# Supplementary Information

Figures

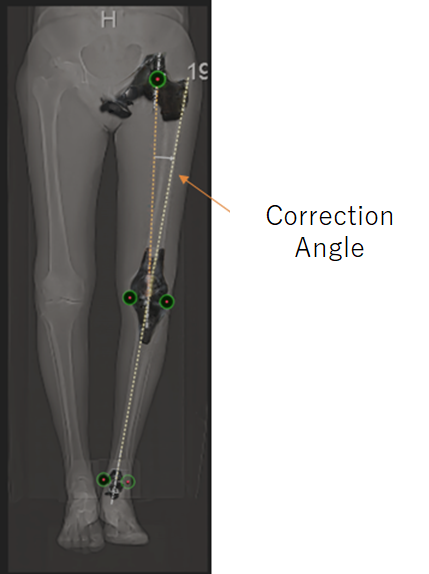


Figure S1: Correction angle assessment using five alignment landmarks from CT data

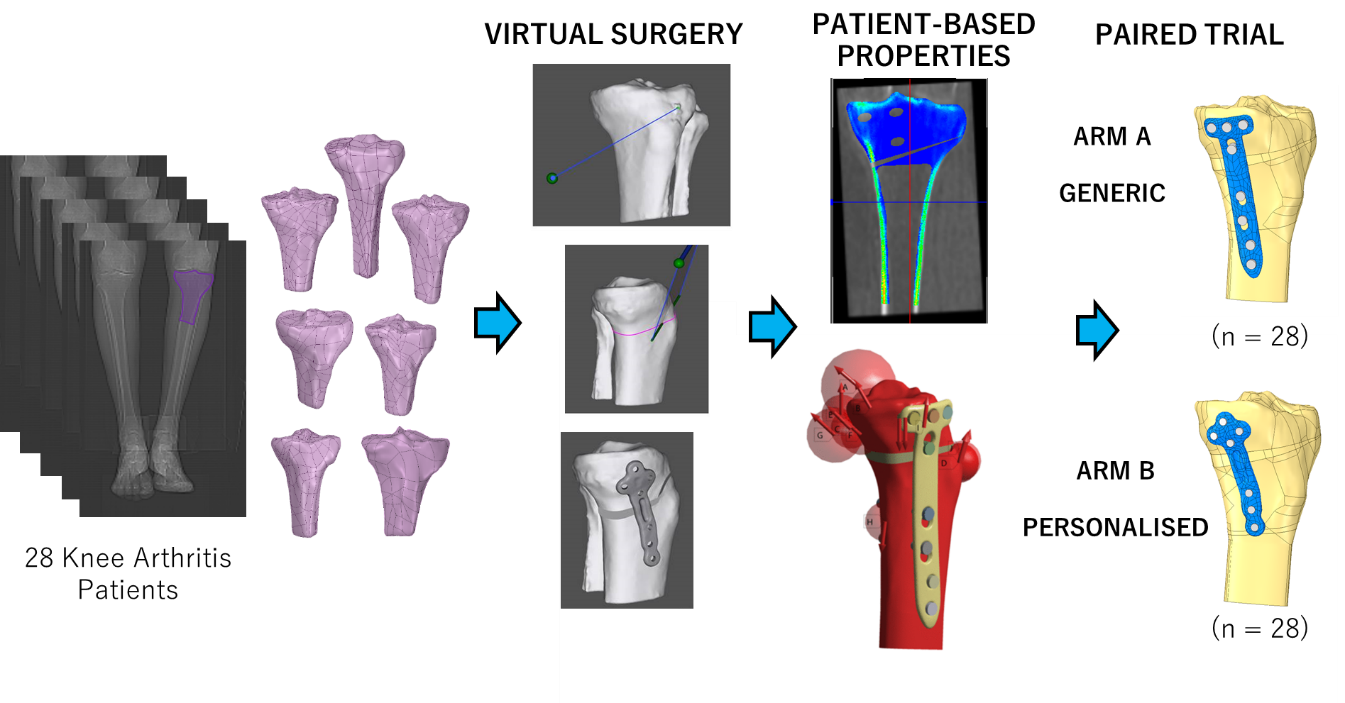


Figure S2: Workflow to generate each of the patient models in the trial

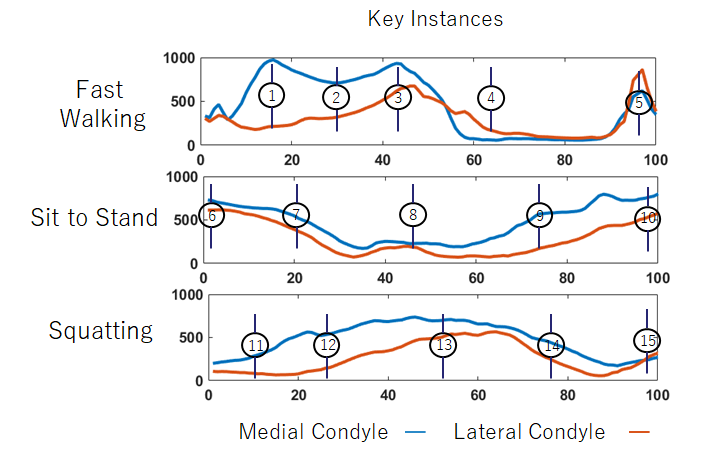


Figure S3: Key instances during the different activities examined in the study. The joint reaction forces (N) acting on the medial and lateral condyles are plotted (y-axis) as a function of the activity cycle time expressed as a percentage (x-axis) for an example patient. For each activity, the five key instances were implemented as load steps applied to each finite element model, the load steps numbers are given in the circles on each activity.

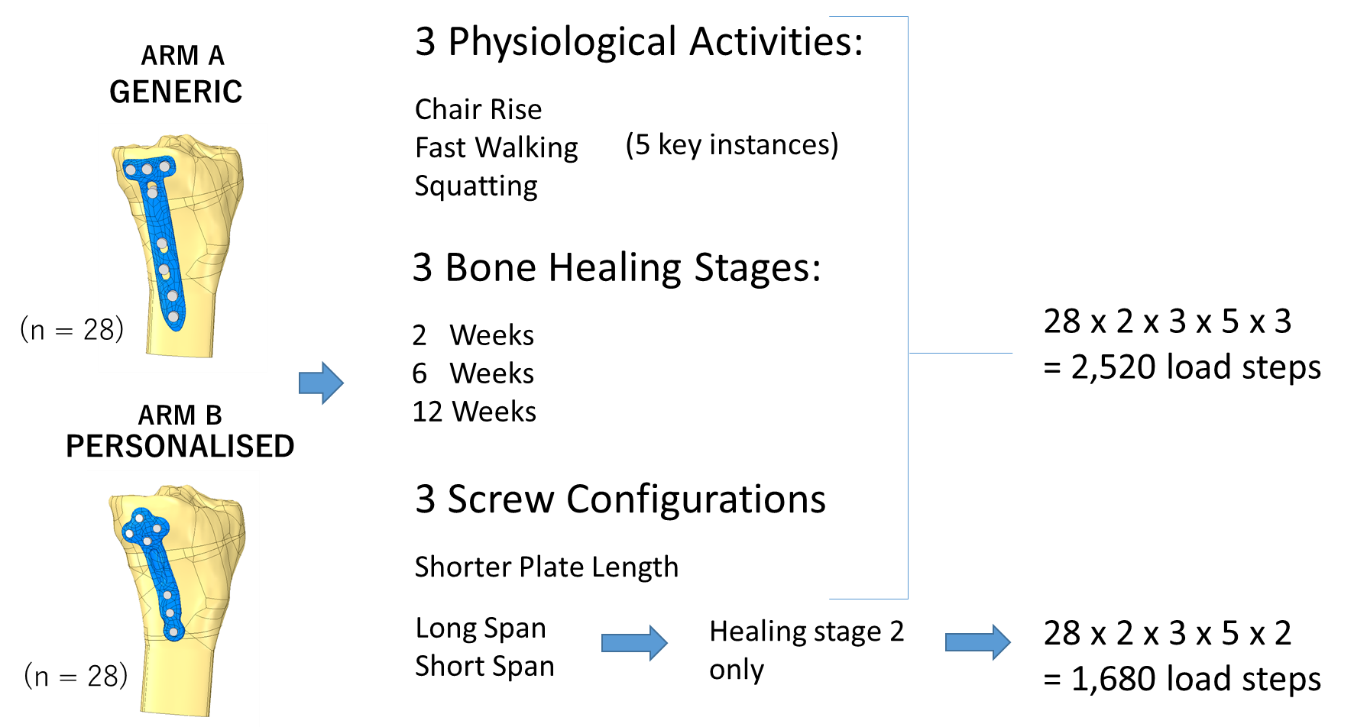


Figure S4: Conditions simulated were three activities, with three different screw configurations, and then three healing stages for screw configuration 3.

Tables

Table S1: Demographics of patients in the study, note the correction angle is the virtual correction angle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Patient number | Height (cm) | Weight (kg) | M/F | Age (years) | Correction Angle (degrees) |
| 1 | 174 | 77.4 | M | 72 | 9.38 |
| 2 | 159 | 78 | F | 77 | 7.50 |
| 3 | 149 | 70.1 | F | 84 | 2.91 |
| 4 | 161 | 70 | F | 57 | 2.03 |
| 5 | 158 | 75.9 | F | 69 | 1.90 |
| 6 | 174 | 102.2 | F | 67 | 2.17 |
| 7 | 161 | 82.2 | F | 87 | 3.66 |
| 8 | 182 | 103.9 | M | 69 | 9.43 |
| 9 | 178 | 95.1 | M | 77 | 6.33 |
| 10 | 191 | 121.4 | M | 59 | 6.38 |
| 11 | 189 | 108 | M | 59 | 5.42 |
| 12 | 173 | 72.8 | M | 70 | 7.96 |
| 13 | 179 | 105.9 | M | 66 | 9.26 |
| 14 | 169 | 70.8 | M | 83 | 13.09 |
| 15 | 173 | 109.5 | M | 55 | 4.70 |
| 16 | 163 | 81.6 | F | 71 | 7.10 |
| 17 | 154 | 81.1 | F | 66 | 2.47 |
| 18 | 184 | 116 | M | 64 | 9.01 |
| 19 | 175 | 102.4 | F | 65 | 8.68 |
| 20 | 160 | 103.5 | F | 66 | 3.86 |
| 21 | 159 | 70.6 | F | 62 | 1.97 |
| 22 | 156 | 82.5 | F | 69 | 4.60 |
| 23 | 164 | 96.8 | F | 63 | 5.41 |
| 24 | 151 | 86.8 | F | 53 | 2.60 |
| 25 | 147 | 68.8 | F | 69 | 9.74 |
| 26 | 184 | 104.3 | M | 70 | 5.26 |
| 27 | 181 | 110.3 | M | 50 | 14.39 |
| 28 | 174 | 76.1 | M | 76 | 0.57 |
| AVERAGE | 169 | 90.1 | 13 / 28 | 68 | 5.99 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Hemert Grade (van Hemert et al., 2004)** | 0 | | 1 | | 2 | | 3 | | 4 | | 5 | |
| **Description** | Inflamation & Haematoma | | Soft Callus | | Soft and Hard Callus | | Hard Callus Remodelling (healed osteotomy) | | Consolidated Callus Remodelling (osteotomy recognisable) | | Remodelling (no sign of osteotomy) | |
| **Assumed Material Characteristic** | Granulation Tissue | | Fibrous Tissue | | Cartilage | | Immature Bone | | Mature Bone | | Cortical Bone | |
| **Material Stiffness Values (MPa)** | lower | upper | lower | upper | lower | upper | lower | upper | lower | upper | lower | upper |
| **Isaksson et al., 2006** | 1 | | 2 | | 10 | | 1000 | | 6,000 | | 15,750 | |
| **Steiner et al., 2013** | 0.99 | N/A | N/A | 3 | 3.1 | 200 | 201 | N/A | N/A | 8,300 | 10,000 | 20,400 |
| **Poisson's Ratio, ν** | 0.167 | N/A | N/A | 0.4 | 0.167 | 0.47 | 0.23 | N/A | N/A | 0.32 | 0.325 | 0.39 |
| **Approximate Post Operative Time (van Hemert et al., 2004, Seo et al, 2005)** | - | | 2 weeks | | 6 weeks | | 12 weeks | | - | | - | |
| **Hemert Grade Found at Time Point (Seo 2005)** | - | | N/A | | 1.83 ± 0.41 | | 2.67 ± 0.52 | | - | | - | |
| **In Silico Trial Healing Stage** | N/A | | 2 | | 3 | | 4 | | - | | - | |
| **Young's Modulus, E, value adopted (MPa)** | - | | 1.4 | | 24 | | 528 | | N/A | | Bone Mat | |
| **Poisson's Ratio, ν, value adopted** | - | | 0.33 | | 0.33 | | 0.3 | | N/A | | 0.26 | |

Table S2: - Material Properties used for the Osteotomy Gap Healing, E=Young’s Modulus, ν=Poisson’s ratio

Table S3 – Joint reaction forces for the different activities included in the study

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Medial Condyle Force (%BW) | | | Lateral Condyle Force (%BW) | | |  |
| Load Step | **Instance of Activity Cycle (%)** | **x** | **y** | **z** | **x** | **y** | **z** | **Total Joint Force (% BW)** |
| 1 | 15 | 18.7 | 16.6 | -150.5 | 4.8 | 2.7 | -33.2 | 186.2 |
| 2 | 28 | 13.9 | 10.2 | -110.2 | 6.3 | 3.8 | -48.4 | 160.5 |
| 3 | 44 | 11.5 | 5.9 | -137.1 | 18.9 | 12.2 | -100.8 | 241.0 |
| 4 | 63 | 0.9 | -1.0 | -9.6 | 3.7 | -0.4 | -26.2 | 36.1 |
| 5 | 96 | -8.9 | -17.6 | -101.1 | 38.8 | 7.1 | -130.9 | 239.8 |
| 6 | 0 | 15.2 | -45.2 | -117.3 | 13.4 | -42.5 | -99.0 | 235.1 |
| 7 | 21 | 9.4 | -13.7 | -78.5 | 7.8 | -3.1 | -54.1 | 135.0 |
| 8 | 47 | 4.0 | 2.2 | -36.0 | 3.7 | 2.6 | -24.4 | 61.1 |
| 9 | 76 | 11.3 | -7.2 | -91.4 | 4.7 | -0.7 | -32.2 | 124.9 |
| 10 | 100 | 16.8 | -49.9 | -129.7 | 12.9 | -40.9 | -94.9 | 244.1 |
| 11 | 10 | 5.5 | 3.1 | -46.5 | 2.0 | 1.4 | -12.3 | 59.4 |
| 12 | 26 | 10.5 | -2.4 | -84.8 | 3.5 | 0.1 | -23.7 | 109.5 |
| 13 | 54 | 14.5 | -45.8 | -112.7 | 11.9 | -37.9 | -86.3 | 217.5 |
| 14 | 77 | 7.7 | -1.5 | -63.4 | 4.5 | 0.3 | -31.5 | 95.6 |
| 15 | 98 | 4.3 | 2.2 | -40.3 | 6.8 | 4.6 | -46.3 | 87.6 |

# Main Result Tables:

Table 1: Contingency tables for number of load steps in which maximum Von Mises stress exceeded the fatigue limit (FLIM) comparing the two arms of the study, Generic and Personalised for each of the three healing stages (HS) for screw configuration 3. OR=Odds Ratio.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Generic\*** | | | **Personalised\*** | | | **Personalised vs Generic\*** | |
|  | **N2: Stress< FLM** | **N1: Stress> FLM** | **Total** | **N2: Stress< FLM** | **N1: Stress> FLM** | **Total** | **OR (95% CIs)** | **p-values** |
| **HS2** | 96 (24.6%) | 295 (75.4%) | 391 | 73 (17.8%) | 337 (82.2%) | 410 | 1.80 (0.90, 3.61) | 0.10 |
| **HS3** | 364 (88.8%) | 46 (11.2%) | 410 | 341 (87.0%) | 51 (13.0%) | 392 | 1.25 (0.76, 2.06) | 0.37 |
| **HS4** | 413 (99.3%) | 3 (0.7%) | 416 | 419 (100%) | 0 (0%) | 419 | 0.14 (0.01, 2.73)\*\*\* | 0.20\*\*\* |

\* data are presented for all observations, which are clustered within participants.

\*\* Estimates are based on a multi-level logistic model using repeated measures over time and allowing for additional clustering within participants using robust standard errors.

\*\*\* Estimate obtained from a penalised maximum likelihood logistic regression

Table 2: Maximum von Mises stress (Stress) in the plates, maximum Von Mises strain (Strain) in the bone adjacent to the plates screws and maximum inter-fragmentary movement (IFM) for the two arms, and the differences between the arms for each of the three healing stages (HS), all cases are for screw configuration 3.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Generic\*** | | | | **Personalised\*** | **Adjusted Difference (95% CIs)\*\* Generic - Personalised** |  |
|  | **n** | **Mean (SE)** | **n** | **Mean (SE)** | | **p-values** |
| **Stress (MPa)** |  |  |  |  | |  |  |
| HS2 | 391 | 331.8 (13.55) | 410 | 345.1 (9.54) | | -12.5 (-70.0, 45.0) | 0.67 |
| HS3 | 410 | 90.6 (3.56) | 392 | 108.3 (3.81) | | -17.1 (-26.2, -7.9) | <0.001 |
| HS4 | 416 | 37.0 (1.64) | 419 | 48.3 (1.60) | | -11.1 (-15.3, -6.8) | <0.001 |
| **Strain (unitless)** |  |  |  |  | |  |  |
| HS2 | 391 | 0.015 (0.00071) | 365 | 0.017 (0.00067) | | -0.0011 (-0.0030, 0.0008) | 0.27 |
| HS3 | 410 | 0.011 (0.00065) | 392 | 0.011 (0.00056) | | -0.0002 (-0.0024, 0.0021) | 0.88 |
| HS4 | 416 | 0.0096 (0.00067) | 419 | 0.0090 (0.00055) | | 0.0005 (-0.0020, 0.0031) | 0.67 |
| **IFM (mm)** | |  |  |  | |  |  |
| HS2 | 391 | 0.31 (0.012) | 410 | 0.33 (0.015) | | -0.014 (-0.045, 0.017) | 0.37 |
| HS3 | 410 | 0.12 (0.005) | 392 | 0.12 (0.004) | | -0.005 (-0.010, 0.001) | 0.10 |
| HS4 | 416 | 0.04 (0.002) | 419 | 0.06 (0.003) | | -0.036 (-0.054, -0.018) | <0.001 |

\* data are presented for all observations, which are clustered within participants.

\*\* Estimates are based on a multi-level logistic model using repeated measures over time and allowing for additional clustering within participants using robust standard errors.