INTRODUCTION: The goals of total knee arthroplasty (TKA) are to restore knee function and stability, and to relieve pain in patients suffering from osteoarthritis of the joint. A combination of bony resection and alignment techniques, and soft tissue releases are performed during surgery to realign the joint and balance the load on the medial and lateral plateaus\(^1\). The goal of soft tissue balance is to achieve medial/lateral load balance in flexion and extension. Although mechanical spacers are currently used to assess balance, there is no quantitative intra-operative method to achieve this goal\(^2\). Our purpose is to employ a previously validated tibial load cell (TLC)\(^3\) to assess current methods of soft tissue balance during total knee arthroplasty and to determine whether use of the TLC can further improve balance.

METHODS: Ten paired fresh-frozen cadaveric knee specimens were amputated 20cm proximal to the distal femoral condyle and 25cm distal to the tibial articular surface. Each femur was rigidly clamped to a frame that fixed the knee at five discrete flexion angles (0°, 30°, 60°, 90°, 100°) while allowing it to remain unconstrained in internal/external rotation and varus/vaugar angulation. Total knee replacement (Nexgen, Zimmer, Warsaw, IN) arthroplasty was performed on each knee. Traditional bone cutting and alignment techniques were performed to prepare the bones for the implant. An instrumented tibial load cell (TLC)\(^4\) that measured in real time the magnitude of compressive loading in the medial and lateral compartments was then inserted into the joint. The paired knees were randomly assigned into one of two groups: soft tissue balance without the aid of the load cell (noTLC) and with the aid of the load cell (TLC). Prior to and following soft tissue balance, compressive forces on each plateau were recorded in the unloaded situation. Measurements performed at the five discrete flexion angles.

RESULTS: Prior to balancing, significant differences were observed between the compressive forces on the medial and lateral plateaus (p<0.05)(Figure 1). Forces were consistently higher on the medial plateau with a maximum compressive force of 91.6±31.1N. Loads at full extension (0° flexion) were significantly higher than loads at all other angles studied on both plateaus indicating a flexion-extension gap imbalance.

Soft tissue balance performed without the aid of the TLC showed no significant differences between the load in the medial and lateral compartment (p=0.16)(Figure 2). This suggests that balance has improved when compared to the pre-balance results at all angles studied. The magnitude of load on both plateaus decreased slightly at all angles of flexion suggesting less soft tissue tension.

Soft tissue balance performed with the aid of the load cell also showed no significant differences following balance (p=0.60) indicating an improved soft tissue balance in the joint (Figure 3). There is a trend for improved medial vs. lateral balance as compared to those knees balanced without the assistance of the load cell. In both the noTLC and TLC situations, however, the flexion-extension imbalance that existed prior to balance remained following soft tissue balance.

**DISCUSSION:** Failure to achieve perfect ligamentous balance results in unequal load distribution on the plateaus of the knee and may result in premature wear, osteolysis, and loosening of the components. Large variations in data post-balance could be attributed to limitations associated with current bone cutting alignment guides and techniques used to align the joint prior to balance. For instance, despite resecting additional distal femoral bone, compressive forces remained significantly higher in extension than in flexion. The effects of these limitations could be amplified in the compressive forces recorded following soft tissue balance particularly in the knees balanced without the aid of the TLC. Current balancing techniques are not perfect, but appear to be improved with the use of the load cell.


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