

**RESEARCH ARTICLE**

# Position of the Patella among Emirati Adult Knees. Is Insall-Salvati Ratio Applicable to Middle-Easterners?

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*Research performed at Rothman Institute Thomas Jefferson University, Philadelphia, USA**Received: 31 December 2014**Accepted: 2 November 2015***Abstract**

**Background:** Abnormal patellar height is associated with anterior knee pain and several conditions that affect the patellofemoral joint. The aim of this study was to 1) report the incidence of patella alta and patella baja and 2) investigate whether the normal limits of the Insall-Salvati ratio is applicable in adult Middle-Easterners.

**Methods:** A radiographic review of the lateral radiographs of 736 Middle-Eastern knees were performed. Patellar tendon length (TL) and the patellar length (TP) was digitally measured and the ratios of these measures was used to calculate the Insall-Salvati ratio.

**Results:** The overall mean TL/PL ratio was  $1.20 \pm 0.17$ . The Insall-Salvati ratio was higher ( $p=0.0013$ ) in males ( $1.22 \pm 0.12$ ) than in females ( $1.18 \pm 0.17$ ). According to our measurement, the recommended levels for defining abnormal patellar position should be 0.86 for patella baja and 1.54 for patella alta.

**Conclusion:** The use of TL/PL ratio demonstrated a higher incidence of patella alta and a higher mean TL/PL ratio compared to other techniques. The normal ranges for the TL/PL differs from western populations and may be attributed to lifestyle differences.

**Keyword:** Insall-Salvati ratio, Middle-Easterner, Patellar position

**Introduction**

Anterior knee pain is a common orthopaedic musculoskeletal complaint. During the evaluation of anterior knee pain, patellar height is often evaluated because many conditions are often associated with an abnormal patellofemoral relationship. Patella alta, a high riding patella, is often observed in patients with recurrent lateral patellar subluxation, patellar chondromalacia, patellar ligament rupture, Sinding-Larsen-Johansson disease, Osgood-Schlatter disease, and patellar or quadriceps tendonitis (1-7). Conversely, a low-riding patella, patella baja, may be a sign of quadriceps tendon rupture, neuromuscular disorders, achondroplasia. It can also be seen following surgical advancement of the tibial tuberosity or patellar tendon harvesting for ligament reconstruction (8-10).

Due to the many associated conditions with abnormal patellar height, several methods have been proposed for

its measurements. Of the many available measurement techniques, the most accepted and widespread method is the Insall-Salvati ratio, the patellar tendon length (TL) to patellar length (PL) ratio (11). This ratio is commonly used because of its simplicity and consistency in all degrees of flexion. Although the Insall-Salvati ratio remains one of the gold standards for assessing patellar height, there are only a paucity of studies evaluating the sensitivity of the Insall-Salvati ratio in detecting patellar height abnormalities (12). Furthermore, even fewer studies have investigated the measurements of knees in different ethnic groups, despite well-known ethnic differences in knee morphology (13-16). The importance of this issue relies on the fact that the thresholds for identifying abnormal patellar height are established based on the measurements of Western populations and therefore, it may not represent ethnic variations in the knee that may result from evolutionary or lifestyle differences.

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**Table 1. Insall-Salvati Ratio by Gender**

Characteristic	Mean	SD	P-value
Males	1.22	0.12	0.0013
Females	1.18	0.20	
Total	1.2	0.17	-

With interest in potential ethnic and lifestyle variations in patellar position, the aim of this study was to 1) report the incidence of patella alta and patella baja and 2) investigate whether the normal limits of the Insall-Salvati ratio applies to adult Middle-Easterners; a population in which sitting on the ground, kneeling, and squatting is common.

### Material and Methods

Seven hundred and sixty four lateral radiographs of the knee (400 patients) were obtained between March 2007 and March 2014. Patients with a history of underlying knee pathology, knee surgery, or knee pain that was manifested during walking or squatting were excluded. Males made up 53.7% (395) of the knees. The mean age was  $52.2 \pm 7.3$  for males and  $49.7 \pm 8.4$  for females. Approval from our Institutional Review Board was obtained prior to conducting this retrospective radiographic review.

Lateral weight-bearing plain radiographs of the knee were taken with the knee positioned at 30 degrees for all cases. Although the Insall-Salvati relationship is presumed to remain consistent in all degrees, semiflexion (30°) was consistently used to aid visualization of the tibial insertion. Radiographs were obtained 100 cm from the film and positioned and centered perpendicular to the knee joint.

For all measurements, a single experienced physician (AS) analyzed all radiographic patellar parameters with digital imaging software (Agfa viewer, Agfa-Gevart, Mortsel, Belgium). Patellar length (LP) was measured digitally from the superior articular pole to the inferior non-articular pole of the patella [Figure 1]. Patellar tendon length (LT) was measured from the origin of the patellar tendon at the inferior pole to its insertion on the tibial tubercle [Figure 1]. The Insall-Salvati ratio was subsequently calculated by obtaining the LT to LP ratio. Based on the established classic criteria of abnormal patellar position by Insall et al. Patella alta and patellar baja was defined as a LT/LP ratio greater than 1.2 and less than 0.8 respectively (11).

All statistical analysis was performed using statistical software (Version 22, SPSS, Chicago, IL). A normality test was used to verify the presence of a normal distribution. New recommendations for defining patella alta and baja were based on the upper and lower 2.5% of the ratio (1.96 standard deviations). The Insall-Salvati ratio was compared between males and females using a paired student t-test. An alpha level of 0.05 was used to determine significance.

### Results

The overall mean LT/LP ratio was 1.20 (SD 0.17).

**Table 2. Insall-Salvati Ratio Distribution**

P-Value	Frequency	Number
<0.8	4%	29
0.8-1.0	23%	169
1-1.2	35%	258
1.2-1.4	33%	243
1.4<	5%	37

Comparison between genders revealed that the mean LT/LP ratio was higher ( $P=0.0013$ ) in males than females with a mean of 1.22 (SD 0.12) and 1.18 (SD 0.20), respectively [Table 1]. Using previous criteria of defining abnormal patellar position ( $1.00 \pm 20\%$ ) based on Insall's study, the overall incidence was 38% (280/736) and 4% (29/736) for patella alta and patella baja (280/736) respectively [Table 2].

According to our measurements, the redefined ratios for patella baja and alta were 0.98 and 1.46 respectively in males and 0.78 and 1.58 respectively in females. When combining both genders, the overall threshold levels were 0.86 for patella baja and 1.54 for patella alta.

### Discussion

The position of the patella has an important role on patellofemoral function. Abnormalities in patella position have thus been associated with anterior knee pain and many extensor mechanism disorders. While many techniques have been developed to measure patellar position such as the Blacburne's ratio, the Insall Salvati ratio still remains one of the most popular, largely because it is easy to use and remember (17-19). Despite its popularity, recent studies have suggested that the current normal ranges should be extended, as the ratios may not be applied to ethnicities outside western regions (15, 16). Thus, the aim of our study is to determine the incidence of patella alta and baja in a Middle Eastern culture with considerable lifestyle differences than western cultures. Our results demonstrate that there is a high incidence of patella alta when using Insall's classic threshold of 1.2. Furthermore, due to the higher mean ratios, we recommend that the reference range be extended to 1.54 for patella alta and 0.86 for patella baja.

Our study had a number of limitations, and our findings should be interpreted in light of these issues. First, the cohort in this study were all healthy and without pathological conditions associated with abnormal patellar position. Second, range of motion and functional outcomes were not readily available for clinical correlation to determine the levels at which abnormal patellar position may be symptomatic. Third, the ratio could not be calculated in children since their bones are cartilaginous and may not be apparent on X-rays. Lastly, only a single physician evaluated the plain radiographs.

Insall and Salvati introduced a ratio in 1971 to describe the position of the patella that has been accepted as practical as well as accurate (11). This ratio was established and is most often used in Western groups;

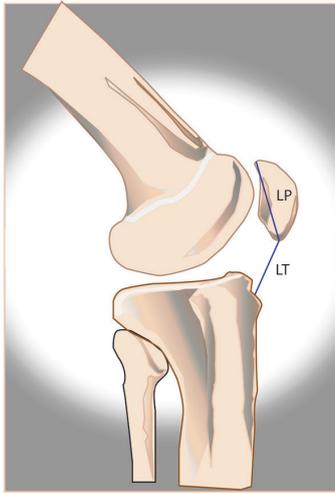


Figure 1. Patellar measurements for measuring LP/LT ratio.

however, our results suggest that it cannot be generalized to all populations. Similar to our findings, a recent study of 800 knees from central India by Upadhyay et al. demonstrated that the mean LT/LP ratio was 1.14 with an incidence of patella baja of 19% using Insall's classic 1.2 cutoff. Furthermore, they recommended that the reference values be 0.7 to 1.5 in their population (15). Additionally, Leung et al. revealed that the patellar position was 15-20% higher in southern China compared to western regions and thus recommended a value of greater than 3.4 for defining patella alta (16). While it appears that Asian knees have higher patellar position than western cultures, interestingly, several studies have revealed that African knees do not exhibit differences compared to western cultures (13, 14).

Given the well-documented differences in

anthropometric morphology of Asian knees, evolutionary and lifestyle variations may account for the observed differences in patellar position among different populations (10). It has been proposed that the high flexion daily activities of Middle-Easterners and Asians e.g. squatting, praying, and sitting cross-legged, may largely account for some of these differences. The continued stretching of the patellar tendon from these activities may result in a lengthening of the patella, and consequently a higher LT/LP value (20). The wide distribution of LT/LP ranges may thus reflect variations in lifestyle activities within the Middle Eastern population. Based on this hypothesis, it may be assumed that Middle-Easterners who do not partake in these activities may have lower ratios. This relationship of flexion activities with patellar position, may also, in part, explain the lack of ethnic differences observed in patellar position between Africans and western cultures; both cultures that do not rely on high flexion activities.

In summary, the patellar position of Middle-Easterners may be different than that of western populations. The Insall-Salvati ratio may thus be less applicable to Middle-Eastern populations and other culture groups where high flexion activities are common. The results of our study suggest that the recommended reference ranges for Insall-Salvati ratios be 0.86 to 1.54.

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