Evaluating pre-operative coronal plane deformity in total knee arthroplasty: standing radiographs vs. customized instrumentation software

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Introduction: Assessment of preoperative coronal plane alignment is essential to planning total knee arthroplasty (TKA). The presence of varus or valgus deformity can help to guide coronal resection decisions, femoral component rotation, and the need for possible soft-tissue releases. An accurate assessment of pre-operative coronal plane alignment is important for performing an appropriate pre-operative plan. Conventional long-leg standing radiographs have been the gold standard for assessing coronal plan alignment. Computer-assisted navigation allows surgeons to accurately and reliably establish desired coronal alignment. We have previously reported that a poor correlation exits between the navigation determined pre-surgical coronal alignment of an extremity and conventional long-leg standing radiographs. This lack of correlation is particularly significant in limbs with large deformities. These are the extremities for which pre-operative planning is particularly important. Computer navigation has not been a widely adopted surgical tool. Customized instrumentation utilizing magnetic resonance imaging (MRI) is an emerging technology in total knee replacement. The efficiency, ease of use and short learning curve associated with customized instrumentation may lead to its widespread use. The purpose of this study was to evaluate the correlation between MRI-based imaging and conventional radiography in the assessment of preoperative coronal plane deformity.

Methods: One hundred fifty patients underwent TKA utilizing the Patient Specific Instrumentation. The pre-operative planning software was used to determine the coronal plane deformity based on MRI imaging. Varus and valgus deformity was also assessed for each patient on long-leg standing radiographs. Regression analysis was then performed to determine the correlation of the results.

Results: In the overall population of 150 patients, MRI-based imaging and conventional standing radiographs showed high correlation when measuring preoperative coronal plane deformity ($p<0.001$, R-squared =0.85, See Figure 1). In the 114-varus knees, there was still high correlation between radiographs and MRI (R-squared 0.62, $p<0.001$). However there was a tendency for overestimation of varus deformity by 2.3 degrees ($p<0.001$) on radiography. In the 36 valgus patients there was also high correlation between MRI and radiography (R-squared = 0.7, $p <0.001$) and no tendency for over or underestimation ($p=0.4$). The high correlation between MRI and standing radiographs is still preserved when assessing MRI deformities greater than 7.5 degrees (R-squared = 0.919).

Discussion: Customized instrumentation is an emerging technology in TKA. Our study shows that MRI based imaging shows high correlation to conventional radiography in the assessment of coronal plane deformity. There is a tendency for standing radiographs to show a greater degree of varus deformity compared to MRI imaging. A key difference between the two imaging modalities is that the MRI is performed supine compared to the long-leg films that are performed upright. There was no difference in pre-operative coronal deformity between the non-weight bearing based MRI's and the weight bearing long standing radiographs. Although standing radiographs are the gold standard for evaluating preoperative alignment, limb rotation and knee flexion can lead to a perception of greater deformity. Therefore, caution should be used in measuring the radiographic coronal deformity in patients with large varus or valgus deformities and flexion contractures. MRI-based imaging can be utilized to supplement and confirm a radiographic evaluation. Surgeons should utilize both conventional radiography and advanced imaging when assessing coronal plane deformity in TKA.

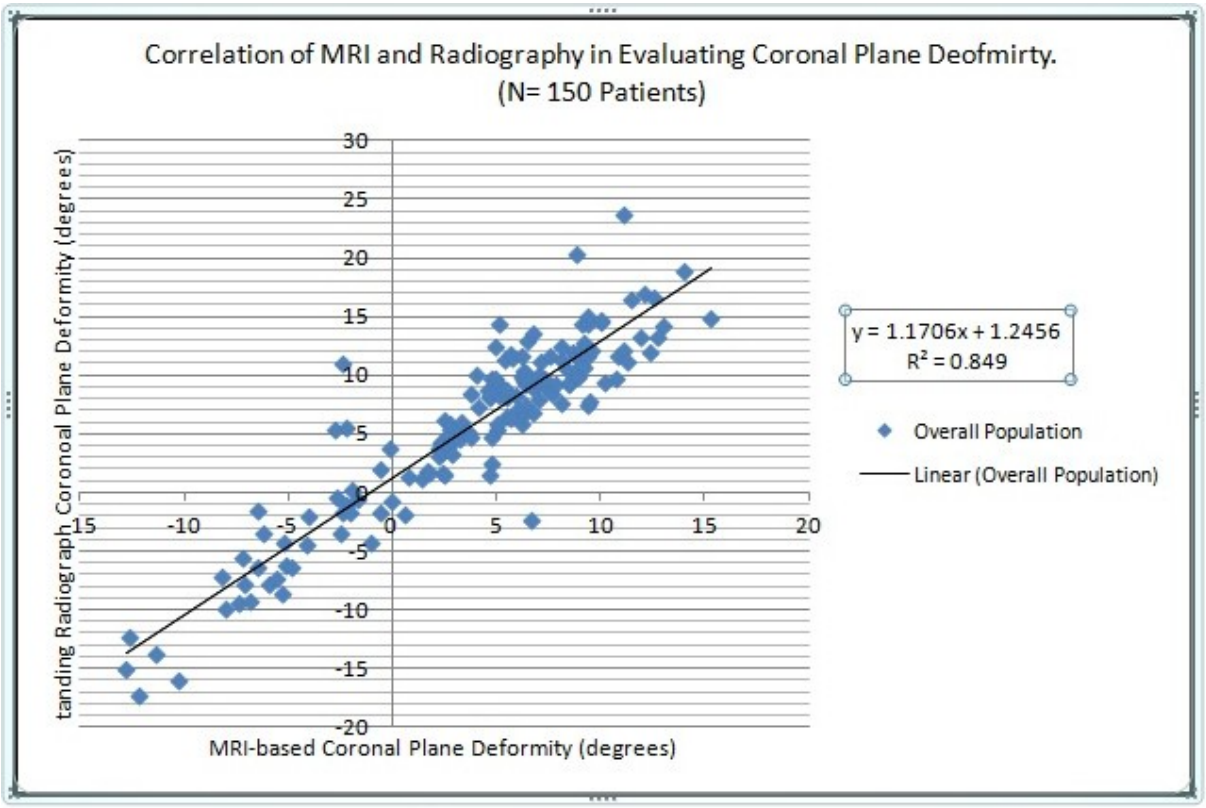

Figure 1: Linear Regression Analysis of MRI-based imaging vs. Conventional Radiographs in the assessment of Preoperative Coronal Plane Deformity. In the image, valgus deformity is denoted by negative (<0) degree and varus deformity is denoted as positive (>0) degrees. The R-squared values of 0.85 shows very high correlation (P<0.0001) between MRI and conventional radiography.