheli L, Eajazi A, Miniator Sajadi MR, Okhovatpoor MA, Farhang Zanganeh R et al. Pseudo-patella baja after total knee arthroplasty. Med Sci Monit. 2011; 17:CR292–CR296.
4. Chonko DJ, Lombardi AV Jr, Berend KR. Patella baja and total knee arthroplasty (TKA): etiology, diagnosis, and management. Surg. Technol. Int. 2004; 12:231–238.
5. Weale AE, Murray DW, Newman JH, Ackroyd CE. The length of the patellar tendon after unicompartmental and total knee replacement. J. Bone Joint Surg. Br. 1999; 81:795.
6. Maeno S, Kondo M, Niki Y, Matsumoto H. Patellar impingement against the tibial component after total knee arthroplasty. Clin. Orthop. Relat. Res. 2006; 452:265–269.
7. Insall J, Salvatia E. Patella position in the normal knee joint. Radiology. 1971; 101(1):101–104.
8. Blackburne JS, Peel TE. A new method of measuring patellar height. J. Bone Joint Surg. Br. 1977; 59(2):241–242.
9. Caton J, Deschamps G, Chambat P, Lerat JL, Dejour H. Patella infera. Apropos of 128 cases. Rev. Chir. Orthop. Reparatrice Appar. Mot. 1982; 68:317–25.
10. Grelsamer RP, Meadows S. The modified Insall-Salvati ratio for assessment of patellar height. Clin. Orthop. Relat. Res. 1992; 282:170–6.
11. Caton JH, Prudhon JL, Aslanian T, Verdier R. Patellar height assessment in total knee arthroplasty: a new method. Int Orthop. 2016; 40:2527–31.
12. Jawhar A, Sohoni S, Shah V, Scharf HP. Alteration of the patellar height following total knee arthroplasty; Arch. Orthop. Trauma Surg. 2014; 134:91–97.
13. Behrend H, Graulich T, Gerlach R, Spross C, Ladurner A. Blackburne–Peel ratio predicts patients' outcomes after total knee arthroplasty; Knee Surg. Sports Traumatol Arthrosc. 2019; 27(5):1562-1569.
14. Cabral F, Sousa-Pinto B, Pinto R, Torres J. Patellar height after total knee arthroplasty: Comparison of 3 methods; J. Arthroplasty. 2016; 32(2):552-557.
15. Gaillard R, Bankhead C, Budhiparama N, Batailler C, Servien E, Lustig S. Influence of patella height on total knee arthroplasty: outcomes and survival; Journal of Arthroplasty. 2019; 34(3):469-77.
16. Prudhon JL, Caton JH, Aslanian T, Verdier R. How is patella height modified after total knee arthroplasty? Int. Orthop. 2018; 42(2):311-316.