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PERSONALIZED POST-OPERATIVE REHABILITATION ASSESSMENT FROM KNEE ARTHROPLASTY WITH INSTRUMENTED IMPLANT

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1 INTRODUCTION

Global burden of diseases impacts human longevity and quality of live with the need of early diagnosis and intervention for restoring autonomy. Disability-adjusted life-years (DALYs) due to falls and osteoarthritis have increased from 1990 to 2019 on 50-74 and 75 years and older age [1]. Due to osteoarthritis, other diseases and injuries, subjects are confronted with the need of joint replacements, namely at the lower limb for the hip [2] and the knee [3], with the need for post-operative recovery process assessment of total arthroplasty [4]. Due to the lack of data on internal joint loads to assess proper fixation and operation of the implants, musculoskeletal models and simulation were implemented and executed to estimate internal joint loads from external kinematics and dynamics, with differences between estimated and measured loads under various gait conditions [2-3], pointing to the need of instrumented implants for direct measurements and transmission of internal joint loads for personalized post-operative rehabilitation.

2 MATERIAL AND METHODS

Personalized rehabilitation assessment was performed based on case study of a post-operative male subject from total left knee arthroplasty due to osteoarthritis indication, with 63 years old at implantation, 1.77 m height, 100 kg weight, 3.0º varus of tibia-femoral angle and 5º slope. The study was approved by the Charite´ Ethics committee (EA4/069/06), registered at the 'German Clinical Trials Register' (DRKS00000606) and the patient gave prior written informed consent. Knee joint instrumented implant corresponds to a modified INNEXTM System, Type FIXUC (Zimmer GmbH, Winterthur, Switzerland). The standard femur component and tibial insert were used with the tibial component modified enabling the integration of the electronic devices. The knee implant with a 9-chanel telemetry transmitter enables the six-component load measurements at primary total knee replacement, corresponding to the axial, medio-lateral and anterior-posterior forces and flexion-extension, varus-valgus and internal-external moments. The coordinate system is right-handed fixed at the height of the lowest part of the polyethylene insert right tibial implant, with z-axis aligned with the stem axis of the implant and the measured forces and moments at the

left knee were transformed to the right side. Vertical knee joint force components (*Fz*) were selected for analysis according to its higher contribution for resultant join force, with the variability of the knee joint vertical load assessed through modified statistical metric of the *Fz* standard deviation σ normalized to the subject body weight (BW) at gait trial PO assessment date.

3 RESULTS AND DISCUSSION

Personalized post-operative (PO) rehabilitation assessment was performed for K1l subject at different gait trials (T1-T22) as presented on Figure 1, starting the recovery process on T1-T2 at 0.5 months (M) after PO on level walking 4-point support up to T3 at 1 M, passing at 2.3 M on T4 to walking on treadmill at 3 km/h and at 4 M to level walking on T5, changing to level walking barefoot on T6-T7 at 10 M and initiating walking on treadmill at 4 km/h on T8-T12 for 18 M PO. K1l rehabilitation assessment continued at 24 M PO on T13-T14 walking on gym floor and ended at 44 M PO walking on treadmill at 4 km/h, with 5 mm lateral wedged insoles (LWI) T15, 5 mm LWI and ankle orthosis (AO) T16, lateral wedged shoe soles (LWSS) 0 mm T17, LWSS 0 mm with AO T18, LWSS 10 mm T19, LWSS 10 mm with AO T20, LWSS 5 mm T21 and LWSS 5 mm with AO T22.

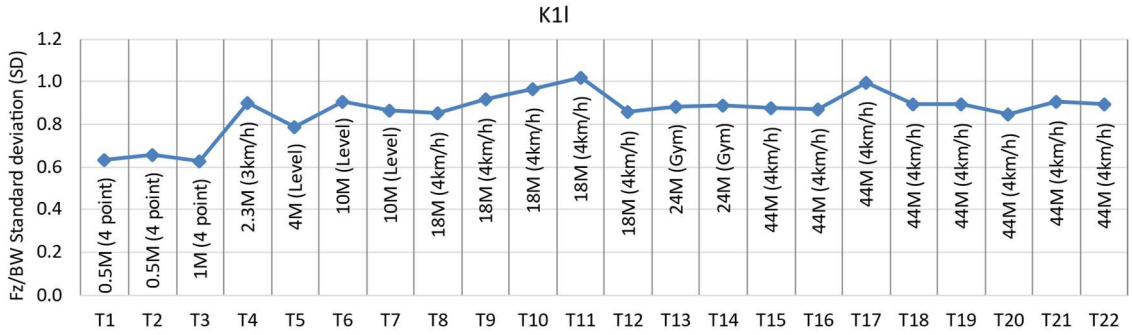

Figure 1 – Standard deviation of the knee vertical force (*Fz*) normalized to K1l body weight (BW) at different trials.

Selected metric from standard deviation of the knee vertical force (*Fz*) normalized to subject body weight contributed to detection of the subject specific thresholds for personalized rehabilitation PO process from total left knee arthroplasty, accounting for underlying joint load distribution while searching for the most adequate shoe configuration to optimize this metric. The use of AO as well as higher sole thickness pointed to lower *Fz*/*BW* variability, given the higher level of support. LWI also tend to have lower *Fz*/*BW* variability than LWSS.

4 CONCLUSION

This study points to the importance of instrumented implant to obtain realistic measurements from *in-vivo* internal joint loads to assess personalized total knee arthroplasty PO process rehabilitation, and the advantage that the selected specific metric can provide in assessing PO evolution on gait mode, shoe and support prescription to ensure faster and successful rehabilitation.

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