

GENDER DIFFERENCE IN THE MODIFIED INSALL-SALVATI RATIO IN A BLACK KENYAN POPULATION

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ABSTRACT

The patellar tendon (PT) is part of the extensor mechanism of the knee attaching to the apex of the patella and tibial tuberosity. Gender differences of the PT have been described in terms of response to tensile forces. This response may be influenced by the patella height. An index for assessment of patellar height is the modified Insall-Salvati ratio. This ratio is used to classify the patella as either high riding (alta) or low riding (baja). Patella alta has been correlated to chronic patellar tendinopathy. Patellar tendinopathy is more common in males (6:1). The hypothesis of the study was that males would have a higher ratio and there was an expectation of more cases of patella alta among males. One hundred and two pairs of patellar tendons (58 male, 44 female) were thus obtained by simple random sampling from postmortem specimens at the Kenyatta National Hospital and Nairobi City mortuary. All the patellar tendons and patella bones were used to study the modified Insall-Salvati ratio, using a digital vernier caliper. This ratio was determined by dividing the length of the posterior lamina of the patellar tendon with the maximum diagonal length of the patella. The mean of the modified Insall-Salvati ratio for the right was 1.201 +/- 0.0901 in females and 1.1275 +/- 0.133 in males, $p=0.001$. The mean of the modified Insall-Salvati ratio for the left was 1.206 +/- 0.085 in females and 1.132 +/- 0.123 in males, $p=0.001$. Therefore, using the cut off value of 2.0, no cases of patella alta were observed. The modified Insall-Salvati ratio was thus observed to be higher in females in the Kenyan population. This observation of disparity between the expected and the observed results is confounding yet similar and consistent with previous findings in other populations. Research on the prevalence of patellar tendinopathy in the Kenyan population and radiological determination of the modified Insall-Salvati ratio is recommended.

Keywords: Modified Insall-Salvati ratio, black Kenyan population

INTRODUCTION

The patellar tendon (PT) has its proximal attachment at the apex of the patella. It is distally attached to the tibial tuberosity (Standring, 2008). Emerson et al, (2011) found a correlation between the height of the patella and chronic patellar tendinopathy. The group

with chronic tendinopathy showed significantly higher values of patella height than the control group. The patella height is the denominator in the modified Insall Salvati ratio and thus its increase results in the decrease of the modified Insall-Salvati ratio. The ratio is determined by

Submitted 14th October 2015, corrected 5th April 2016. Published online 18th May 2016. To cite: Wambua B, Awori K, Ongeti K, Kigera J, Olabu B. 2016. Gender difference in the modified Insall-Salvati ratio in a black Kenyan population. *Anatomy Journal of Africa*. 5: 686 – 692.

dividing the length of the posterior lamina of the patellar tendon with the maximum length of the patella (Meneghini et al., 2006).

A radiological study by Miller et al., (1996) found no sex difference in the ratio while recently Olateju, Philander and Mubarak (2013) found the ratio to be higher in females. The ratio is an index of the patella position in the patellofemoral joint. The Q-angle is also an index of patellofemoral stability though it has been shown to be similar in males and females of the same height (Grelsamer et al., 2005). The position of the patella affects its articulation with the trochlear. The patella articulates with the trochlear at high degrees of flexion (Colvin and West, 2008). Thus a high riding patella may contribute to contact friction between the posterior region of the patellar tendon and femoral condyles before it articulates with the trochlear. Therefore, the aim of the study was to determine and compare the modified Insall-Salvati ratio, cellularity and vascularity of the patellar tendon between the sexes.

The modified Insall-Salvati ratio is described as the length of the patellar tendon (posteriorly) divided by the maximum length of the patella independent of knee flexion (Grelsamer and Steve, 1992). It is the most commonly used index for assessment of patellar tendon length and patella height (Grelsamer and Steve, 1992; Kadakia and Omer, 2003). The modified Insall-Salvati ratio is popular as it is sensitive to patella shapes and presence of enthesophytes. Measurements done in-situ such as in cadaveric specimens tend to be more accurate than radiographic methods (Olateju, Philander and Mubarak, 2013). Radiographic measurements involve approximation of tibial tuberosity length and does not account for different patella shapes which may affect the maximum length of the patella determined (Olateju, Philander and Mubarak, 2013). According to Wiberg (1941), there are three different types of patellae. Patella type 1 was defined as patella whose medial articulating facet (MAF) and lateral articular facet (LAF) widths are concave and equal. A type 2 patella is one in which the width

of the MAF is flat or slightly convex and smaller than the width of the LAF. In type 3 the width of the MAF is convex and considerably smaller than the width of the LAF.

According to Schlenzka and Schwesinger (1990) males have significantly larger patella bone dimensions. Miller Staron and Feldman (1996), found no sex difference in the ratio. However, in South Africans of European descent it was found to be 1.53 in females and 1.49 in males (Olateju, Philander and Mubarak, 2013). The ratio is useful in assessment of patella height and resting position (Grelsamer and Steve, 1992). A study by Emerson et al., (2011) showed a correlation between patella alta and chronic patellar tendinopathy. The cut off value for patella alta using the modified Insall-Salvati ratio is 2 (Grelsamer and Steve, 1992). The ratio is an index of the patella position in the patellofemoral joint.

The Q-angle is also an index of patellofemoral stability though it has been shown to be similar in males and females of the same height (Grelsamer, Dubey and Weinstein, 2005). The patella articulates with the trochlear at high degrees of flexion (Colvin and West, 2008). Patella alta may contribute to contact friction between the posterior region of the patellar tendon and femoral condyles before it articulates with the trochlear. There is paucity of data on the gender-specific values of the modified Insall-Salvati ratio yet a correlation between patella alta and chronic patellar tendinopathy has been established. Therefore the study aimed at determining the modified Insall-Salvati ratio and comparing it between the sexes. The modified Insall-Salvati ratio has become a useful index for the patella position on the patellofemoral articulation. Its gender dimorphism may aid in explaining the difference in patellofemoral biomechanics. The gender dimorphism of the modified Insall-Salvati ratio of the patellar tendon may aid in explaining the difference in prevalence of tendinopathy between the sexes and regional distribution of forces in the patellar tendon.

MATERIALS AND METHODS

One hundred and two pairs of patellar tendon were used as study specimens. They were obtained by simple random sampling during autopsy procedures at the KNH mortuary and Nairobi City Mortuary. The autopsy specimens were collected from subjects without any obvious musculoskeletal pathology to the knee joint and above the age of 18 years. With the help of a pathologist at autopsy, any subjects with patellar tendinopathy, trochlear dysplasia, grossly malformed patella, multiple enthesophytes and trauma to the knee was excluded.

Measurement of the modified Insall-Salvati ratio

The skin of the anterior knee was incised longitudinally from the superior part of the patella and extended downwards to a distance

approximately 2cm below the tibial tuberosity. The subcutaneous fat and prepatellar bursa was cleared. The paratenon of the patellar tendon was also incised longitudinally. It was then retracted laterally and medially to expose the tendon running from the apex of the patellar tendon to the tibial tuberosity. The patella was separated from the patellofemoral articulation by transection of the quadriceps tendon. The maximum length of the tendon was measured posteriorly using a digital vernier caliper (Sealey Professional Tools™ with an accuracy of 0.1mm) from the apex of the patella to the tibial tuberosity. Three measurements were taken and an average obtained. The maximum length of the patella was measured posteriorly from the apex to the superolateral/ medial edge of the patella depending on the shape of the patella (type 1, 2 or 3).

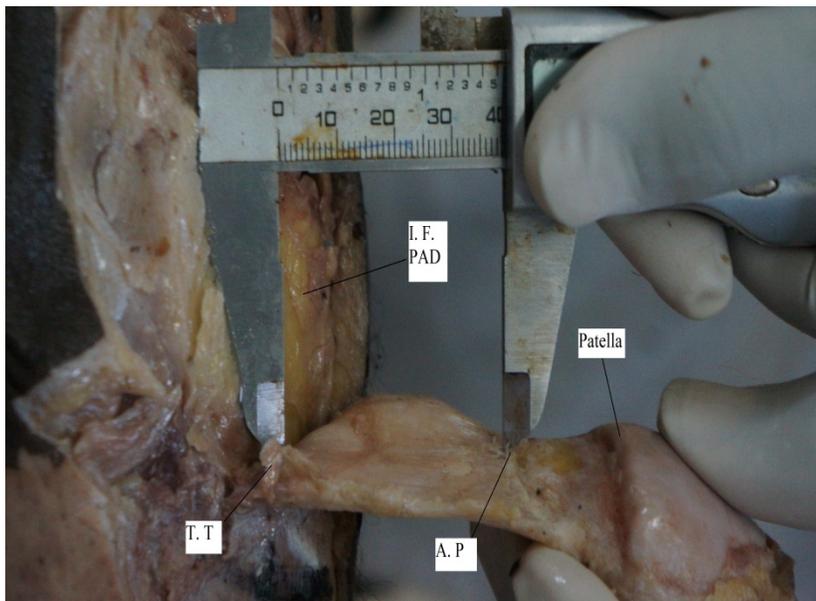


Figure 1a: Measurement of maximum length of patellar tendon . The length of the tendon was measured posteriorly from the apex of the patella (A.P) to the tibial tuberosity (T.T). The infrapatellar fat (I.F pad) pad left intact.

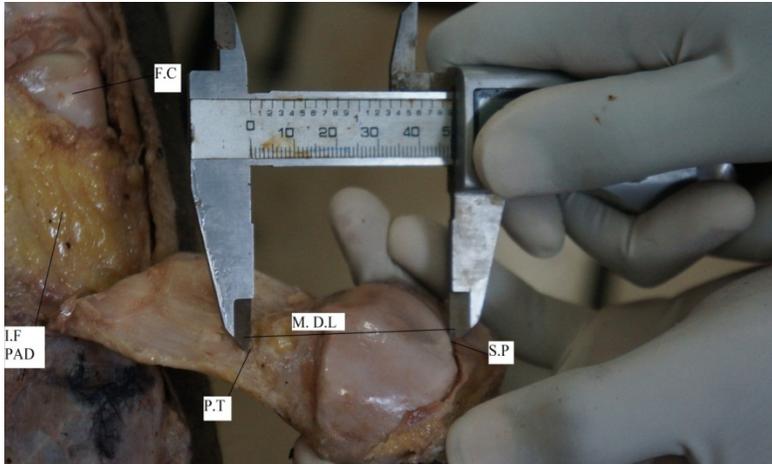


Figure 1b: Measurement of maximum diagonal length of the patella

The patella was disarticulated from its joint with the femoral condyles (F.C). The maximum diagonal length of the patella (M.D.L) was measured from the junction of the patellar tendon with the apex of the patella (P.T) to the superolateral part of the patella (S.P). It was determined as a type 3 patella.

The observations and measurements were coded, tabulated and analyzed using SPSS version 21.0 (Armonk, NY: IBM Corp). The

means, modes and standard deviations of the Insall-Salvati ratio in males and females was generated. Ethical approval for use of specimen obtained from autopsy material and conduction of the study was sought from the Kenyatta National Hospital/University of Nairobi Ethics and Research Committee before the commencement of the study. Informed consent for the use of autopsy material was obtained from the next of kin of the deceased.

RESULTS

The overall mean of the modified Insall-Salvati ratio for the left was found to be 1.17 +/- 0.111. The distribution curve showed a normal distribution. The minimum value was 0.94 and the maximum value 1.43. The mode was determined as 1.2 in the sample population. . The mean of the modified Insall-Salvati ratio for the left in females was found to be 1.206 +/- 0.084 while in males it was lower at 1.133 +/- 0.128 (p=0.001). The overall mean of the modified Insall-Salvati ratio for the right was found to be 1.17 +/- 0.116. The distribution curve showed a normal distribution. The minimum was 0.938, the maximum was 1.402. The mode for the right modified Insall-Salvati was found to be 1.25 in the sample population. In females the mean of the modified Insall-

Salvati for the right was found to be 1.201 +/- 0.09 while in males it was 1.128 +/- 0.133 (p=0.00). The overall mean of the left modified Insall-Salvati ratio was found to be 1.17 +/- 0.111. The distribution curve showed a normal distribution. The minimum value was found to be 0.94 and the maximum value was found to be 1.43. The mode was determined as 1.2 in the sample population. The mean of the left modified Insall-Salvati ratio in females was found to be 1.206 +/- 0.084 while in males it was found to be 1.133 +/- 0.128. This difference in means was found to be statistically significant (p=0.001).

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population. In females the mean of the right modified Insall-Salvati was found to be 1.201 +/- 0.09 while in males it was 1.128 +/- 0.133. This difference in means was found to be statistically significant ($p=0.001$).

DISCUSSION

The determination of the modified Insall Salvati ratio in cadaveric studies has been shown to avoid the bias of assumption of tibial tuberosity length (Grelsamer and Steve, 1992). In Africa, it has been described in South Africans of European descent (Olateju, Philander and Mubarak, 2013) and Nigerians of African and Caucasian origin (Udoaka, 2013). According to the study by Udoaka (2013) amongst Nigerians, the Insall Salvati ratio was higher in people of African descent than in Caucasians. The value for Nigerians was 1.04 +/- 0.07 while in Caucasians it was found to be 1.02 +/- 0.13.

In the present study, the mean of the left modified Insall-Salvati ratio in females was found to be 1.206 +/- 0.084 while in males it was lower at 1.133 +/- 0.128, ($p=0.001$). In females the mean of the right modified Insall-Salvati was found to be 1.201 +/- 0.09 while in males it was 1.128 +/- 0.133, ($p=0.001$). These results are in agreement with other studies where the female Insall Salvati ratio has been found to be higher (Basso, Johnson and Amis, 2001; Olateju, Philander and Mubarak, 2013).

The results from the present study have been shown to be lower than that of European South Africans (Olateju, Philander and Mubarak, 2013) where the Insall Salvati ratio was found to be 1.53 for females and 1.49 for males. This difference may be due to the technique of assessment of patella height. The present study utilized the modified Insall-Salvati ratio method while the study by Olateju Philander and Mubarak (2013) applied the Insall-Salvati ratio method. In both studies however, females have shown a higher ratio. Patella alta was detected by Olateju, Philander and Mubarak (2013) though it was not detected in the present study.

Patella alta has been correlated with chronic patellar tendinopathy (Emerson et al., 2011). Patella alta is a high riding patella which is defined by a value of 1.5 in the traditional Insall-Salvati ratio and 2.0 in the modified Insall-Salvati ratio (Grelsamer and Steve, 1992). The patella engages with the trochlear of the femur at high degrees of flexion (Colvin AND West, 2008). Thus, patella alta may contribute to contact friction between the posterior region of the patellar tendon and femoral condyles before it articulates with the trochlear. The study by Emerson et al (2011) used the traditional Insall-Salvati ratio which is less sensitive to patella morphology and it was conducted radiologically where an assumption of tibial tuberosity length is made (Kadokia and Omer, 2003). In the present study however, the modified Insall-Salvati ratio was applied which is sensitive to patella morphology and it was conducted in-situ (cadaveric) avoiding assumptions of tibial tuberosity length. Therefore, it would be hasty to suggest that females have more cases of patella alta and are thus likely to be predisposed to patellar tendinopathy.

The study by Emerson et al (2011) applied the traditional Insall-Salvati ratio which is less sensitive to patella shapes and it was conducted radiologically where an assumption of tibial tuberosity length is made. In the present study however, the modified Insall-Salvati ratio was applied which is sensitive to patella morphology and it was conducted in-situ (cadaveric) avoiding assumptions of tibial tuberosity length.

The modified Insall-Salvati ratio is an index of the patella position in the patellofemoral joint. The position of the patella affects its articulation

with the trochlear. The patella articulates with the trochlear at high degrees of flexion (Colvin and West, 2008). Patella alta may contribute to contact friction between the posterior region of the patellar tendon and femoral condyles before it articulates with the trochlear. It is plausible that females may have higher rates of patella alta but it would be a huge leap to assume that they will be predisposed to patellar tendinopathy more than their male counterparts.

The overall mean of the left modified Insall-Salvati ratio was found to be 1.17 +/- 0.111. The distribution curve showed a normal distribution. The minimum value was found to be 0.94 and the maximum value was found to be 1.43. The

mode was determined as 1.2 in the sample population. The mean of the left modified Insall-Salvati ratio in females was found to be 1.206 +/- 0.084 while in males it was found to be 1.133 +/- 0.128. This difference in means was found to be statistically significant ($p=0.001$).

In conclusion, results from our study show that the modified Insall-Salvati ratio may be higher in Kenyan females based on the sample from the population. The correlation between the modified Insall Salvati ratio and patellar tendinopathy cases should be established in the population. Data on the prevalence of patellar tendinopathy amongst Africans would also be useful.

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