B-P™ White Paper #1 - Improved Femoral Articulating Surface

by

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Introduction: The LCS® is designed to provide near congruent contact at peak loading. In order to obtain adequate flexion, however, the LCS provides only incongruent contact during flexion beyond peak loading. This is a compromise which has been clinically shown to work quite well.[1-5] The B-P femoral component improves on this excellent design by increasing contact congruety and the range of congruent contact to reduce stresses thus improving its wear characteristics.

The LCS: The New Jersey Knee uses a common generating curve to form the articulator surface of the femur. A similar curve is used to form the tibial and patellar articulating surfaces insuring that at least near line contact will be maintained for all motion phases.

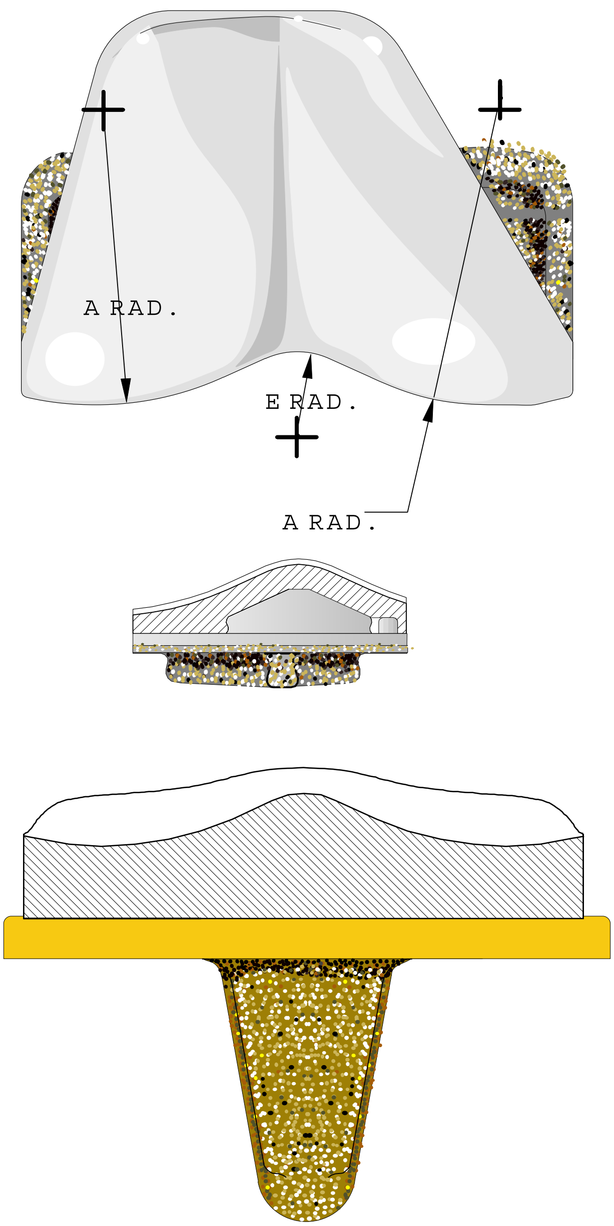

Fig. 1 Common Generating Curve

This generating curve is swept around a series of parallel axes to form the femoral articulator shape.

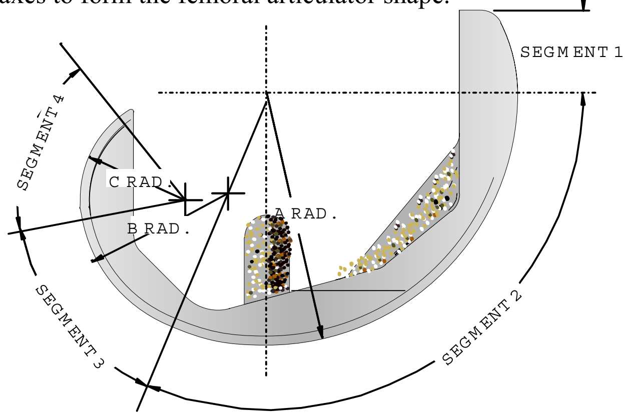

Fig. 2 LCS Articulating Surface Segments

Segment 2 the "Principal Load Bearing Segment" is generated by rotating the generating curve about an axis through the centers of the two "A" radii of Fig. 1. This produces two spherical regions in the Principal Load Bearing Segment. The tibial bearings have similar complimentary spherical surfaces, and thus all articulation in this region has near congruent area contact. This produces near congruent tibiofemoral contact during peak load phases of walking and near congruent patellar articulation during all motion phases except near full extension where patellofemoral compressive loads are very small.

Tibiofemoral Loading: The forces in the knee during walking are on the order of about 3 to 4 times body weight in normal gait.[6]

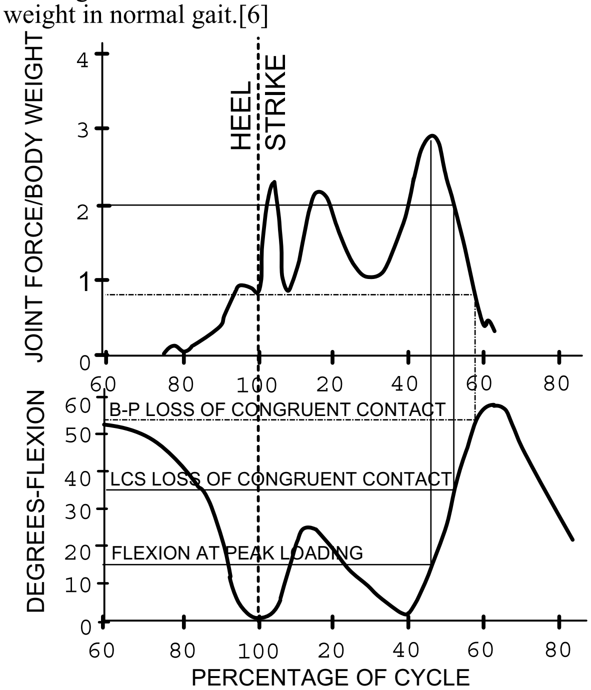

Fig. 3 Joint Forces and Motion for Normal Gait [7]

Peak forces occur at about 15° of flexion but substantial forces are present from 0° to 40°.

Comparison of the LCS with the B-P: A comparison of the lateral LCS and B-P shapes is shown in Fig.4.

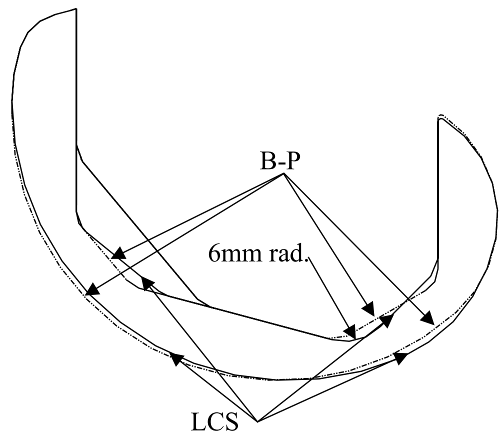

Fig. 4 LCS and B-P Lateral Shapes.

The shapes are slightly different in that the B-P segment 2 has a slightly smaller radius and extends an additional 19°. Segment 4 is eliminated. The internal B-P box chamfers are different in that the angle of the posterior chamfer is changed to accommodate the new B-P posterior shape and to avoid the 6mm radius in the LCS. This radius often requires removal of the corner of bone at the edge of the posterior chamfer cut to allow proper seating of the femoral component. The anterior B-P chamfer is reduced in size to require less bone removal.

The current LCS looses congruent contact at about 35° of flexion. At this phase of motion the force on the knee joint is about 2 times body weight as may be seen from Fig. 3. Segment 2 of the B-P component is extended by 19° and this extends congruent contact by a similar amount. Thus loss of congruent contact occurs at about 54° in the B-P. Here joint loading is less than body weight.

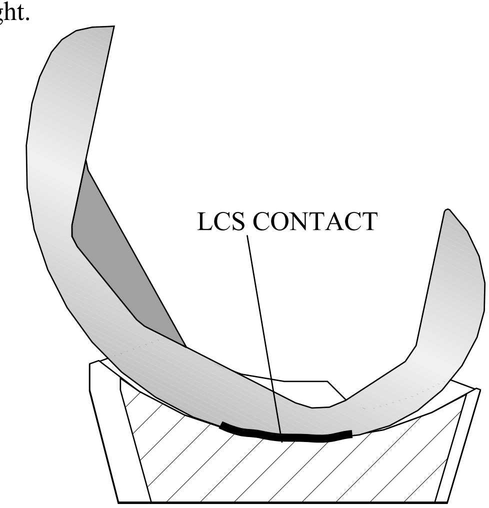

Fig. 5 LCS Bearing Contact at Peak Loading.

Further, as may be seen from Fig. 5 at peak loading only part of the bearing is loaded.

Finally the LCS generating curve does not exactly match the curve for the tibial and patellar bearings. This was done to accommodate the meniscal bearing design.[9] Thus even in the "congruent" contact mode the surfaces are slightly incongruent further reducing the contact region.

The longer segment 2 of the B-P provides a greater length of the contact region at peak load bearing. Further, since the B-P does not need to accommodate meniscal bearings the generating curves of the femoral component and bearings can be exactly the same providing full congruency in the larger congruent phase. Thus the region of contact is much larger for the B-P Knee than for the LCS as illustrated in Fig. 6.

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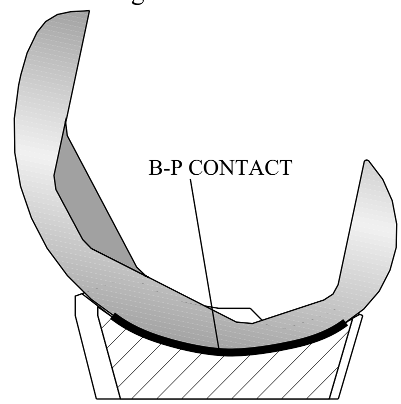

Fig. 6 Contact with the B-P Knee at Peak Loading

Materials and Manufacture: DePuy markets a ceramic coated LCS as a premium product. They license and use our propriety coating and polishing process and we help DePuy manufacture such devices. Their testing[9] shows that our TiN ceramic coating should improve wear resistance. Further since our femoral articular surface is accurately machined to an exact shape our femoral component is more accurately made than DePuy's further improving B-P wear performance.

Conclusion: As a result of what appear to be minor changes in shape stresses in the B-P knee are substantially less than with the LCS. This reduction in contact stress along with improved materials and manufacture reduces the potential for wear associated with the already excellent wear properties of the LCS.

Thus the B-P Femoral Component represents a substantial advance beyond LCS.

References:

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