SIX DOF KNEE GAIT KINEMATICS OF KINEMATIC ALIGNED TKA

Ann-Kathrin Einfeldt (1), Lars Tücking (2), Peter Savov (2), Max Ettinger (2), Henning Windhagen (2), Eike Jakubowitz (1)

1. Laboratory for Biomechanics and Biomaterials, Hannover Medical School, Germany; 2. Department of Orthopaedic Surgery, Diakovere Annastift, Hannover Medical School, Germany)

Introduction

The goal of kinematic alignment (KA) of total knee arthroplasty (TKA) is to precisely restore the individual knee anatomy, including ligament tension, by maintaining the patient-specific joint line [1]. Compared to conventional mechanical alignment (MA), this hypothesis has already been indirectly confirmed using functional knee scores since a faster recovery and improved outcomes were observed [2,3]. However, whether this improvement is directly associated with joint kinematics remains unanswered to date. Thus, conventional gait analysis considering only the rotatory components of joint kinematics (3-DOF) also comes to controversial results [4,5]. Therefore, the aim of the present randomized, observer-blinded, and prospective study was to analyze full knee joint kinematics (6-DOF) after KA TKA. Both a non-arthritic as well as a MA cohort served as references.

Methods

74 patients (34 KA, 40 MA) treated with the GMK Sphere TKA (Medacta), and 9 healthy controls were included. All patients had to complete a 3D gait analyses on a treadmill the day before surgery and one year later at maximum possible speed. Kinematic data was acquired with a motion capture system with 12 infrared cameras (200 Hz). For detailed 6-DOF knee kinematics a Helen Hayes marker set was modified by using additional markers resulting in an over-determination of leg segments, and a quasi-static (frame to frame calculation) optimization algorithm was used to calculate joint movements using an inverse kinematics approach. The Forgotten Joint Score (FJS) and the Knee Society Score (KSS) were collected. For statistics t-tests and Statistical Parametric Mapping were used.

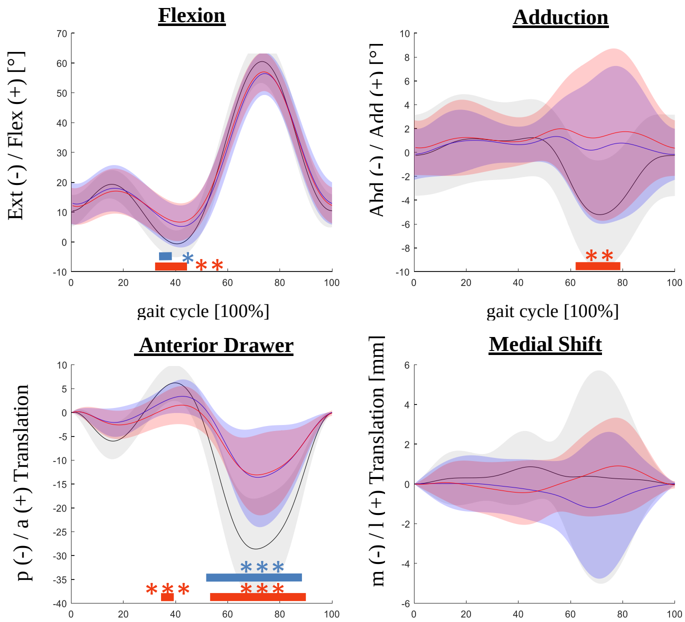

*Figure 1: Sagittal and frontal plane movements for KA (blue), MA (red) and Controls (black). Bars and * indicate significant difference towards Controls for KAs (blue) and MAs (red) this time in the gait cycle (* p = 0.02, **p = 0.01, *** p < 0.01).*

Results

Post-OP, both groups show a significantly reduced knee extension in terminal stance (MA: p = 0.01, KA: p = 0.02) and significantly reduced posterior translations during swing phase (p < 0.01) (Fig. 1). The MA also shows a significantly reduced anterior translation during terminal stance (p < 0.01). In frontal plane rotations KA shows a tendency of a greater adduction during swing, in MA this difference is significant (p = 0.01, Fig. 1). In frontal plane translations, there are no differences between KA, MA, and Controls (Fig. 1). In transversal joint rotations and translations, there are no differences neither between TKA groups nor between TKA groups and controls in both conditions. Post-OP, the KA shows a significantly increased FSJ score (KA = 63.7 vs. MA = 49.6, p = 0.01) whereas due to the KSS the groups do not differ (KA = 80.5 vs. MA = 74.5, p = 0.13).

Discussion

This study is the first to show 6 DOF knee kinematics one year after KA TKA. A significantly reduced anterior translation in terminal stance for MA appears to be associated with significantly reduced knee extension during this interval. For KA, this anterior translation is restored again, resulting into not as great reduced knee extension compared to controls. Contrary to expectations, MA shows a greater adduction post-OP in the swing phase, indicating that the static leg axis does not reflect the joint angles in motion. Considering all results, KA shows fewer significant differences compared to controls than MA, suggesting a more physiological gait pattern one year after TKA. This might be the reason why patients with KA are more likely to forget about their knee in everyday life.

References

1. Nogler et al., Int Orthop, 36:2249–2253, 2012.
2. Woon et al., Arch Orthop Trauma Surg,. 138:1293–1303, 2018.
3. Yoon et al.,. Medicine, 96: e8157, 2017.
4. Blakeny et al. (2019). Knee Surg. Sports Traumatol. Arthrosc, 27:1410–1417, 2019.
5. McNair et al., J. Arthroplasty, 33:560–564, 2017.