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COMPUTER MODELLING OF ARTICULAR CONTACT FOR ASSESSING TOTAL KNEE REPLACEMENT CONSTRAINT CRITERIA

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INTRODUCTION

Amongst patients deemed to receive total knee replacements (TKR), differences exist in terms of stabilization needs. Reinstatement of kinematic integrity is accomplished via TKR selection based on its range of constraint (ROC). As three-dimensional computer simulations are developed into authoritative tools for assessing joint kinematics, standard tests performed in an *in vitro* setting are being replaced in the product development process with sophisticated modelling interfaces. This study presents a test bed for parametric TKR variational analyses that features a novel surface-to-surface contact algorithm (VKS/ROC) for solving joint dynamics.

METHODS

The preprocessing module allows the user to select, orient, and position CAD components imported as shells through IGES, or the user can request that the system automatically calculate a neutral position for the respective parts. Antero-posterior (AP) draw, mediolateral (ML) shear, rotary laxity (IE), and distraction conditions are then defined according to F1223 standard (ASTM, 1989), the tibial component referencing the relative displacements. During execution, an external module generates contact forces based on a network of compressive springs at discrete data points on a surface and is accessed by the solver (ADAMS, Mechanical Dynamics, Ann Arbor, MI, USA) in reaction to forces applied to the system. Changing topologies are foreseen through the incorporation of stick/slip friction and local deformation. Parameters such as penetration depth and shear characteristics, can be adjusted to reflect the properties of the surfaces in contact. Resolution of the non-linear (differential/algebraic) equations stated in the VKS/ROC model yields the constraint values that refer to the component's displacements, while guided by their inherent geometrical features.

RESULTS

Kinemax Condylar (Figure 1), Stabilizer, and Low Stress designs (Howmedica, Rutherford, NJ, USA), were tested in AP, ML and IE. Experimental (mean of 4 samples, col. 1) and analytical results (col. 2), are shown in Table 1 for the Kinemax Condylar Design.

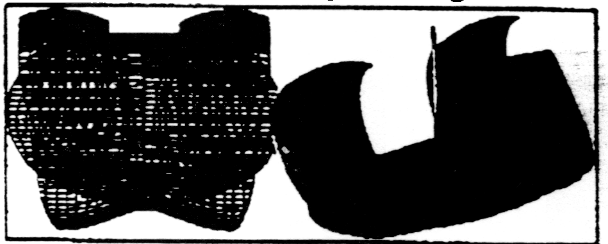

Figure 1 - Kinemax Condylar

Table I - Condylar Design Ratios (ASTM F1223-89)

	APC[1]	MLC[2]	RLC[3]
0°	1.7/2.0	2.5/2.6	1.6/2.1
30°	1.1/1.5	2.4/2.6	1.7/1.8
60°	1.1/1.5	2.4/2.6	1.7/1.6
90°	1.1/1.5	2.4/2.6	1.7/1.5

[1]Anteroposterior Constraint Ratio, [2]Mediolateral Constraint Ratio, [3]Rotary Laxity Constraint Ratio

CONCLUSION

Analytical outcome agrees considerably with experimental results. Immediately, this may have a tremendous impact on decreasing the TKR product design cycle.

REFERENCE

ASTM F1223-89. Standard Test Method for Determination of Total Knee Replacement Constraint.

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