# EFFECT OF IMAGE QUALITY ON JOINT COORDINATE SYSTEM REPEATABILITY

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## INTRODUCTION

In 1983, Grood and Suntay [1] developed a joint coordinate system for the knee, based on the Transepicondylar Line (TEL) and the mechanical axis of the femur. However, for this coordinate system, it is necessary to have the femoral head included in the analysis. Another coordinate system in use also uses the TEL, but instead of using the mechanical axis, it uses the anatomical axis along the femoral shaft [2].

In this study, the effect of scan acquisition volume, particularly the medio-lateral (ML) dimension, on coordinate frame repeatability are investigated and recommendations are made for scan parameters.

## METHODS

26 MRI scans, from healthy adults, as approved by the University of Rochester Research Subjects Review Board, were reconstructed as previously described [3] to give 3D models of the distal femur. These were then imported into *Arthron* [4], a custom developed programme for shape analysis applications in Biomechanics. The epicondylar points were identified manually, the centre of the TEL calculated and added to the femoral coordinate frame.

For the proximo-distal axis, a best fit cylinder was constructed along the femoral shaft by creating 15 parallel, equispaced, polylines along the shaft and calculating the least-squares line of best fits through the centroids (Figure 1). The third axis was mutually perpendicular to the first two.

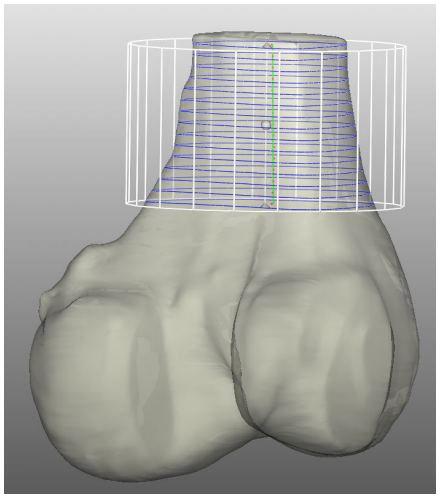

**Figure 1:** Construction of axis along femoral shaft

For each of the 26 scans, the reference frame was created in each of five distinct sessions over five days by a single user. The five repetitions of each scan were then compared and analyzed for variation in internal/external (I/E) and varus/valgus (V/V) rotation using the open–source software *ImageJ* [5].

## RESULTS AND DISCUSSION

11 of the 26 models showed considerable variation in orientation (>1°) (Table 1), resulting from differences in epicondylar point selection. In all 11 scans, it was found that the scan volume was truncated in the ML direction, resulting in the need to estimate epicondylar location.

**Table 1:** Measured variation in degrees

| Subject | 1st | 1st | 2nd | 2nd | 3rd | 3rd | 4th | 4th |
|---|---|---|---|---|---|---|---|---|
| | I/E | V/V | I/E | V/V | I/E | V/V | I/E | V/V |
| 1 | 0.00 | 9.84 | 0.00 | 10.32 | 0.00 | 9.81 | 0.00 | 9.56 |
| 2 | 0.00 | 2.20 | 0.00 | 2.02 | 0.00 | 1.42 | 0.00 | 1.92 |
| 3 | 0.00 | 4.03 | 0.00 | 2.84 | 0.00 | 3.53 | 0.00 | 4.42 |
| 4 | 0.00 | 3.95 | 0.00 | 2.71 | 0.00 | 4.45 | 0.00 | 2.91 |
| 5 | 0.00 | 2.11 | 0.00 | 2.78 | 0.00 | 2.13 | 0.00 | 3.81 |
| 6 | 0.00 | 1.06 | 0.00 | 1.07 | 4.49 | 1.43 | 1.88 | 1.67 |
| 7 | 0.00 | 3.57 | 0.00 | 2.51 | 0.00 | 1.92 | 0.00 | 0.33 |
| 8 | 0.00 | 4.36 | 0.00 | 2.57 | 0.00 | 4.26 | 0.00 | 2.14 |
| 9 | 0.00 | 3.97 | 0.00 | 3.25 | 0.00 | 3.75 | 0.00 | 1.58 |
| 10 | 0.00 | 2.10 | 4.43 | 0.00 | 0.00 | 1.19 | 3.19 | 1.41 |
| 11 | 2.06 | 0.00 | 4.77 | 0.00 | 0.00 | 0.63 | 1.73 | 0.00 |

## CONCLUSIONS

All the scans used in this study were taken in the sagittal plane and therefore risked being truncated at the epicondyles, resulting in rotational error in the reference frame parameters. However, the TEL is used to set the coordinate frame, and therefore, truncation at the epicondyles is undesirable as it leads to variability in the coordinate frame, with epicondylar inaccuracy resulting in V/V alignment changes. In order to ensure repeatability of the coordinate frame, and to maximize accuracy in biometrics, it is recommended that scans should be made in the transverse plane.

## REFERENCES

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