**Additional material**

This document contains the additional material associated with the paper “Variations of lower-limb joint kinematics associated to the use of different ankle joint models” by Montefiori E., Hayford C. F., Mazzà C.

Table A1 – Individual maximum absolute differences between kinematic curves obtained with M1 and M2, M2 and M3, and M3 and M1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Pelvis tilt | Pelvis list | Pelvis rot | Hip Flex | Hip Add | Hip rot | Knee flex | Ankle PF | Foot PA |
| Max |ΔM12| | **S1** | 0.2 | 1.2 | 0.2 | 2.0 | 3.8 | 8.4 | 3.0 | 6.8 | 11.2 |
| **S2** | 0.1 | 1.0 | 0.2 | 2.5 | 4.9 | 11.1 | 4.3 | 13.5 | 15.8 |
| **S3** | 0.1 | 1.1 | 0.1 | 1.2 | 3.5 | 6.1 | 2.5 | 10.5 | 9.2 |
| **S4** | 0.0 | 0.4 | 0.0 | 0.5 | 1.1 | 4.6 | 1.2 | 3.0 | 2.4 |
| **S5** | 0.2 | 1.7 | 0.1 | 1.6 | 4.5 | 6.1 | 2.6 | 6.2 | 11.1 |
| **S6** | 0.1 | 0.7 | 0.1 | 0.8 | 2.3 | 4.5 | 2.0 | 7.1 | 6.9 |
| **S7** | 0.1 | 0.9 | 0.1 | 0.6 | 2.8 | 3.9 | 1.2 | 6.3 | 7.4 |
| **S8** | 0.5 | 2.6 | 0.2 | 4.0 | 7.2 | 12.6 | 5.6 | 7.0 | 14.7 |
| **S9** | 0.5 | 3.6 | 0.3 | 3.8 | 7.9 | 13.8 | 6.1 | 7.2 | 9.6 |
| **S10** | 0.1 | 0.5 | 0.0 | 0.4 | 1.2 | 3.9 | 0.8 | 2.0 | 6.4 |
| **S11** | 0.0 | 0.3 | 0.0 | 0.8 | 1.4 | 3.4 | 2.2 | 6.4 | 3.8 |
| **S12** | 0.4 | 2.2 | 0.3 | 2.8 | 6.0 | 10.4 | 4.8 | 17.5 | 17.2 |
| **S13** | 0.1 | 1.4 | 0.1 | 1.9 | 4.2 | 9.5 | 3.7 | 9.7 | 7.1 |
| **S14** | 0.0 | 0.8 | 0.1 | 1.0 | 2.5 | 6.9 | 2.1 | 5.3 | 6.3 |
| **S15** | 0.1 | 0.9 | 0.1 | 1.7 | 2.9 | 5.3 | 4.4 | 14.1 | 9.0 |
| **Max** | **0.5** | **3.6** | **0.3** | **4.0** | **7.9** | **13.8** | **6.1** | **17.5** | **17.2** |
| Max |ΔM23| | **S1** | 0.0 | 0.1 | 0.0 | 0.4 | 0.5 | 2.7 | 0.4 | 19.3 | 1.3 |
| **S2** | 0.1 | 0.3 | 0.0 | 0.6 | 0.6 | 3.9 | 0.6 | 17.3 | 4.3 |
| **S3** | 0.0 | 0.1 | 0.0 | 0.1 | 0.3 | 1.4 | 0.2 | 12.3 | 1.1 |
| **S4** | 0.0 | 0.2 | 0.0 | 0.4 | 0.7 | 3.9 | 0.4 | 10.7 | 1.8 |
| **S5** | 0.0 | 0.1 | 0.0 | 0.2 | 0.6 | 2.0 | 0.2 | 5.1 | 2.9 |
| **S6** | 0.2 | 0.3 | 0.1 | 0.6 | 0.9 | 6.4 | 1.0 | 6.7 | 1.8 |
| **S7** | 0.1 | 0.2 | 0.1 | 0.3 | 0.2 | 4.3 | 0.4 | 7.6 | 0.7 |
| **S8** | 0.1 | 0.3 | 0.1 | 0.8 | 0.7 | 5.0 | 0.9 | 9.2 | 3.1 |
| **S9** | 0.1 | 0.5 | 0.0 | 0.4 | 1.2 | 2.9 | 0.6 | 12.1 | 2.5 |
| **S10** | 0.0 | 0.1 | 0.0 | 0.1 | 0.2 | 1.3 | 0.1 | 6.9 | 0.9 |
| **S11** | 0.1 | 0.2 | 0.1 | 0.5 | 0.6 | 3.3 | 1.0 | 12.1 | 4.4 |
| **S12** | 0.1 | 0.3 | 0.0 | 0.2 | 1.0 | 2.8 | 0.5 | 19.8 | 5.6 |
| **S13** | 0.1 | 0.2 | 0.0 | 0.4 | 0.5 | 3.7 | 0.5 | 10.2 | 1.7 |
| **S14** | 0.0 | 0.1 | 0.1 | 0.4 | 0.4 | 5.4 | 0.7 | 7.7 | 1.5 |
| **S15** | 0.0 | 0.1 | 0.0 | 0.4 | 0.3 | 2.9 | 0.9 | 19.2 | 1.5 |
| **Max** | **0.2** | **0.5** | **0.1** | **0.8** | **1.2** | **6.4** | **1.0** | **19.3** | **5.6** |
| Max|ΔM13| | **S1** | 0.2 | 1.2 | 0.2 | 1.9 | 4.0 | 8.6 | 2.9 | 12.6 | 12.2 |
| **S2** | 0.1 | 1.1 | 0.2 | 2.5 | 5.2 | 11.9 | 3.9 | 3.9 | 18.8 |
| **S3** | 0.1 | 1.1 | 0.1 | 1.2 | 3.5 | 5.4 | 2.4 | 2.0 | 10.0 |
| **S4** | 0.1 | 0.4 | 0.1 | 0.6 | 1.6 | 5.1 | 1.3 | 9.1 | 3.5 |
| **S5** | 0.2 | 1.8 | 0.1 | 1.6 | 5.0 | 5.6 | 2.6 | 4.3 | 13.9 |
| **S6** | 0.2 | 0.7 | 0.1 | 0.8 | 2.3 | 7.2 | 1.7 | 5.2 | 7.2 |
| **S7** | 0.1 | 0.9 | 0.1 | 0.6 | 2.9 | 4.3 | 1.1 | 6.1 | 7.7 |
| **S8** | 0.6 | 2.8 | 0.2 | 3.8 | 7.5 | 11.6 | 5.3 | 4.1 | 16.7 |
| **S9** | 0.5 | 4.0 | 0.4 | 4.2 | 9.1 | 15.0 | 6.5 | 5.0 | 11.9 |
| **S10** | 0.1 | 0.5 | 0.1 | 0.3 | 1.3 | 2.9 | 0.7 | 6.4 | 7.1 |
| **S11** | 0.1 | 0.4 | 0.1 | 0.9 | 1.6 | 5.2 | 2.3 | 8.3 | 7.8 |
| **S12** | 0.4 | 2.4 | 0.3 | 2.9 | 6.6 | 8.3 | 4.6 | 2.4 | 21.2 |
| **S13** | 0.2 | 1.6 | 0.1 | 1.9 | 4.6 | 9.3 | 3.6 | 0.8 | 8.4 |
| **S14** | 0.1 | 0.8 | 0.1 | 0.9 | 2.3 | 5.2 | 1.9 | 6.8 | 5.9 |
| **S15** | 0.1 | 1.0 | 0.1 | 1.6 | 3.2 | 5.0 | 4.1 | 7.5 | 10.5 |
| **Max** | **0.6** | **4.0** | **0.4** | **4.2** | **9.1** | **15.0** | **6.5** | **12.6** | **21.2** |

Table A2 - Pearson’s correlation coefficient *r* obtained by correlating the listed DOFs in M1, M2 and M3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Correlated DOFs | | Pearson's correlation coefficient *r* | | | | | |
| **M1** | | **M2** | | **M3** | |
| **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** |
| Pelvis obliquity | **Pelvis tilt** | -0.06 | 0.35 | -0.06 | 0.34 | -0.06 | 0.34 |
| Pelvis rotation | **Pelvis tilt** | 0.06 | 0.47 | 0.06 | 0.47 | 0.05 | 0.47 |
| **Pelvis obliquity** | -0.19 | 0.37 | -0.26 | 0.37 | -0.27 | 0.38 |
| Hip flexion | **Pelvis tilt** | -0.04 | 0.56 | -0.04 | 0.56 | -0.04 | 0.56 |
| **Pelvis obliquity** | 0.04 | 0.34 | 0.04 | 0.32 | 0.06 | 0.32 |
| **Pelvis rotation** | -0.60 | 0.32 | -0.60 | 0.32 | -0.60 | 0.31 |
| Hip adduction | **Pelvis tilt** | 0.02 | 0.42 | 0.02 | 0.40 | 0.02 | 0.40 |
| **Pelvis obliquity** | 0.75 | 0.26 | 0.82 | 0.19 | 0.82 | 0.20 |
| **Pelvis rotation** | 0.02 | 0.37 | -0.08 | 0.34 | -0.09 | 0.33 |
| **Hip flexion** | -0.37 | 0.23 | -0.30 | 0.22 | -0.28 | 0.21 |
| Hip rotation | **Pelvis tilt** | 0.02 | 0.48 | -0.01 | 0.42 | -0.05 | 0.38 |
| **Pelvis obliquity** | 0.18 | 0.39 | 0.30 | 0.36 | 0.28 | 0.39 |
| **Pelvis rotation** | 0.47 | 0.40 | 0.42 | 0.35 | 0.39 | 0.34 |
| **Hip flexion** | -0.70 | 0.25 | -0.60 | 0.29 | -0.51 | 0.36 |
| **Hip adduction** | 0.49 | 0.23 | 0.59 | 0.26 | 0.51 | 0.29 |
| Knee flexion | **Pelvis tilt** | -0.04 | 0.34 | -0.05 | 0.34 | -0.05 | 0.33 |
| **Pelvis obliquity** | -0.40 | 0.33 | -0.54 | 0.18 | -0.54 | 0.19 |
| **Pelvis rotation** | 0.40 | 0.18 | 0.40 | 0.18 | 0.40 | 0.18 |
| **Hip flexion** | 0.15 | 0.15 | 0.15 | 0.15 | 0.14 | 0.15 |
| **Hip adduction** | -0.48 | 0.16 | -0.61 | 0.09 | -0.62 | 0.10 |
| **Hip rotation** | -0.37 | 0.34 | -0.30 | 0.40 | -0.33 | 0.45 |
| Ankle dorsiflexion | **Pelvis tilt** | 0.14 | 0.31 | 0.18 | 0.36 | 0.14 | 0.33 |
| **Pelvis obliquity** | 0.36 | 0.29 | 0.33 | 0.32 | 0.48 | 0.22 |
| **Pelvis rotation** | 0.05 | 0.30 | 0.18 | 0.35 | 0.05 | 0.31 |
| **Hip flexion** | -0.30 | 0.23 | -0.40 | 0.23 | -0.31 | 0.24 |
| **Hip adduction** | 0.54 | 0.17 | 0.48 | 0.23 | 0.64 | 0.14 |
| **Hip rotation** | 0.34 | 0.29 | 0.33 | 0.30 | 0.41 | 0.33 |
| **Knee flexion** | -0.50 | 0.18 | -0.39 | 0.33 | -0.52 | 0.16 |
| Foot progression | **Pelvis tilt** | -0.01 | 0.42 | -0.07 | 0.47 | -0.08 | 0.49 |
| **Pelvis obliquity** | 0.55 | 0.32 | 0.42 | 0.27 | 0.35 | 0.29 |
| **Pelvis rotation** | -0.33 | 0.33 | -0.13 | 0.38 | -0.08 | 0.40 |
| **Hip flexion** | -0.21 | 0.26 | -0.38 | 0.31 | -0.41 | 0.33 |
| **Hip adduction** | 0.69 | 0.22 | 0.56 | 0.22 | 0.52 | 0.24 |
| **Hip rotation** | 0.46 | 0.38 | 0.41 | 0.29 | 0.34 | 0.28 |
| **Knee flexion** | -0.79 | 0.12 | -0.54 | 0.27 | -0.43 | 0.31 |
| **Ankle dorsiflexion** | 0.13 | 0.46 | 0.16 | 0.22 | 0.15 | 0.18 |

Table A3 - Individual RMSD between kinematic curves obtained with M1 and M2, M2 and M3, and M3 and M1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Pelvis | Pelvis | Pelvis | Hip | Hip | Hip | Knee | Ankle | Foot |
|  |  | **tilt** | **obliquity** | **rotation** | **flexion** | **adduction** | **rotation** | **flexion** | **dorsiflexion** | **progression** |
| RMSD M1 | **S1** | 1.6 | 1.1 | 3.4 | 5.1 | 3.2 | 9.6 | 8.2 | 6.6 | 6.8 |
| **S2** | 7.6 | 2.4 | 5.6 | 6.5 | 3.8 | 12.6 | 4.4 | 9.7 | 7.8 |
| **S3** | 3.0 | 2.5 | 3.9 | 4.1 | 4.6 | 6.4 | 2.5 | 6.0 | 2.0 |
| **S4** | 7.0 | 2.3 | 3.3 | 9.7 | 4.1 | 10.9 | 7.1 | 3.0 | 1.8 |
| **S5** | 3.0 | 2.3 | 3.5 | 5.8 | 6.2 | 17.3 | 9.6 | 4.8 | 4.2 |
| **S6** | 6.8 | 1.6 | 3.3 | 8.3 | 2.2 | 5.6 | 3.7 | 6.5 | 4.1 |
| **S7** | 1.5 | 3.6 | 4.0 | 3.6 | 2.0 | 3.4 | 5.5 | 5.7 | 6.5 |
| **S8** | 2.5 | 1.0 | 2.8 | 3.2 | 2.1 | 10.0 | 5.8 | 5.2 | 3.9 |
| **S9** | 2.3 | 1.6 | 2.9 | 8.7 | 2.0 | 5.8 | 10.6 | 10.3 | 8.8 |
| **S10** | 5.6 | 1.5 | 2.4 | 9.5 | 2.2 | 2.2 | 13.9 | 10.3 | 12.1 |
| **S11** | 2.0 | 1.2 | 2.8 | 3.3 | 5.3 | 6.5 | 4.9 | 2.4 | 5.5 |
| **S12** | 5.5 | 2.4 | 2.5 | 9.4 | 4.1 | 11.0 | 5.0 | 3.8 | 5.5 |
| **S13** | 7.8 | 4.1 | 3.0 | 13.5 | 2.7 | 7.0 | 7.6 | 4.9 | 4.5 |
| **S14** | 3.7 | 4.1 | 2.7 | 5.2 | 2.9 | 5.0 | 2.4 | 7.8 | 3.0 |
| **S15** | 1.1 | 1.2 | 3.8 | 2.1 | 1.8 | 6.8 | 5.0 | 2.8 | 6.2 |
| **Max** | **7.8** | **4.1** | **5.6** | **13.5** | **6.2** | **17.3** | **13.9** | **10.3** | **12.1** |
| RMSD M2 | **S1** | 2.5 | 1.7 | 2.2 | 7.8 | 2.2 | 5.2 | 12.2 | 8.3 | 11.0 |
| **S2** | 4.6 | 2.4 | 4.6 | 4.5 | 3.2 | 8.2 | 8.7 | 14.2 | 11.5 |
| **S3** | 1.5 | 3.5 | 3.1 | 2.9 | 4.0 | 2.8 | 5.2 | 7.8 | 5.4 |
| **S4** | 3.7 | 2.1 | 2.0 | 5.5 | 4.2 | 7.5 | 8.5 | 3.6 | 7.7 |
| **S5** | 1.1 | 3.3 | 2.8 | 5.9 | 5.1 | 13.0 | 11.6 | 10.7 | 3.9 |
| **S6** | 3.6 | 1.8 | 4.0 | 4.2 | 1.8 | 6.8 | 4.1 | 7.8 | 4.7 |
| **S7** | 2.6 | 2.7 | 2.4 | 3.8 | 2.0 | 3.1 | 8.4 | 7.3 | 2.5 |
| **S8** | 1.4 | 1.0 | 1.7 | 5.4 | 1.7 | 8.2 | 6.5 | 4.2 | 3.2 |
| **S9** | 1.7 | 0.9 | 2.0 | 3.8 | 2.8 | 7.3 | 6.4 | 6.9 | 3.7 |
| **S10** | 2.4 | 1.6 | 2.1 | 5.5 | 2.2 | 1.6 | 9.2 | 7.8 | 4.8 |
| **S11** | 2.1 | 1.4 | 3.4 | 3.6 | 5.1 | 7.0 | 3.0 | 4.3 | 12.0 |
| **S12** | 8.7 | 2.3 | 2.0 | 14.7 | 1.8 | 6.1 | 6.7 | 7.3 | 6.7 |
| **S13** | 4.7 | 2.8 | 4.2 | 10.8 | 2.9 | 10.5 | 10.9 | 4.7 | 6.3 |
| **S14** | 6.8 | 5.3 | 4.2 | 8.7 | 2.5 | 8.1 | 4.4 | 6.8 | 5.1 |
| **S15** | 2.6 | 1.8 | 3.4 | 4.8 | 1.9 | 3.7 | 5.5 | 6.6 | 12.3 |
| **Max** | **8.7** | **5.3** | **4.6** | **14.7** | **5.1** | **13.0** | **12.2** | **14.2** | **12.3** |
| RMSD M3 | **S1** | 4.0 | 1.2 | 3.7 | 6.3 | 2.4 | 5.3 | 6.0 | 9.0 | 5.3 |
| **S2** | 3.5 | 3.2 | 2.4 | 2.1 | 2.5 | 7.4 | 5.4 | 3.2 | 6.4 |
| **S3** | 1.5 | 1.7 | 1.5 | 3.7 | 1.9 | 5.4 | 5.3 | 3.2 | 3.1 |
| **S4** | 3.7 | 2.3 | 1.2 | 5.3 | 5.4 | 2.4 | 4.3 | 2.5 | 2.0 |
| **S5** | 1.4 | 1.5 | 1.4 | 2.1 | 3.0 | 4.8 | 3.2 | 6.3 | 6.0 |
| **S6** | 2.8 | 2.0 | 4.4 | 4.5 | 1.8 | 12.9 | 8.6 | 8.4 | 3.9 |
| **S7** | 3.8 | 3.5 | 2.3 | 3.1 | 3.5 | 9.8 | 4.4 | 4.9 | 9.7 |
| **S8** | 2.1 | 1.4 | 3.5 | 7.1 | 2.6 | 3.6 | 11.3 | 7.7 | 6.7 |
| **S9** | 2.5 | 2.6 | 2.6 | 6.5 | 5.5 | 13.7 | 11.7 | 18.5 | 11.6 |
| **S10** | 2.5 | 1.9 | 3.5 | 8.9 | 2.6 | 7.8 | 17.6 | 9.0 | 12.7 |
| **S11** | 2.8 | 1.3 | 5.6 | 3.1 | 7.6 | 12.6 | 7.9 | 4.2 | 6.6 |
| **S12** | 9.6 | 1.7 | 2.0 | 14.9 | 1.9 | 1.4 | 9.3 | 8.0 | 6.5 |
| **S13** | 3.9 | 4.2 | 5.7 | 9.0 | 4.5 | 14.6 | 5.4 | 8.9 | 4.7 |
| **S14** | 7.8 | 3.9 | 6.1 | 9.8 | 2.3 | 13.1 | 5.9 | 8.3 | 4.0 |
| **S15** | 3.9 | 1.2 | 3.2 | 4.3 | 2.4 | 5.6 | 5.0 | 10.6 | 4.5 |
| **Max** | **9.6** | **4.2** | **6.1** | **14.9** | **7.6** | **14.6** | **17.6** | **18.5** | **12.7** |

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**Figure A1 - Effect size quantified based on Cohen’s d value for the comparisons M1-M2 (blue), M1-M3 (red), and M2-M3 (orange).**