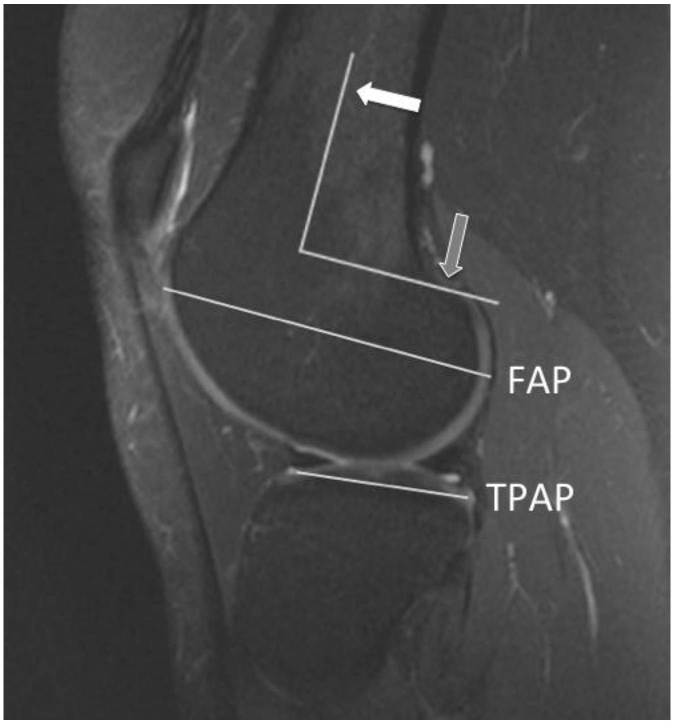


Fig. E-1
Weight-bearing midsagittal magnetic resonance image of the knee. The anteroposterior length of the distal aspect of the femur (FAP) was defined as the maximal anteroposterior length of a line (gray arrow) drawn perpendicular to the femoral anatomic axis (white arrow) and connecting the anterior and posterior articular cartilage surfaces of the femur. The anteroposterior length of the lateral aspect of the tibial plateau (TPAP) was defined as the maximal anteroposterior length of a line drawn within the subchondral plate and connecting the anterior and posterior articular cartilage surfaces of the tibial plateau.

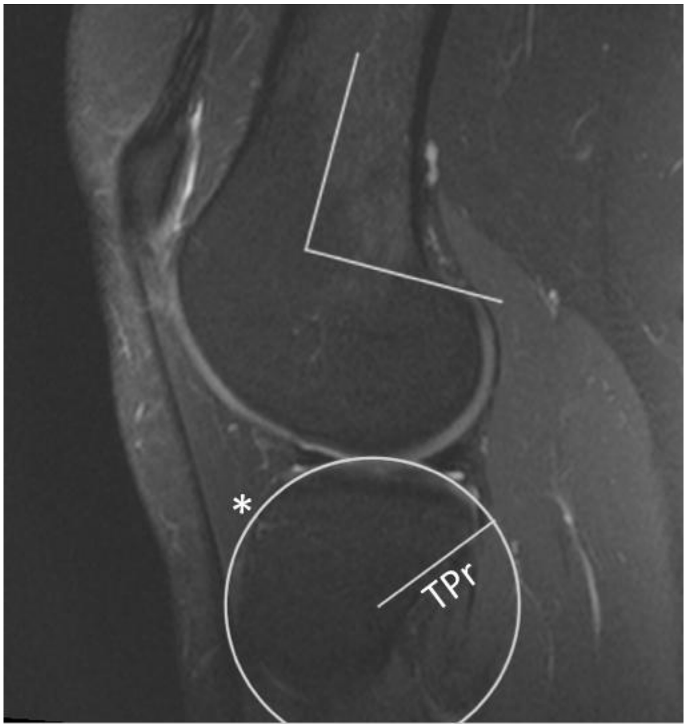
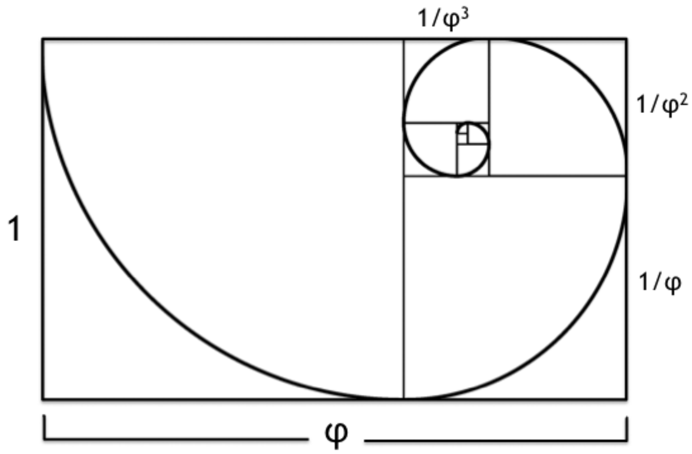


Fig. E-2
Magnetic resonance image showing the determination of the radius of curvature of the weight-bearing surface of the lateral aspect of the tibial plateau (TPr). A “best-fit” circle was digitally superimposed directly on the articular cartilage surface of the lateral aspect of the tibial plateau to match the articular length and height (asterisk). The radius of curvature of this superimposed circle (TPr) was recorded for the weight-bearing surface of the lateral tibial plateau.



$$\varphi = \frac{1+\sqrt{5}}{2} \approx 1.6180339887...$$

Fig. E-3
The Fibonacci spiral and the golden ratio. The squares that bound each 90° segment of the curve are derived from the Fibonacci sequence (0, 1, 1, 2, 3, 5, 8,…) such that the length of the sides of each square is equal to the sum of the lengths of the sides of the two preceding squares. The resulting sequence closely follows a true logarithmic curve or a “golden spiral” whose growth factor is related to the “golden ratio.”

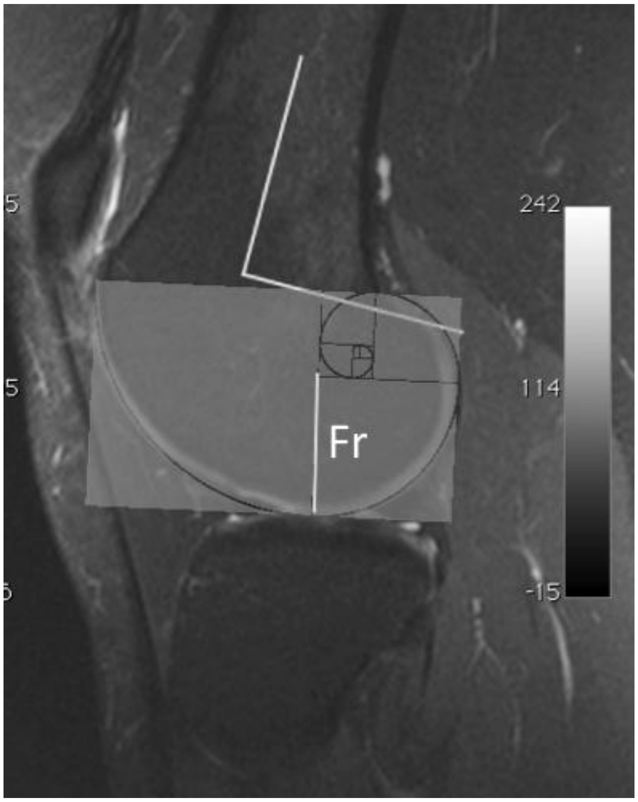


Fig. E-4
Magnetic resonance image showing the determination of the radius of curvature of the distal aspect of the femur (Fr). A “best-fit” Fibonacci curve (bounded by the gray rectangle) is superimposed on the distal femoral articular surface. The length of the side of the square that corresponds to the flexion-extension arc of the knee (Fr) was used to approximate the femoral radius of curvature. Proximally, Fr approximates the center of rotation of the knee. The distal boundary is the point of contact between the femoral and tibial articular surfaces.

TABLE E-1 Age, Injury Mechanism, and Tegner Score According to ACL Injury Status (N = 173)

Risk Factor		Uninjured (N = 61)		Unilateral (N = 69)		Bilateral (N = 43)	
		Male (N = 36)	Female (N = 25)	Male (N = 43)	Female (N = 26)	Male (N = 22)	Female (N = 21)
Mean age (stand. dev.) *(yr)*	28.4 (7.1)	28.3 (7.3)	26.0 (7.0)	28.1 (5.5)	30.3 (9.5)	30.9 (5.2)	26.6 (7.1)
Age in yr *(no.)*							
16-19	20 (12%)	5	7	1	3	0	4
20-29	82 (47%)	15	9	29	9	10	10
30-39	54 (31%)	13	7	11	7	11	5
40-45	17 (10%)	3	2	2	7	1	2
Primary injury *(no.)*							
Soccer	54 (33%)	6	6	15	10	9	8
Other	28 (16%)	8	8	5	3	0	4
Basketball	23 (13%)	0	1	10	2	8	2
Skiing	18 (10%)	4	1	5	5	1	2
Chronic reinjury	11 (6%)	6	5	0	0	0	0
No information	8 (5%)	4	1	0	0	2	1
Rugby	5 (3%)	2	1	1	1	0	0
Football	5 (3%)	2	1	1	1	0	0
Snowboarding	5 (3%)	1	0	1	0	1	2
Volleyball	4 (2.%)	0	1	1	1	1	0
Ultimate frisbee	4 (2%)	0	0	2	0	0	2
Flag football	3 (2%)	1	0	1	1	0	0
Tennis	3 (2%)	2	0	0	1	0	0
Softball	1 (2%)	0	0	1	1	0	0
Tegner score *(no.)*							
6	66 (38%)	14	9	17	12	7	7
7	65 (38%)	14	4	19	9	13	6
8	7 (4%)	1	2	1	1	1	1
9	34 (20%)	7	9	6	4	1	7
10	1 (1%)	0	1	0	0	0	0

TABLE E-2 Intraclass Correlation Coefficient (ICC) of Directly Measured Knee Geometry Parameters Between Blinded Observers

Parameter	ICC*	95% Confidence Interval	
Femoral anteroposterior length (FAP)	0.90	0.88	0.92
Femoral Fibonacci radius of curvature (Fr)	0.90	0.88	0.92
Tibial plateau anteroposterior length (TPAP)	0.57	0.50	0.63
Lateral tibial plateau radius of curvature (TPr)	0.86	0.83	0.88

*An ICC (kappa value) of <0 = poor agreement, 0.0 to 0.20 = slight agreement, 0.21 to 0.40 = fair agreement, 0.41 to 0.60 = moderate agreement, 0.61 to 0.80 = substantial agreement, and 0.81 to 1.00 = almost perfect agreement.

APPENDIX E-1 Method of Measurement of the Femoral Axis, FAP, TPAP, TPr, Fr, and Length and Radius Ratios

Determination of the Longitudinal Axis of the Femur

The longitudinal axis of the femur was determined as described by Hashemi et al[24,28]. The midpoint between the anterior and posterior surfaces of the femur was determined on the midline sagittal plane at two points approximately 4 to 5 cm apart. This sagittal line was taken to represent the anatomic axis of the femur. A line perpendicular to this longitudinal axis line was then used to determine the maximum anteroposterior length of the distal aspect of the femur.

Establishing the Midsagittal Reference Plane

In most patients, T2-weighted proton-density images gave exceptional contrast among cartilage, bone, and the surrounding tissue. In rare cases of motion artifact or when T2-weighted proton-density images were not available, suitable T1-weighted images were utilized. Linked, cross-referenced coronal and sagittal-plane views were used to identify the central weight-bearing axis of the lateral tibiofemoral articulation (Fig. 1). This "reference" plane was defined as the most caudad point along the distal femoral articular surface, and it corresponded closely to the mediolateral midpoint of the lateral aspect of the tibial plateau and the distal femoral articular surface. The reference plane for each knee was agreed on by the three observers. The femoral anatomic axis and the perpendicular to this axis were superimposed on the reference midsagittal image, linked to a random study number, and exported (Fig. E-1). Measurements were made independently by the three observers on each referenced midsagittal image.

Measurement of the Maximum Femoral Anteroposterior Length (FAP)

The anteroposterior length of the lateral femoral condyle (FAP) was measured along a line perpendicular to the anatomic axis and was defined as the maximal distance between the anterior and posterior articular cartilage surfaces (Fig. E-1).

Measurement of the Maximal Tibial Plateau Anteroposterior Length (TPAP)

The anteroposterior length of the lateral aspect of the tibial plateau (TPAP) was defined as the maximal anteroposterior length of the articular cartilage surface of the tibial plateau at the subchondral plate (Fig. E-1).

Since it was assumed that the male patients, on average, would have larger knees than the female patients, the ratio of femoral anteroposterior length to tibial plateau anteroposterior length (FAP:TPAP) was also calculated to assess whether the relative sizes of the tibia and femur differed between ACL-injured and uninjured patients regardless of patient size.

Measurement of the Radius of Curvature of the Tibial Plateau (TPr)

The radius of curvature of the articular cartilage surface of the lateral aspect of the tibial plateau (TPr) was assessed by digitally superimposing a “best-fit” circle on this surface to match the articular length and height (Fig. E-2). This is analogous to the method described by Baré et al.[33]. The radius of curvature of the superimposed circle was recorded.

Measurement of the “Fibonacci” Femoral Articular Radius of Curvature (Fr)

The articular surface of the distal aspect of the lateral femoral condyle is convex but noncircular in the sagittal plane. The curvature is variable and appears to closely follow the shape of the Fibonacci “golden” spiral (Fig. E-3). A “best-fit” Fibonacci curve was superimposed on the midsagittal image of the distal aspect of the femur. Particular attention was paid to the fit of the second “quadrant” of the series, which is the quadrant that is primarily involved in the flexion-extension arc of the knee. Since most ACL injuries occur at close to full extension or at small flexion angles, we defined the distal femoral radius of curvature (Fr) as the length of the radial segment in the second quadrant of a superimposed Fibonacci-series logarithmic curve at the point of contact between the distal femoral and proximal tibial surfaces (Fig. E-4).

To control for size differences due to sex and to variations among individuals, the ratio of the radius of curvature of the tibial plateau to that of the distal aspect of the femur (Fr:TPr) was also calculated.