applied sciences

MDPI

Article

Gender Differences in Patellar Positions among the Korean Population

Hyoung-Taek Hong [1,†], Yong-Gon Koh [2,†], Ji-Hoon Nam [1], Paul Shinil Kim [3], Yoon Hae Kwak [4,*] and Kyoung-Tak Kang [1,*]

1 Department of Mechanical Engineering, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea; hyoungtaekhong@gmail.com (H.-T.H.); namjh8901@naver.com (J.-H.N.)
2 Department of Orthopaedic Surgery, Joint Reconstruction Center, Yonsei Sarang Hospital, 10 Hyoryeong-ro, Seocho-gu, Seoul 06698, Korea; osygkoh@gmail.com
3 Department of Orthopaedic Surgery, The Bone Hospital, Seoul 07014, Korea; shinilgs@naver.com
4 Department of Orthopaedic Surgery, Yonsei University College of Medicine, Severance Hospital, Seoul 03722, Korea
* Correspondence: yoonhaekwak@yuhs.ac (Y.H.K.); tagi1024@gmail.com (K.-T.K.); Tel.: +82-2-2123-4827 (K.-T.K.)
† Hyoung-Taek Hong and Yong-Gon Koh contributed equally to this work and should be considered co-first authors.

Received: 30 October 2020; Accepted: 9 December 2020; Published: 10 December 2020

Abstract: The various factors related to the morphometric characteristics of patella make it difficult to produce a standard interpretation of their respective values. A total of 1423 patients participated in this work. The distribution of Insall–Salvati ratios was investigated, and the upper and lower limits of two standard deviations were used to define the patellar alta and baja. An additional method was used, where 2.5% at each end of the distribution was defined as patellar alta and baja. Ratios in the females and males were 0.92 ± 0.14 and 0.87 ± 0.14, respectively. The ratios were considerably higher in females than in males ($p < 0.05$). Ratios defined for patellar alta and baja were 1.19 and 0.68 for females and 1.13 and 0.58 for males, respectively, when two standard deviations were used. Ratios defined for patellar alta and baja were 1.22 and 0.66 for females and 1.15 and 0.59 for males, respectively, when the extreme 2.5% method was used. No considerable differences in the patellar alta and baja were observed between the two methods. Patellar alta and baja were determined in ratios of more than 1.20 and less than 0.64, respectively. No significant differences in the patellar alta and baja were observed between the genders in the Korean population. Additionally, two standard deviations of the Insall–Salvati index are recommended for defining patellar alta and baja for the Korean population. However, we recommended analyzing the histogram distribution for the population, followed by an analysis of the patellar alta and baja.

Keywords: knee; patellar alta and baja; magnetic resonance imaging

1. Introduction

The patella is one of the important components for the extensor mechanism of the knee joint [1]. It increases the extensor moment arm and the quadriceps' muscle efficiency. Patellar height is an essential measurement of knee structure [2], and can help in the evaluation of patellar instability, knee-joint contracture, and patellofemoral pain [3,4]. Patellar alta and baja denote the extremes of the relationship between patellar length (PL) and patellar tendon length (TL) [5]. Specifically, patellar alta is a well-known anatomic risk factor for recurrent patellar instability that may contribute to patellofemoral pain [6,7]. Insall and Salvati [8] described a method of determining patellar height depending on the ratio of the length of the patellar tendon to the diagonal length of the patella on lateral

radiographs. Various techniques such as those developed by Blackburne and Peel [4], Caton et al. [9], and de Carvalho et al. [10] attempt to classify patellar positions.

There are several ways including ultrasound and magnetic resonance imaging (MRI) to measure the tendon related with the patellar. Some previous studies have shown that ultrasound is an effective way to evaluate patellar tendonitis [11–13]. Measurement using ultrasound is inexpensive and can avoid radiation. However, its quality of measurement to the soft tissues is relatively dependent on the skill of the operator, and it especially shows a poorly defined outline in chronic cases [14,15]. The measurement using MRI has the advantages of good soft-tissue contrast, anatomical definition and it can provide anatomical information about bone and ligaments around the knee [16,17]. In addition, measurements on lateral radiographs are inexpensive and easy to access but they are incapable of visualizing articular cartilage and providing a variable correlation among the various patellar height indices. Therefore, MRI is a better option for measuring patellar height [6,18]. Miller et al. primarily described direct patellar height measurement via MRI data by measuring the patellar articular surface ratio [18]; the study reported that there is no difference in ratios of patellar height between the genders [6]. Other studies, however, have reported that the patellar height ratio in females is higher than that in males [5,19]. The morphometric characteristics are related to genetic, environmental, and sociocultural conditions and lifestyle, health, and functional status. The variation complicates providing a standard interpretation of their respective values [20]. Therefore, this study is aimed at evaluating the patellar-position difference between the genders by using the Insall–Salvati ratio and MRI. The distribution of Insall–Salvati ratios was investigated, and the upper and lower limits of 2 SD were used to define patellar alta and baja. At each end of the distribution, the extreme 2.5% was defined as patellar alta and baja. It hypothesized that gender difference exists in TL to PL ratio.

2. Materials and Methods

The MRI results of 1483 patients with osteoarthritis were analyzed in this study. The patients with any history of osteotomy of the affected limb were excluded. Thus, 1423 patients comprising 1071 females and 352 males participated in this study. The average age of whole, female, and male patients was 69.3 ± 6.8 (with range 32–90), 69.3 ± 6.7 (with range 32–90) and 69.2 ± 7.0 (with range 49–89), respectively. The institutional review board (no.: 18-DR-02, protocol no.: 3D-MRI according to gender_1.0) approved this study for demographic data, radiographs, and MRI studies. MRI data were acquired using a 1.5 T MRI scanner (Achieva 1.5 T; Philips Healthcare, Best, Noord-Brabant, The Netherlands) with the knees in 0° of flexion. Sagittal T1-weighted images were reviewed. MRI scan data were acquired using high resolution images of 1 mm-thick slice on the sagittal plane of the tibiofemoral knee joint. For the non-fat-saturation condition, the MRI comprises a sequence of axial-proton-density. A high-resolution setting was applied to the spectral pre-saturation inversion recovery sequence (echo time, 25.0 ms; repetition time, 3590.8 ms; acquisition matrix, 512 × 512 pixels; number of excitations (NEX), 2.0; field of view, 140 × 140 mm). PL was evaluated from a single mid-sagittal image of the patella from the superior articular margin to the distal anterior tip (Figure 1) [18]. The mid-sagittal image of the patella was selected by determining the number of sagittal images where the patella was visualized. TL was evaluated in a sagittal image representing the shortest length by measuring a straight line connecting the patellar and tibial attachments along the inner margin of the tendon. For each knee joint, the TL/PL ratio was evaluated. The distribution of TL/PL ratios was investigated, and the patellar alta and baja were defined using the upper and lower limits of 2 SD [10]; an alternate method was implemented, where the extreme 2.5% at each end of the distribution was defined as patellar alta and baja [5]. All measurements were recorded by a well-trained observer. To determine the intra-observer and inter-observer variabilities, 100 MRI scans (50 for female and 50 for male patients) were re-measured by the identical observer and also by a second observer more than six weeks from when the initial measurements were recorded.

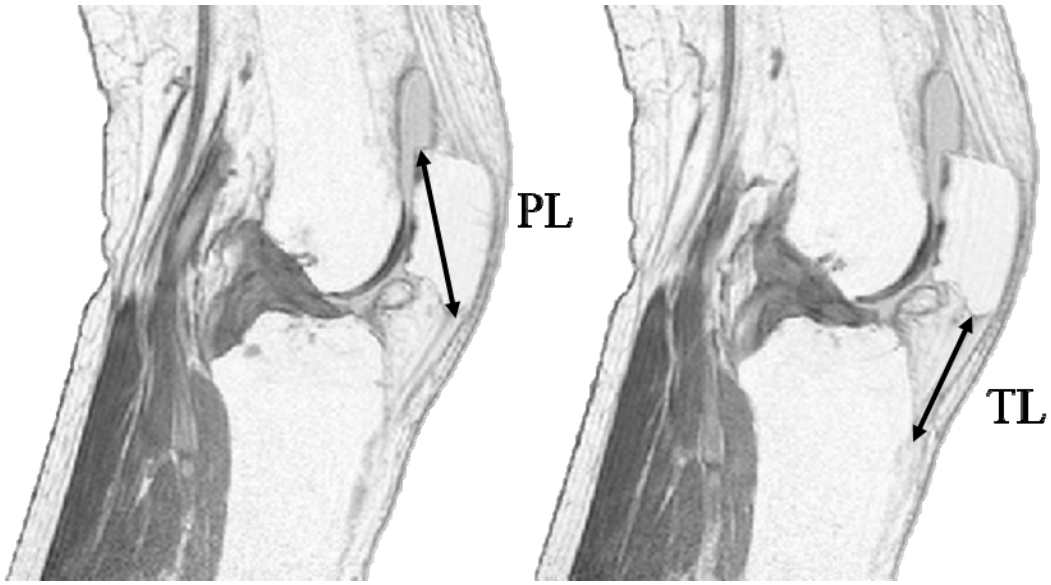

Figure 1. Sagittal T1-weighted magnetic resonance images (MRI): patellar length (PL) and patellar tendon length (TL) measured using Insall–Salvati methods.

Statistical Analysis

We performed statistical analyses using SPSS (version 12.0; SPSS, Chicago, IL, USA) for Windows, and the Student's *t*-test was performed to evaluate the significance of the differences between the genders. Probability (p) values below 0.05 were considered as statistically significant.

The interclass correlation (ICC) was applied to determine intra-observer and inter-observer variabilities. A post hoc power analysis was performed for the TL/PL ratio between the two groups using G power 3.1.9.4. The *t*-test was used for the comparison of the two independent groups. The alpha value was 0.05, and the calculated statistical power was 100.0%. The power analysis determined that 1423 patients are a sufficient sample size as our power value (100.0%) is higher than 80.0%, which was the previously used value [21].

3. Results

No significant difference was shown between the groups (Table 1) regarding demographic information such as age and body mass index (BMI). The range of the TL/PL ratio for the patients was between 0.43 and 1.55, and the average was 0.92 ± 0.14. The TL/PL ratios in females and males were 0.94 ± 0.14 and 0.87 ± 0.14, respectively. The TL/PL ratio was considerably higher in females than in males ($p < 0.05$). The results exhibited a symmetric curve in a histogram (Figure 2).

Table 1. Comparison of the age, TL, PL, TL/PL ratio among the Korean population.

Parameter	Whole Patients (n = 1423)	Female (n = 1071)	Male (n = 352)	p-Value (Female Versus Male)
	Mean ± SD (Range)	Mean ± SD (Range)	Mean ± SD (Range)	
Age	69.3 ± 6.8 (32, 90)	69.3 ± 6.7 (32, 90)	69.2 ± 7.0 (49, 89)	0.409
TL (mm)	37.3 ± 4.8 (15.4, 53.2)	36.9 ± 4.5 (20.4, 51.8)	38.6 ± 5.2 (15.4, 54.2)	<0.05
PL (mm)	40.9 ± 3.8 (21.8, 56.9)	39.6 ± 2.9 (21.8, 54.8)	44.9 ± 3.4 (31.6, 56.9)	<0.05
TL/PL ratio	0.92 ± 0.14 (0.43, 1.55)	0.94 ± 0.14 (0.52, 1.55)	0.87 ± 0.14 (0.43, 1.34)	<0.05

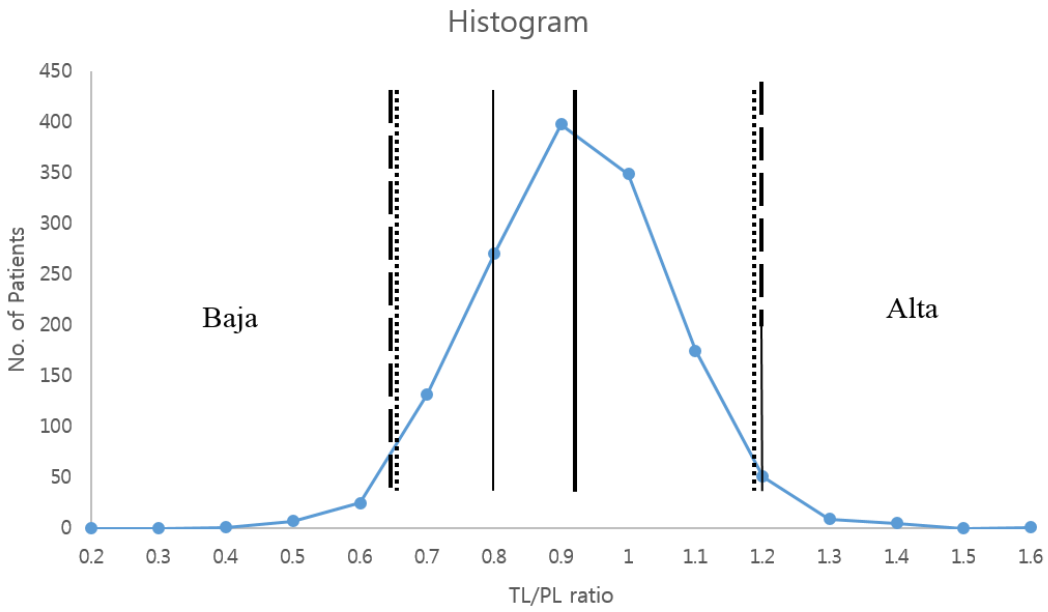

Figure 2. The distribution of the Insall–Salvati index (ISI) for the whole sample: a symmetrical curve; the thick solid line shows the mean (0.92), the thin solid lines show the normal range from the previous study (0.8, 1.20) [9], the broken lines show the normal range using 2 SD from the mean (0.64, 1.20), and the dotted line shows the normal range using the extreme 2.5% at each end of the distribution (0.65, 1.19).

Patellar alta and baja ranges were more than 1.2 and less than 0.64, respectively, for the patients with 2 SD. The ratios delineated for patellar alta and baja were 1.22 and 0.66 for females and 1.15 and 0.59 for males, respectively, when 2 SD was used. Patellar alta and baja ranges were more than 1.19 and less than 0.65, respectively, for the patients for the extreme 2.5%. Ratios defined for patellar alta and baja were 1.19 and 0.68 for females, and 1.13 and 0.59 for males, respectively, for the extreme 2.5%. No considerable difference was shown between the two different methods for dividing patellar alta and baja. The intra-observer error was 0.89, and the inter-observer error was 0.92; these were calculated using the ICC method.

4. Discussion

The key finding that can be derived from this study is that there are differences in the TL/PL ratio between genders. Further, the TL/PL ratio is significantly higher in females than in males. However, there is no difference in the patellar alta and baja between the 2 SD method and the extreme value method.

The joint-reaction-force on the patellofemoral joint is associated with the patellar height. Patellar alta is a condition related with malalignment of patellofemoral joint and a reduced patellofemoral contact area; it leads to patellofemoral pain and instability [22,23]. Patellar baja is related with restricted motion of the knee, called Osgood–Schlatter disease, and patellofemoral arthritis [24,25]. Realignment yields a satisfactory outcome in the cases of patellar malalignment or malposition [26]. It is important to shift the tendon insertion both medially and distally in order to perform a patellar-tendon transfer for patellar subluxation [27]. Patellofemoral arthritis may occur if the patellar tendon is rerouted too far distally as the articular surface of the patella is forced against the femoral condyles. Patellar tendon transfer must be performed only when the patellar height is clearly abnormal. Therefore, there is a requirement for a clear definition of the normal patellar position in the knee. Several techniques have been developed for performing radiological evaluation of patellar height [4,8–10]. The Insall–Salvati ratio is independent of the degree of knee flexion and is a simple method to evaluate [18]. In the Blackburne–Peel method, there is no consideration of patellar ligament when assessing the patellar

height [4]. In general, squatters have a higher range of knee flexion. The presence of the quadricipital groove that results from patellar ligament pressure against the upper end of the tibia makes projecting a forward line along the tibial plateau difficult [28]. It yields different results for squatters. Thus, grading the patellar level in relation to the tibial plateau is not appropriate for assessing the patellar position in squatters. By comparing the Insall–Salvati ratio measurements on MRIs to those on radiographs, it has been demonstrated that the ratio can be measured more precisely on MRIs [18]. Based on the previously conducted studies, the size of abnormal patellar to length of patellar tendon, defined by the Insall–Salvati ratio, is too frequent to be regarded as abnormal [5]. It led to measurement of the Insall–Salvati ratio in a large population that was referred for clinical knee MRI examination. In addition to lateral radiographs, MRIs are increasingly being used for analyzing patellofemoral anatomy in patients with patellofemoral instability. Orthopedic surgeons use MRIs to evaluate the patellar height, but traditional cutoff values of patellar height ratios based on lateral radiographs are not comparable to these MRI values. Our study yields a TL/PL ratio that is smaller than those reported in previously conducted studies [5,6,8,18]. Only two previous studies, similar to our study, yielded a TL/PL ratio less than one [29,30]. TL/PL ratios in the study conducted by Narkbunnam et al. and our study were 0.961 ± 0.14 and 0.92 ± 0.14, respectively [29]. As previously mentioned, morphometric characteristics are determined by sociocultural, environmental, and genetic conditions and by functional, health, and lifestyle status. In addition, the patellar positions in the population of South China are 15–20% higher than that in the population of West China [31]. This may be because there is the constant stretching effect over the patellar tendon during squatting and kneeling, which are common activities in India, Japan, China, and the Middle East [1]. This trend is opposite to that reported in our study. However, the population considered in our study consisted of Asians who were old-age patients and found it less comfortable to perform such activities. Therefore, the obtained results are reasonable. Our results indicate that the TL/PL ratio is higher in females than in males. The TL/PL ratios in females and males were 0.94 ± 0.14 and 0.87 ± 0.14, respectively, in our study. These results show good agreement within other studies that found higher TL/PL ratio for females [5,6,8,18]. However, some other studies have demonstrated the opposite trend [32]. The mean TL/PL ratio for 100 males and females each were found to be 1.41 and 1.28 in the population of South India [32]. No significant differences in TL/PL ratios between males and females were reported in a previous study [18]. Likewise, Schlenzka and Schwesinger [33] and SoeJbjerg, et al. [34] found the ratio to be independent of gender. However, a difference in TL/PL ratio between the genders was found in our study. Such a trend has also been found in other studies [5,8]. The TL/PL ratio is a reliable and general index to estimate the height of the patella. We can see that different studies show inconsistent results in the gender difference of TL/PL. In this study, a much wider Korean population was examined. In addition, our results indicate a slightly skewed distribution that shows a mean ratio of 0.92. Therefore, we defined patellar alta and baja with the 2 SD method and the extreme 2.5% method. Two SD at the other end, where the curve is more moderate, include more than the extreme 2.5% [5]. These results can explain why in previous studies patellar alta appeared more common than patellar baja [5]. Our results show slightly skewed distribution but there was no difference between the 2 SD method and extreme 2.5% method. It showed a slightly skewed distribution but there is no problem with investigating alta and baja using the 2 SD method. In the extreme 2.5% method, there are 34 (2.39%) in alta and 35 (2.46%) in baja, in the 2 SD method, there are 27 (1.90%) in alta and 30 (2.11%) in baja. However, in Insall and Salvati's previous article, 95% of the population fell within the ratios of 1.00 ± 20%; thus, defining the normal limits [8]. If the identical numeric criteria of 1.00 ± 20% were applied to our population, 27 knees of 1423 patients (1.9%) would be determined as patellar alta and 282 (19.8%) patellar baja. We also recognize that our population of patients with painful knees is biased, but it is fairly likely to represent a large group of patients undergoing clinical MRI knee examinations. Our results are replicated by other groups to ensure the transferability of our conclusions to different populations. The TL/PL ratio is one of the indices of the patellar position in the patellofemoral joint. The Q-angle is also an index of patellofemoral stability in males and females of identical height [35].

The patella articulates with the trochlear at high degrees of flexion [35]. Patellar alta may contribute to contact friction between the posterior region of the patellar tendon and femoral condyles before it articulates with the trochlear. Its gender dimorphism may help explain the difference in patellofemoral biomechanics. The gender dimorphism of the Insall–Salvati ratio of the patellar tendon may help explain the difference in prevalence of tendinopathy between the genders and the regional distribution of forces in the patellar tendon [35]. We studied a wider group without symptoms, and disregarded history and other MRI findings. In addition, we did not make an attempt to determine if patients were at the extremes of the TL/PL ratios with patellofemoral symptoms or patellofemoral MRI abnormalities. Further works will be required to evaluate whether it is clinically relevant to define populations as having patellar alta or baja, whether TL/PL ratio has clinical significance, and if it is truly related to numerous forms of patellofemoral disease. However, a previous asymmetric distribution study has suggested not to use 2 SD of the population when defining patellar alta and baja [5].

We do not recommend patellar alta as TL/PL > 1.2 and patellar baja as TL/PL < 0.8 in assessing patellar alta and baja. We recommend analyzing histogram distribution in that population followed by analyzing alta and baja. There are three limitations in this study; first, there is a lack of ethnic diversity in the population of this study and the results cannot represent other populations. Second, we did not make an attempt to determine if patients at the extreme ends of TL/PL ratios had patellofemoral symptoms or patellofemoral MRI abnormalities. Third, anatomical evaluation was conducted on the osteoarthritis patients and this patient-bias has probability to cause statistical differences from data of healthy people. In conclusion, we determined patellar alta and baja as a TL/PL of more than 1.20 and less than 0.64, respectively, for a Korean population. It was found that a gender difference exists for patellar alta and baja in this Korean population. In addition, the Insall–Salvati index 2 SD is recommended for dividing patellar alta and baja in the Korean population.

Author Contributions: Conceptualization, Y.-G.K. and K.-T.K.; methodology, H.-T.H.; software, J.-H.N.; validation, H.-T.H. and J.-H.N.; formal analysis, Y.-G.K.; investigation, H.-T.H. and P.S.K.; resources; Y.-G.K., data curation, P.S.K.; writing—original draft preparation, Y.-G.K. and H.-T.H.; writing—review and editing, P.S.K., Y.H.K. and K.-T.K.; visualization, J.-H.N.; supervision, Y.H.K. and K.-T.K.; project administration, Y.-G.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Upadhyay, S.; Raza, H.K.; Srivastava, P. Position of the patella in adults in central India: Evaluation of the Insall-Salvati ratio. *J. Orthop. Surg.* **2013**, *21*, 23–27. [CrossRef] [PubMed]
2. Kaufer, H. Mechanical function of the patella. *J. Bone Joint Surg.* **1971**, *53*, 1551–1560. [CrossRef] [PubMed]
3. Aglietti, P.; Insall, J.N.; Cerulli, G. Patellar pain and incongruence. I: Measurements of incongruence. *Clin. Orthop. Relat. Res.* **1983**, *176*, 217–224.
4. Blackburne, J.S.; Peel, T.E. A new method of measuring patellar height. *J. Bone Joint Surg.* **1977**, *59*, 241–242. [CrossRef]
5. Shabshin, N.; Schweitzer, M.E.; Morrison, W.B.; Parker, L. MRI criteria for patella alta and baja. *Skelet. Radiol.* **2004**, *33*, 445–450. [CrossRef]
6. Yue, R.A.; Arendt, E.A.; Tompkins, M.A. Patellar Height Measurements on Radiograph and Magnetic Resonance Imaging in Patellar Instability and Control Patients. *J. Knee Surg.* **2017**, *30*, 943–950. [CrossRef]
7. Ferlic, P.W.; Runer, A.; Dammerer, D.; Wansch, J.; Hackl, W.; Liebensteiner, M.C. Patella Height Correlates With Trochlear Dysplasia: A Computed Tomography Image Analysis. *Arthrosc. J. Arthrosc. Relat. Surg.* **2018**, *34*, 1921–1928. [CrossRef]
8. Insall, J.; Salvati, E. Patella position in the normal knee joint. *Radiology* **1971**, *101*, 101–104. [CrossRef]
9. Caton, J.; Deschamps, G.; Chambat, P.; Lerat, J.L.; Dejour, H. Patella infera. Apropos of 128 cases. *Rev. Chir. Orthop. Reparatrice L'appareil Mot.* **1982**, *68*, 317–325.

10. De Carvalho, A.; Holst Andersen, A.; Topp, S.; Jurik, A.G. A method for assessing the height of the patella. *Int. Orthop.* **1985**, *9*, 195–197. [CrossRef]
11. Meiburger, K.M.; Salvi, M.; Giacchino, M.; Acharya, U.R.; Minetto, M.A.; Caresio, C.; Molinari, F. Quantitative analysis of patellar tendon abnormality in asymptomatic professional "Pallapugno" players: A texture-based ultrasound approach. *Appl. Sci.* **2018**, *8*, 660. [CrossRef]
12. Sunding, K.; Fahlström, M.; Werner, S.; Forssblad, M.; Willberg, L. Evaluation of Achilles and patellar tendinopathy with greyscale ultrasound and colour Doppler: Using a four-grade scale. *Knee Surg. Sports Traumatol. Arthrosc.* **2016**, *24*, 1988–1996. [CrossRef]
13. Van Ark, M.; Rabello, L.M.; Hoevenaars, D.; Meijerink, J.; van Gelderen, N.; Zwerver, J.; van den Akker-Scheek, I. Inter-and intra-rater reliability of ultrasound tissue characterization (UTC) in patellar tendons. *Scand. J. Med. Sci. Sports* **2019**, *29*, 1205–1211. [CrossRef]
14. King, J.; Perry, D.; Mourad, K.; Kumar, S. Lesions of the patellar ligament. *J. Bone Joint Surg.* **1990**, *72*, 46–48. [CrossRef]
15. Fritschy, D.; de Gautard, R. Jumper's knee and ultrasonography. *J. Orthop. Med.* **1993**, *15*, 70–73. [CrossRef]
16. Bodne, D.; Quinn, S.F.; Murray, W.T.; Bolton, T.; Rudd, S.; Lewis, K.; Daines, P.; Bishop, J.; Cochran, C. Magnetic resonance images of chronic patellar tendinitis. *Skelet. Radiol.* **1988**, *17*, 24–28. [CrossRef]
17. El-Khoury, G.; Wira, R.; Berbaum, K.; Pope, T., Jr.; Monu, J. MR imaging of patellar tendinitis. *Radiology* **1992**, *184*, 849–854. [CrossRef]
18. Miller, T.T.; Staron, R.B.; Feldman, F. Patellar height on sagittal MR imaging of the knee. *AJR. Am. J. Roentgenol.* **1996**, *167*, 339–341. [CrossRef]
19. Olateju, O.I.; Philander, I.; Bidmos, M.A. Morphometric analysis of the patella and patellar ligament of South Africans of European ancestry. *S. Afr. J. Sci.* **2013**, *109*, 01–06. [CrossRef]
20. Koh, Y.G.; Nam, J.H.; Chung, H.S.; Kim, H.J.; Chun, H.J.; Kang, K.T. Gender differences in morphology exist in posterior condylar offsets of the knee in Korean population. *Knee Surg. Sports Traumatol. Arthrosc.* **2019**, *27*, 1628–1634. [CrossRef]
21. Markstrom, J.L.; Tengman, E.; Hager, C.K. ACL-reconstructed and ACL-deficient individuals show differentiated trunk, hip, and knee kinematics during vertical hops more than 20 years post-injury. *Knee Surg. Sports Traumatol. Arthrosc.* **2018**, *26*, 358–367. [CrossRef]
22. Ward, S.R.; Powers, C.M. The influence of patella alta on patellofemoral joint stress during normal and fast walking. *Clin. Biomech.* **2004**, *19*, 1040–1047. [CrossRef] [PubMed]
23. Ward, S.R.; Terk, M.R.; Powers, C.M. Patella alta: Association with patellofemoral alignment and changes in contact area during weight-bearing. *J. Bone Joint Surg.* **2007**, *89*, 1749–1755. [CrossRef] [PubMed]
24. Neogi, D.S.; Bae, J.H.; Seok, C.W.; Lim, H.C. Impact of patellar height on unicompartment knee arthroplasty: Does patella baja lead to an inferior outcome? *J. Orthop. Traumatol.* **2014**, *15*, 47–54. [CrossRef]
25. Chen, A.F.; Tetreault, M.W.; Levicoff, E.A.; Fedorka, C.J.; Rothenberg, A.C.; Klatt, B.A. Increased incidence of patella baja after total knee arthroplasty revision for infection. *Am. J. Orthop.* **2014**, *43*, 562–566.
26. Insall, J.N. Intra-articular surgery for degenerative arthritis of the knee. A report of the work of the late K. H. Pridie. *J. Bone Joint Surg.* **1967**, *49*, 211–228. [CrossRef]
27. Hughston, J.C. Subluxation of the patella. *J. Bone Joint Surg.* **1968**, *50*, 1003–1026. [CrossRef]
28. Kate, B.R.; Robert, S.L. Some observations on the upper end of the tibia in squatters. *J. Anat.* **1965**, *99*, 137–141.
29. Narkbunnam, R.; Chareancholvanich, K. Effect of patient position on measurement of patellar height ratio. *Arch. Orthop. Trauma Surg.* **2015**, *135*, 1151–1156. [CrossRef]
30. Anagnostakos, K.; Lorbach, O.; Kohn, D. Patella baja after unicompartmental knee arthroplasty. *Knee Surg. Sports Traumatol. Arthrosc.* **2012**, *20*, 1456–1462. [CrossRef]
31. Leung, Y.F.; Wai, Y.L.; Leung, Y.C. Patella alta in southern China. A new method of measurement. *Int. Orthop.* **1996**, *20*, 305–310. [CrossRef]
32. Kumar, A.; Ram, G.G. Measurement of Insall Salvati ratio and modified Insall Salvati ratio to assess the position of the patella in South Indian population. *Int. J. Res. Orthop.* **2017**, *3*. [CrossRef]
33. Schlenzka, D.; Schwesinger, G. The height of the patella: An anatomical study. *Eur. J. Radiol.* **1990**, *11*, 19–21. [CrossRef]

34. Soejbjerg, J.O.; Hvid, I.; Dalgaard, E. The vertical position of the patella estimated by four radiographic measurements. *Eur. J. Radiol.* **1986**, *6*, 244–247.
35. Wambua, B.; Awori, K.; Ongeti, K.; Kigera, J.; Olabu, B. Gender difference in the modified Insall-Salvati ratio in a black Kenyan population. *Anat. J. Afr.* **2016**, *5*, 686–692.