INTRODUCTION
Many surgical procedures incorporate pre-operative planning based upon the tibiofemoral angle as a guideline. These approximations involve the assumption that the tibiofemoral angle is representative of the alignment of the knee (1). On the macro-scale this has seemed a very reasonable approach. For example, osteotomies rely upon the tibiofemoral angle in pre-operative planning. Unfortunately, these procedures have yielded less than consistent results. With the objective of improving long-term results for these procedures a reassessment of the validity of this benchmark is appropriate.

The purpose of this study was to investigate the correlation of the individual tibial and femoral angular components of the tibiofemoral angle. We hypothesize that the performance of osteotomies based on the tibiofemoral angle alone is significantly broad (>7.5°). Furthermore, we hypothesize that the mechanical axes of the tibia and the femur are independent of each other. We consider that this decoupling of the tibial and femoral angles has been a contributing factor in the long-term performance of these procedures.

METHODS
Two data sets were analyzed to test each hypothesis.

Data Set A: A meta-analysis was done on the findings of four papers describing the distribution of late post-operative (5-7 year follow-up) tibiofemoral angles (2-5). All of the 348 Coventry osteotomies were performed for tibiofemoral angulation associated with medial compartment arthritis. Fitting the distribution to a Gaussian produces probability statistics to characterize the long-term results of these procedures.

Data Set B: One hundred consecutive full length A-P standing x-rays of patients with tibiofemoral angulation and medial compartment arthritis were selected for measurement of the tibiofemoral angle and the individual femoral and tibial axes (Fig. 1-A). Tibiofemoral angle was measured using methods previously described (6). The tibial and femoral components were decomposed from the lines composing tibiofemoral angle. The tibial angle is measured with respect to the vertical while the femoral angle was measured from the femoral line to the vertical (Fig. 1-A). For a given tibiofemoral angle, considerable differences can exist in the independent angles (Fig. 1-B-C).

RESULTS
Data Set A: The outcomes of the tibiofemoral angle in 348 cases after a Coventry osteotomy show a large variance in outcomes (Fig. 2). The distribution shows an average correction of 179.9° with a standard deviation of 11.6°. Considering a targeted value of 183°, the performance is significantly broad (6). If one considers the mean as the target value one would predict that over 30% of patients will have a discrepancy in alignment of over 11.6° in either direction.

Data Set B: The analysis of the pre-operative standing x-rays showed that there is very little correlation between the femoral and tibial angles. The Pearson’s linear correlation coefficient is 0.032 for tibial angle dependence on the femoral angle (Fig. 3). Even after removing those of greater than 2 standard deviations and those with femoral dominated components of the tibiofemoral angle there is still little correlation (Pearson’s = 0.137).

DISCUSSION
Both hypotheses are validated. The standard deviation (11.6°) of the long-term results of osteotomies is large. The assumption that the tibiofemoral angle is correlated with the mechanical axes of the tibia and femur appears to be a poor one. Considering both results we believe that reliance upon the tibiofemoral angle is a contributing factor in the inconsistent performance of these procedures. To improve results, we have found from experience, that patients with a large component of tibia vara to be good candidates for realignment and those patients with large contributions of femoral abduction to be poor candidates for tibial osteotomies. Improved performance is expected with incorporation of the tibial and femoral angles in the pre-operative planning of realignment procedures.

REFERENCES

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