Congruous versus Incongruous Patellar Tilt
A Preliminary Study

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Abstract
Although the presence of patellar tilt usually implies a tight lateral retinaculum and unhealthy pressure distributions within the patellar cartilage, it is possible for the bony portion of the patella to appear tilted while the articular cartilage is in fact fully congruous in a medial-lateral direction. We call this “congruous tilt.” In such cases, a patient may not suffer from an excessive lateral pressure phenomenon, despite the presence of tilt.

Materials and Methods: One hundred and forty-nine knee MRIs were evaluated with respect to patellar tilt and Wiberg morphology.

Results: Thirty-one patellae were tilted (tilt angle > 10°). Twenty-five of 31 patellae demonstrated normal morphology in the axial plane (Wiberg 2). One of these 25 tilted patellae demonstrated congruous tilt. Three of 31 patellae were of the Wiberg type 3 (a long lateral facet, a very short medial facet). In two out three of these, the tilt was deemed to be congruous.

Conclusion: Based on this preliminary study, a tilted patella of the Wiberg 3 variety is likely to demonstrate congruous tilt. It remains to be determined whether patients with congruous tilt are less prone to pain but more prone to instability than their incongruous counterparts.

Patellar tilt is one of the many possible causes of patellar pain. It represents a malalignment of the patella, specifically abnormal rotation in the axial (transverse) plane, lateral side down. It is found in conjunction with tightness of the lateral retinaculum.

When the patella is tilted, a line drawn across the medial and lateral borders of the patella on transverse imaging studies is angulated relative to the posterior condyles. Moreover, the lateral portion of the patella is usually fully in contact with the lateral wall of the trochlea while the medial aspect of the patella appears to have little if any contact with the medial wall. This is increasingly true with increasing degrees of tilt.

Pain can be produced by noxious changes within the retinaculum and an abnormal pressure distribution under the patella. More precisely, the medial soft tissues are stretched, the medial aspect of the patellar cartilage is under-loaded, and the lateral aspect is overloaded.

Not all patients with patellar tilt, however, complain of pain. Our premise is that tilting of the patella, as it is commonly assessed, may not always reflect excessive pressures across the lateral patella. Anatomic variations of the patella in the axial plane, Wiberg 3 or “Hunter’s cap” variations for example, can be associated with bony tilting and a relatively flat, congruent patellofemoral articulation. This we have called “congruous tilt,” to distinguish it from the more commonly-found “incongruous tilt.”

In this preliminary study, we sought to investigate two items: what percentage of patients with patellar tilt might in fact demonstrate congruous tilt? Would patients with congruous tilt be likely to demonstrate a Wiberg 3 or Hunter’s cap variation?

Materials and Methods
We collected MRIs in accordance with procedures set forth by the Mount Sinai School of Medicine Grants and Contracts Office. A listing of all knee MRIs performed at two hospital locations was obtained. Patients under the age of 18 in addition to patients with a history of ipsilateral knee arthroplasty were excluded. This left us with 149 scans to
evaluate. All scans were performed in the same fashion, with the knee flexed approximately 10°. For each patient, cuts from axial MRI scans of the knee were chosen that exhibited some patellofemoral contact anywhere along the articulation. This eliminated from consideration the most proximal cuts of the patella since the proximal patella is not in contact with the trochlea when the knee is slightly bent. Based on these criteria, most scans had one or possibly two appropriate cuts for each patient. Occasionally, a high-riding patella would have no contact with the trochlea on any cut, and these few patients were excluded.

The morphology of each patella was identified according to Wiberg’s classification. A patella was designated Type 1 if the medial and lateral (bony) facets were approximately equal in size. A Type 2 designation was given if the lateral facet was larger than the medial facet (the most common type), and Type 3 designation was given if the lateral facet comprised the majority of the posterior surface.

The tilt angle was determined for each image by measuring the angle subtended by a line drawn along the posterior border of the femoral condyles and a line drawn across the widest portion of the patella. As per a prior study,7 abnormal tilt was defined as an angle greater than 10°.

MRIs of all patients determined to have tilt were assessed for the presence of congruence. An incongruent patellofemoral joint was defined as one where there appeared to be no contact in the medial portion of the patellofemoral articulation (at that degree of flexion). Tilt was considered congruent, conversely, when contact appeared to be present throughout the articulation, from medial to lateral. This presented in a number of ways, including an increased size of the medial trochlea, increased thickness of medial patellar or trochlear cartilage, and relatively flat trochlea in the setting of a Wiberg type 3 or Hunter’s cap patella. A subset of scans was selected and classified as questionably congruent when one of the above features was present, and there was minimal increase in the medial joint space compared to the lateral.

Two examiners (JS, RG) performed an analysis of all images classified as tilted. Measurements of tilt angles were performed using PACS software.

Results
One hundred and fifty-six consecutive knee MRIs were collected. One scan was eliminated because the patient was under 18 years of age, one scan due to the presence of a total knee arthroplasty, and five scans were excluded because the trochlear cartilage, posterior condyles cartilage, and patellar cartilage were not present simultaneously on any single cut due to patella alta. This left a total of 149 MRIs for analysis.

Of these scans, 19 were classified as tilted, and 12 were classified as having borderline tilt (marginally above 10°). These 31 MRIs were grouped by their Wiberg type and examined for congruence (Figs. 1 and 2). There was a clear preponderance of (normal) Wiberg type 2 patellae, which comprised 25 of the 31 patellae. Of these, 18 were determined to be incongruous, 6 were determined to be questionably congruous, and one was frankly congruous. Types I and III patellae were far less common, with only 3 of each type present. Of the type 1 patellae, two were questionably congruous, and one was incongruous. For type 3 patellae, one was questionably congruous, and two were congruous.

Discussion
Although the presence of patellar tilt usually implies a tight lateral retinaculum and unhealthy pressure distributions within the patellar cartilage, it is possible for the bony portion of the patella to appear tilted while the articular cartilage is in fact fully congruous in a medial-lateral direction (a patella is never congruous in the sagittal plane). In such cases, a patient may not suffer from an excessive lateral pressure phenomenon.

It would appear that the shape of the patella is a major determinant of congruous tilt. In this preliminary study, type 3 patellae made up only 10% of all scans analyzed but ac-
counted for two out of the three clearly congruous patellae present.

Many tilt parameters have been described. As with our previous MRI tilt study, we chose a tilt angle that assesses tilt by way of a line drawn across the medial and lateral borders of the patella. This was first described on computerized scanning by Nove-Josserand and Dejour, and it is the radiographic equivalent of assessing tilt on the physical examination. Other tilt parameters (beginning chronologically with Laurin’s) assess the slope of the lateral facet as a surrogate for tilt. Paradoxically, with these parameters, the lower the tilt angle, the greater the tilt. Therefore, all Type 3 patellae, with their flat, horizontal patellar cartilage will have abnormal tilt angles. Certainly all three of our tilted Type 3 patellae would be defined as tilted even with a Laurin-type of tilt parameter.

Staubli and coworkers demonstrated that the articular cartilage in the patellofemoral articulation does not automatically follow the contour of the subchondral bone. Thus, true articular congruence can be over- or under-estimated by an analysis of bony anatomy. This is a related but different issue from the one discussed in this study. Our focus has been on the potential disconnect between patellar cartilage and the overall axial geometry of the patella rather than on the patellar cartilage versus its underlying bone.

**Conclusion**

Although a tilted patella is usually associated with increased lateral pressures, diminished medial patellofemoral contact, and a tight retinaculum, none of these may occur in the presence of certain patellofemoral morphologies. Specifically, in the setting of a Wiberg 3 or Hunter’s cap patella (especially in combination with a flat trochlea) bony tilt and articular congruence may co-exist in the absence of abnormally high pressure distributions. On the other hand, such a geometry may be more unstable.

**Disclosure Statement**

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

**References**