Pure and Mixed Imaging Tests, Precision, and Sex Dependence in Patellofemoral Imaging: Letter to the Editor

Dear Editor:

I have read with a childlike interest the article entitled "Reliability of the Tibial Tubercle–Roman Arch Distance for Evaluating Tibial Tubercle Malposition and Predicting Patellar Dislocation via Magnetic Resonance Imaging" by Xu et al,[3] which was recently published in your preeminent journal.

It is becoming increasingly hard to invent anything these days, so I compliment the authors on their effort in bringing us the tibial tuberosity–Roman arch (TT-RA) distance. Femoral trochlear dysplasia indeed makes the measurement of the standard tibial tuberosity–trochlear groove (TT-TG) distance difficult—this is a long-known fact (even I highlighted it close to decade ago,[1] and I am just a little fish in the sea of patellofemoral instability research). However, I do feel there is something else that needs highlighting here.

In the context of *screening*, when there are dislocators and nondislocators, the quintessential question is: Which individual is a dislocator? To answer this, one could use any mixed imaging test at one's disposal (the standard TT-TG distance, the tibial tuberosity–femoral intercondylar midpoint [TT-FIM] distance,[2] now even the TT-RA distance, or any other imaging test for that matter having a femoral reference point) ideally, yet unattainably without bias. This is because a mixed imaging test integrates 2 major sides of the problem: translation and rotation. Having them intermingled in a single yardstick might excel in predicting who may and who may not be a dislocator. In the clinical context, nonetheless, dislocators prevail. Now the quintessential question changes to: What can one do to fix it? To answer this, one would have to have a pure imaging test of tibial tuberosity lateralization that is independent of femorotibial rotation (such as tibial tuberosity–tibial intercondylar midpoint [TT–TIM] distance,[2] for example—it would have been very informative if the authors had had incorporated this into their research methodology, as it would have translated easily to MRI due to its bony landmarks).

Is the TT-RA distance dependent on femorotibial rotation? If it is, then it is a mixed imaging test, and could be used for screening. The authors write, "the mean value and pathological threshold of the TT–RA distance as measured on MRI scans in the current study also differed from those measured on CT scans," and "... although the aim was to have the knee extended in the MRI scanner, the actual knee angle was not measured."[3] Could this be a glimpse that rotational issues might have a bearing in the threshold difference? Unfortunately, this was not investigated. I might be blindly bold to express that any imaging test having a reference point (a symbol) on the femur may be dependent on femorotibial rotation, at least to a certain extent. This line of reasoning could also be a clue as to why mixed imaging tests have higher area under the receiver operating curve (AUC) values—it may be because they predict dislocating events of the patella, simultaneously seeing both sides of the problem. A pure imaging test would only see a translational part without recognizing dislocators on an equal footing. Therefore, lower AUC values may not necessarily indicate a "poorer" imaging test, but rather one better suited for another context. Following a *yin-yang* frame of thought (albeit a simplistic interpretation of a non-philosopher) one could analogize as follows: to know if one is human, one could use an imaging test that sees both *yin* and *yang*. However, to know if one is, say, a woman, one could use an imaging test that sees *yin*, yet is blind to *yang*. If one is looking for higher AUC to recognize a human, the former would stand out. If one is looking for higher AUC to recognize a woman, the latter would stand out. In addition, recruiting healthy individuals as controls is entirely by the book, whereas having patients serve as their own controls is statistically quite fine, as the amount of potential bias is negligible. Even so, I presume this particular is somewhat of immaterial interest with regard to a much graver point of the study: the context.

One other thing easily overlooked respecting the measurement of narrow ranges is *precision*. I apologize if I have missed it, but how precise is TT-RA distance vis-à-vis its counterparts? For most if not all patellofemoral imaging tests, the range of acceptable values is narrow. Therefore, as precise imaging test as possible is required. This is generally a very important though often neglected topic. In practice, despite its accuracy, the TT-TG distance can be rather imprecise. Imprecision, on the other hand, might have a substantial impact on the binary interpretation of the obtained values and thus a need for surgical correction. The TT-TIM distance is, for example, 5 times more precise than the standard TT-TG distance.[2]

In conclusion: (1) Is the TT-RA distance a pure or a mixed imaging test? (2) What is the precision of the TT-RA distance? (3) Is the TT-RA distance sex dependent, and if not, why not (since sexual dimorphism of the human skeleton is natural)? It would appear completely understandable if some of your answers might be incomplete or lacking at this point. Perhaps they are merely the root of future investigations.

My dear fellow researchers, truth is simple, yet the road to truth is complicated. If things are getting simpler, one is closer to the truth. If things are getting more complicated, one is farther from the truth. I suppose we are still on the road. And a long and winding road it is.

The Orthopaedic Journal of Sports Medicine, 11(1), 23259671221142606
DOI: 10.1177/23259671221142606

I wish you an abundance of original ideas and good luck with your forthcoming research.

Dinko Nizić, MD
Zagreb, Croatia

Address correspondence to Dinko Nizić, MD (email: dinko.nizic@gmail.com).

The author has declared that there are no conflicts of interest in the authorship and publication of this contribution. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

REFERENCES

1. Nizić D. The tibial tubercle–trochlear groove distance on axial CT and MRI: letter to the editor. *Am J Sports Med*. 2013;41(12):NP53-NP55.
2. Nizić D, Šimunović M, Pavliša G, Jelić M. Tibial tuberosity–tibial intercondylar midpoint distance measured on computed tomography scanner is not biased during knee rotation and could be clinically more relevant than current measurement systems. *Int Orthop*. 2021;45(4):959-970.
3. Xu Z, Zhao P, Song Y, Wang H, Zhou A, Yu J-K. Reliability of the tibial tubercle–roman arch distance for evaluating tibial tubercle malposition and predicting patellar dislocation via magnetic resonance imaging. *Orthop J Sports Med*. 2022;10(8):23259671221118561.