oks001

Specimen preparation

Protocol Deviations:

1. Quadriceps tendon was prepared (specifically its suturing) during the initial preparation.
2. 1. Registration Markers - Digitization. Digitization order for femur spherical markers are: 1 - anteromedial, 2 - medial, 3 - lateral 1 - lateral, 2 - medial, 3 - posterior (-- aerdemir 2017-04-21 12:39:16 During data analysis, the order of digitization for femur registration markers were corrected). Digitization order for tibia spherical markers are: 1 - lateral, 2 - medial, 3 - posterior. Note that the order of digitization for tibia markers is a deviation from the specifications. Nonetheless, this order is the same for oks004. THIS IS A CANDIDATE FOR UPDATING THE SPECIFICATIONS FOR ALL REMAINING SPECIMENS.
3. Femur and tibia was cut 7.5 inches from the epicondylar line (rather than 8 for femur, 7 for tibia) THIS IS A CANDIDATE FOR UPDATING THE SPECIFICATIONS FOR ALL REMAINING SPECIMENS.

Notes:

1. Plastic screws for registration markers are #8-32 (drill bit diameter 0.136 (for tapping), tap size #8-32, drill wire gage 29), need to include this in the specifications.
2. Brass screws for base plugs are #3 (use drill bit diameter ~.088 in, no tapping), need to include this in the specifications.
3. Patella Optotrak base plug orientation was not specified in specifications; two screw holes should be on the inferior side, need to include this in the specifications.
4. The order of probing divots on the patella registration marker assembly was not documented in specifications, need to include this in the specifications.

Joint Imaging

1) Specimen preparation

Protocol Deviations:

1. The posterior region of the knee was dissected further (removal of skin, fat, and muscle layers) to allow fitting of the whole specimen and the patellafemoral registration marker assembly in the transportation fixture (therefore the knee coil of the MRI).

Notes:

1. The tibia end of foam to secure the tibia during transportation and imaging had to be cut lower to accommodate fitting of the whole specimen and the patellofemoral registration marker assembly in the transportation fixture (therefore the knee coil of the MRI).

2) Imaging

Protocol Deviations:

1. None.

Notes:

1. None.

Joint Mechanical testing

1) Equipment preparation

Protocol Deviations:

1. None.

Notes:

1. C-Line lamination sheet was used to seal the sensor. Put one sheet with sticky side up, roll the sensor over it. Put another sheet with sticky side up, roll the sensor+sheet over it. Trim edges.
2. For equilibration: 5051-P1-11111DT1-1200
3. For equilibration: 6.35 Bars (maximum possible).
4. Need to change data storage information in equilibration to reflect the workflow.
5. Equilibration file (2-pass) name 5051-P1-11111DT1-1200_10-6-14_6 bar.equ. (available in oks001/configuration folder of the pressure sensor data collection computer.
6. During calibration, the use of 2-pass equilibration file was problematic. Second pass was deleted from the file and a new equilibration file was created 5051-P1-11111DT1-1200_10-6-14_6 bar-single_pass.equ, which was used in calibration.
7. Pre-testing calibration file name 5051-P1-11111DT1-1200_10-6-14_6 bar.equ. (available in oks001/configuration folder of the pressure sensor data collection computer.

2) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. None.

3) Testing

Protocol Deviations:

1. None.

Notes:

1. Used a 10 second hold for Varus/Valgus torque and Ant/Post drawer (in laxity testing)
2. Used a 14 second hold for Int/Ext rotation torque (in laxity testing)
3. Version of simVITRO software used was unreleased revision 3024 of the repository. The files can be found in svn://dev.lerner.ccf.org/data1/svn/repos/colbrunn-svn/Projects/Numbered Projects/2013CB-031 Open Knee/Original simVITRO-Tested on oks001 oks002 oks003 oks004

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oks002

Specimen preparation

Protocol Deviations:

1. In specimen dissection, proximal and distal tissue regions (for femur and tibia, respectively) were marked as 4.5 inches. This is needed to accommodate symmetric bone cutting levels, which was recently incorporated in the specifications. THIS IS A SPECIFICATION UPDATE to accommodate flipping of the joint between tibiofemoral and patellofemoral testing.

Notes:

1. A soft copy of serological testing for this specimen and all others should be placed in the in-house data management system in the appropriate specimen folder.
2. Specimen was thawed for 24 hours unwrapped. This may be a good guideline to update specimen preparation specifications.
3. For patella registration and Optotrak marker alignments, brass base plugs were used. Note that the use of a plug simply ensures referencing of the marker sets to the same position and orientation.
4. For patella registration and Optotrak marker alignments, the order of divot probing was the same as oks001. A picture is available to denote this order, which should be included in specimen preparation specifications.
5. One of the femur registration markers was placed anterolaterally rather than anterior or anteromedially.
6. Data from coordinate system optimization (passive flexion) and pre-conditioning are also collected if needed.

Joint Imaging

1) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. None.

2) Imaging

Protocol Deviations:

1. Specimen was inserted tibia first in scanner.
2. DICOM to NIfTI conversion was accomplished manually using 3D Slicer.

Joint Mechanical testing

1) Equipment preparation

Protocol Deviations:

1. None.

Notes:

1. Sensor model is 5051, label is 5051-P1-16813DT1-1200.
2. Equilibration pressure is 6.21 bars. Equilibration is done with Equilibration-1 and Equilibration-2; files are saved as single pass and double pass accordingly. Equilibration files are available in the oks002 folder of pressure sensor measurement laptop.
3. Calibration used single pass equilibration as double pass was problematic (maybe double pass equilibration needs two distinct loading). Calibration file is available in the oks002 folder of pressure sensor measurement laptop.

2) Specimen preparation

Protocol Deviations:

1. For patellofemoral joint testing, grommets were not used for placement of the pressure sensor. The knee was small. To place the sensor, the cavity of the patellofemoral joint was exposed. Without disrupting the surrounding capsular structure, the sensor insertion area was cleaned up. The sensor was curved transversely, which gave it some stiffness along the insertion direction, and pushed through the joint as far as possible. This may be a specification change to expedite preparation. The sensor was actually placed on the robot.

Notes:

1. A woodscrew was used to fix fibula to the tibia. The bone quality of the specimen seemed low and a drill bit passed through these bones were loose. Therefore the drill bit was pulled out and a woodscrew was used to secure
2. During potting bottoms of the tubes were 7.5 inches away from epicondylar axis. This needs to be updated in the specifications.

3. During tibiofemoral joint mounting, the specimen appeared to be a valgus knee.
4. For patellofemoral joint testing, the specifications need to provide the location of quadriceps tendon clamp attachment. The loop of the clamp should be slightly above the bottom plane of femur pot.

3) Testing

Protocol Deviations:

1. None.

Notes:

1. Reproducibility tests (AP laxity at 30 degrees) used 5 seconds wait instead of 10 seconds wait of the actual laxity tests. This seem to be the case in all previous specimens and causes an issue at low forces only. The specifications may need to be updated to refer this test as reproducibility test and indicate its wait time.
2. Quadriceps line of action was digitized in the order of inferior then mid then superior. This may need to be described in the specifications in more detail.
3. Version of simVITRO software used was unreleased revision 3024 of the repository. The files can be found in svn://dev.lerner.ccf.org/data1/svn/repos/colbrunn-svn/Projects/Numbered Projects/2013CB-031 Open Knee/Original simVITRO-Tested on oks001 oks002 oks003 oks004

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oks003

Specimen preparation

Protocol Deviations:

1. Femur registration markers were assembled medially, laterally, and posteriorly (rather than anteriorly or anteromedially). Registration marker probing order was also changed to lateral, medial, posterior. Tibia registration markers were assembled per the specification. Probing order is the same as the specification: lateral medial posterior.
2. Ten points (not twelve) were collected on each registration marker. The specifications may need to change as per Robb this has been how the system was set up all the time.

Notes:

1. Dissected and keeping skin-fat-muscle layers from thigh and shank.
2. Patella Optotrak marker needed to be replaced. Probing of patella registration marker was repeated for this reason.

Joint Imaging

1) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. None.

2) Imaging

Protocol Deviations:

1. None.

Notes:

1. To be able to identify where the patella is after the specimen is in the opaque bag, a double sided tape was secured to connect the transportation fixture to the bag. This helps orienting the specimen better in the MRI.

Joint Mechanical testing

1) Equipment preparation

Protocol Deviations:

1. None.

Notes:

1. Sensor model is 5051, label is 5051-P1-16813DT1-1200.
2. A single pass equilibration at 6 bars was conducted.
3. A double pass equilibration was conducted at an additional pressure level of 3 bars, by using single pass 6 bars data. Software reordered the passes.

2) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. None.

3) Testing

Protocol Deviations:

1. None.

Notes:

1. In tibiofemoral joint testing, passive flexion (for coordinate system optimization) was conducted at 50 N compressive load. Specifications state a 100 N compressive load should be used. Nonetheless, as noted by Tara, all previous specimens has been tested under 50 N compressive load for coordinate system optimization. The relevant protocol may need to be updated this.
2. In tibiofemoral joint testing, robotic testing of combined loading at 90 degrees flexion ended prematurely. An additional trial was conducted to complete the tests.
3. In patellofemoral joint testing, a coordinate system transformation matrix in SimVitro (the matrix that establishes the relationship between the tibia and load cell) needed to be mirrored to accommodate the left knee.
4. In patellofemoral joint testing, at 0 degrees flexion multiple trials were collected for 20, 100, 200, 300, 400, 500 N quadriceps loading. This was necessitated by troubleshooting tendon freeze clamping and tendon actuator response.
5. Version of simVITRO software used was unreleased revision 3024 of the repository. The files can be found in svn://dev.lerner.ccf.org/data1/svn/repos/colbrunn-svn/Projects/Numbered Projects/2013CB-031 Open Knee/Original simVITRO-Tested on oks001 oks002 oks003 oks004

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oks004

Specimen

Protocol Deviations:

1. *Specimen Characteristics.* Donor age (46 yrs) does not match specifications.
2. *Specimen Size.* The specimen is not hip to toe rather mid-femoral shaft to toe.

Notes:

1. None.

Specimen preparation

Data Location:

- Patella Registration and Optotrak Marker Alignment:
    - Sensor in state files are saved in main configuration folder for project
    - The two data files are found in specimen configuration folder
        - digitized_MRI_marker_state.cfg
        - Patella_sensor_to_Reference.tdms

Protocol Deviations:

1. *Femur Anatomical Landmarks.* As the specimen did not include femoral head, landmarks on femoral shaft at its most proximal circumference were digitized.

Notes:

1. *Registration Markers - Preparation.* Drilling axis (for screw placement) and marker center are not concentric. Careful handling is necessary not to rotate the markers after their installation on bones. Preparation of the markers beforehand, by drilling on the lathe may be helpful to establish concentricity.
2. *Registration Markers - Digitization.* Digitization order for femur spherical markers are: 1 - anteromedial, 2 - medial, 3 - lateral. Digitization order for tibia spherical markers are: 1 - lateral, 2 - medial, 3 - posterior.
3. *Specimen Dissection*
    - Mention that quad tendon must be isolating by removing fat around it and then kept moist with saline towel (suggest using tweezers and squeezing to remove muscle that is on tendon)
    - Mention that four inch strip of tibia and fibula shafts must be completely cleaned 360 degrees around shaft and should be made as far proximal as possible without damaging joint capsule to allow room for plugs
    - Add that fibula should be fixed to tibia for MRI
4. *Optotrak Base Plug Placement on Bones*
    - From step 2: Specify that 3 plastic optotrak plugs are needed
    - From step 5:
        - Base plug for femur was placed laterally and for tibia was placed medially (deviation from specification).
        - Oks004 had the 2 screw holes on posterior side instead of anterior side
        - Mention if a screw shears off it is okay to have 2 full screws and a sheared one in the plug
        - Mention if all screws shear then remove screws and try drilling bigger holes first (tip: test with non-cemented screws first to see if they shear)
        - Suggest using k-wire in one hole to hold plug still when screwing in others
        - Suggest checking that drill bit is short enough to prevent going through cartilage on patella (from section 3 of step 5)
        - Mention cut vertical line in skin over patella and pull apart sides to make room for plug (from section 3 of step 5)

- From step 6: mention wiping off excess cement from screw before inserting
- General:
    - have section on cement
        - suggest making small batches and doing one plug at a time to avoid cement hardening before you are ready
        - mention that if cement clumps up when screwing in then it is time for new batch
        - Add caution that cement should be made in a hood and masks should be worn

5. *Registration Marker Placement on Femur and Tibia*
    - From step 1: mention that it is being driven by field of view from MRI spec
    - General: Specify drill bit size, specify type of retractor (mention to check that it is sharp for grip), mention that tissue must be cut to make room for spheres
6. *Preparation of Specimen for Mechanical Joint Testing*
    - Oks004 fibula was screwed/fixed to tibia at this point
    - suggest checking that sensors will fit on plugs with the pot before actually potting
    - mention removing wood metal that hardens over edge of pot with chisel
    - mention liquid nitrogen is used to secure tendon
    - mention that chuck should be used to protect knee when pouring liquid nitrogen onto tendon
    - 0ks004 liquid nitrogen was added to tendon every 15-20 minutes
    - consider smaller grommet size
    - explain that size of sensor is determined by if it is small enough to fit in knee and large enough to collect all data
    - From step 4 mention to check during dissection if any important features were cut when incisions were made

Joint Imaging

1) Specimen preparation

Protocol Deviations:

1. Patella registration marker assembly was not placed on the patella for imaging. This can be prevented by cross-checking with specifications. Alternative imaging or digitization is necessary to align patella local coordinate systems between imaging and motion analysis. This

can be accomplished by i) imaging patella only with the registration marker assembly after dissection, or ii) by digitizing patella anatomy using Optotrak along with patella motion analysis markers. Snehal will follow up to resolve this issue.

2. As an alternative solution to obtain the transformation matrix between the patella Optotrak marker coordinate system to image coordinate system, 48 points on the anterior bony surface of the patella was digitized using the Optotrak probe. First (and last) three points correspond to lateral, medial, and inferior points, respectively.

Notes: -- colbrunn 2016-10-13 16:50:01 In reviewing the imaging it appears the specimen moved slightly for the general purpose imaging set. No difference in anatomy location was identified between cartilage and other imaging sets. However, the general purpose imaging set was slightly different than the other 4 sets. Caution should be used when segmenting with the general purpose image set.

2) Imaging

Protocol Deviations:

1. After localizer we ran ACRT1 Axial test (a localizer/scout)

Notes:

1. General purpose imaging seems very noisy; data source SEQ1_t1_fl3d_sag_iso_0.4_we (@ staging server for data organization)

Joint Mechanical testing

1) Equipment preparation

Protocol Deviations:

1. None.

Notes:

1. Mention that equilibration might have to be run twice in order to successfully equilibrate sensor

2) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. The specifications did not explicitly detail securing of the fibula to the tibia. A drill bit was passed through the fibula and the tibia to prevent fibula's movements during tibiofemoral joint testing. It may be necessary to secure fibula to the tibia during specimen preparation (before detaching the foot) to approximate anatomical alignment. This will require MRI compatible screws, etc. and will ensure keeping the fibula at the same position relative to the tibia in imaging and during robotics testing.

3) Testing

Protocol Deviations:

1. For tibiofemoral joint testing, the knee was assembled upside down. This approach circumvented the need for gravity compensation during force measurements. The tibia was fixed directly to the load transducer, which was assembled on the testing frame.
2. For patellofemoral joint testing, 20N compressive force for tibiofemoral joint was applied to increase stability

Notes:

1. For tibiofemoral joint testing, reprogramming of the robotics testing system was required to accommodate optimization of the joint coordinate system.
2. During tibiofemoral joint testing, the control system had issues loading the knee joint flexed at 90 degrees with a 2.5 Nm valgus moment from an unloaded state. This may be related to a possible singularity of the robot configuration.
3. During tibiofemoral joint testing at 90 degrees flexion, visibility of the femur Optotrak markers was problematic.
4. During patellofemoral joint testing, the knee needed to be oriented axially to accommodate loading direction of the quadriceps tendon. This caused the loss of tibia Optotrak marker data. Robotic system provides redundant information to reconstruct relative locations of patella, femur, and tibia.
5. For patellofemoral joint testing, measurement of quadriceps line of action needs to be detailed.
6. For patellofemoral joint pressure measurements, pressure data was collected to denote medial/lateral, superior/inferior locations of the sensor.
7. During patellofemoral joint testing, patellofemoral kinematics data were not recorded for 0, 15, and 30 degrees flexion conditions. These conditions were repeated. In both case cases (initial and repeat) pressure data were collected.
8. Knee should be aligned obliquely to accommodate line of action of quad because tibia markers are lost and data is not seen in camera
9. During laxity testing at higher flexion angles (30, 60 and 90) non-zero external rotation torque caused the "Anterior Drawer" laxity condition to not truly be an anterior drawer test. The AP translations were not proportional to the AP loads due to coupling with ER rotation. In the future, attention should be made to ensure off-axis loads are zero during laxity testing. Gains and/or settling time can be increased to ensure this.
10. Version of simVITRO software used was unreleased revision 3024 of the repository. The files can be found in svn://dev.lerner.ccf.org/data1/svn/repos/colbrunn-svn/Projects/Numbered Projects/2013CB-031 Open Knee/Original simVITRO-Tested on oks001 oks002 oks003 oks004

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oks006

Specimen preparation

Protocol Deviations:

1. Femur registration markers were assembled medially, laterally, and posteriorly (rather than anteriorly or anteromedially). Registration markers were digitized in the following order: medial, lateral, posterior. This was done to accommodate the quadriceps tendon.

Notes:

1. Specimen did not thaw (at the thigh) adequately. The team waited an additional hour for dissection.
2. Dissected and keeping skin-fat-muscle layers from thigh and shank.
3. Dissected and keeping the femoral head.
4. Dissected and keeping bone from femoral and tibial shafts.

Joint Imaging

1) Specimen preparation

Protocol Deviations:

2. None.

Notes:

1. None.

2) Imaging

Protocol Deviations:

1. None.

Notes:

1. None.

Joint Mechanical testing

1) Equipment preparation

Protocol Deviations:

1. None.

Notes:

1. Sensor model is 5051, label is 5051-P1-16813DT1-1200.

2. A single pass equilibration at 6 bars was conducted.
3. A double pass equilibration was conducted at an additional pressure level of 3 bars, by using single pass 6 bars data. Software reordered the passes.
4. Both equilibrations were repeated due to a sensel equilibration issue at low pressure (3 bar). A snapshot of the equilibration measurements were taken at 3 bar. Files from this repetition (in particular for double pass) were used for calibration.
5. Versions of software used during testing
    1. simVITRO 1.0.3.12
    2. simVITRO Knee Module 1.0.4.8
    3. SSCAD Toolkit 1.0.3.18
    4. SSCAD Toolkit Extensions 1.0.1.3
    5. SSCAD NDI Optotrak 1.0.0.8
    6. NDI Optotrak Drivers 1.0.0.6
    7. BioRobotics Software Configuration 1.0.1.5
    8. BioRobotics Common Tools 1.0.6.3

2) Specimen preparation

Protocol Deviations:

1. Fibula was fixed to tibia with a wood screw immediately after imaging before potting. This practice was adapted for oks003 and other previous specimens in various forms. The specifications may need to change to reflect this.

Notes:

1. None.

3) Testing

Protocol Deviations:

1. None.

Notes:

1. In tibiofemoral joint testing, during combined loading at 30 degrees flexion, the testing ended prematurely with abrupt loading. The test was repeated, in following the scheduled reproducibility testing was conducted and visually compared to first reproducibility testing. Any differences (<0.5 mm translation at peak loads) were attributed to specimen conditioning (and possibly creep).

2. In tibiofemoral joint testing, for combined loading at 90 degrees flexion, the knee fixture (holder angle) was rotated to accommodate range of motion of the robot. SimVitro takes into account of these adjustments to provide desired loading scenarios.
3. In tibiofemoral joint testing, an optimized joint coordinate system was calculated from passive flexion data (0 to 90 degrees) under 50 N compression load (not 100 N). This was the case for all specimens so far and the specifications should reflect that.
4. In patellofemoral joint testing, optimized tibiofemoral joint coordinate system was always re-established from passive flexion data (0 to 60 degrees) under 50 N compression load. This was the case for all specimens so far and the specifications should detail this.
5. Patellofemoral joint testing delayed to update error catching feature of the new SimVitro software in order to accommodate virtual force transducer utilized when the femur is mounted up. There were other software issues that needed to be fixed. These came as a result of the manual process of getting specific properties from the tibiofemoral state configuration file and placing in the state file for patellofemoral testing. As a follow up, we are creating a script to automating this conversion process. This script has been unit tested, but will be validated during the next test.
6. In patellofemoral joint testing, some conditions needed to be repeated as a result of load application issues and robot shut down. The last trial of these conditions should be used for future data analysis.

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oks007

Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. Dissected and keeping skin-fat-muscle layers from thigh and shank.
2. The tibia Optotrak plug was oriented in an oblique manner (with two screws on the anterior side pointing superiorly).
3. The femur registration markers were placed to medial, lateral, and posterior sides (alternative configuration).
4. Suture needs to be ordered for upcoming specimens.
5. Dissected and keeping the femoral head.
6. Dissected and keeping bone from femoral and tibial shafts.

Joint Imaging

1) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. None.

2) Imaging

Protocol Deviations:

1. None.

Notes:

1. None.

Joint Mechanical testing

1) Equipment preparation

Protocol Deviations:

1. None.

Notes:

1. Versions of software used during testing
    1. simVITRO 1.0.3.12
    2. simVITRO Knee Module 1.0.5.10 - with an exception that the bug introduced in this version with regards to femur CS optimization was manually fixed in the code so that it performed in similar manner to previous and future versions.
    3. SSCAD Toolkit 1.0.3.18
    4. SSCAD Toolkit Extensions 1.0.1.3
    5. SSCAD NDI Optotrak 1.0.0.8
    6. NDI Optotrak Drivers 1.0.0.6
    7. BioRobotics Software Configuration 1.0.1.5
    8. BioRobotics Common Tools 1.0.6.3

2) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. None.

3) Testing

Protocol Deviations:

1. None.

Notes:

1. During tibiofemoral joint testing, 1 Nm internal rotation torque (IE laxity testing at 30 & 90 degrees flexion -- possibly others too) was not captured properly. The IE torque was at 0.5 Nm and off-axis loads (varus) were not minimized to zero. Other levels of loads were fine. A separate trajectory was ran with 1 Nm internal rotation torque starting at 90 degrees flexion down to 0 degrees flexion.
2. During patellofemoral joint testing at 0 degrees flexion the sensor did not register much pressure and the location of the pressure sensor needed to be readjusted after the test to accommodate higher flexion angles.
3. During patellofemoral joint testing during 30 degrees flexion there was a discontinuity in pressure measurements on the medial side. This may be attributed to sensor wrinkling or cartilage degradation at that area (needs to be checked).
4. During patellofemoral joint testing at 60 degrees flexion, 600 N loading was repeated as the clamp cover hose was suspected to catch the fixture edge.

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oks008

Specimen

Protocol Deviations:

1. *Specimen Characteristics.* Donor age (40 yrs) does not match specifications.

Notes:

1. None.

Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. Dissected and keeping skin-fat-muscle layers from thigh and shank.
2. The orientation of the bone plug for tibia was slightly tilted to accommodate motion analysis marker in relation to pot.
3. The femur registration markers were placed to medial, lateral, and posterior sides (alternative configuration).
4. The femur registration marker digitization sequence was medial, lateral, posterior.
5. Dissected and keeping the femoral head.
6. Dissected and keeping bone from femoral and tibial shafts.

Joint Imaging

1) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. None.

2) Imaging

Protocol Deviations:

1. None.

Notes:

1. Skin, fat and muscle layer from posterior region of the knee needed to be removed to fit into specimen transportation and imaging fixture.

Joint Mechanical testing

1) Equipment preparation

Protocol Deviations:

1. None.

Notes:

1. None.

2) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. Drill bits to secure the pots were not placed during specimen preparation. This was noticed during the first reproducibility test of the tibiofemoral joint. The specimen was taken down from the robot for placement of drill bits.

3) Testing

Protocol Deviations:

1. None.

Notes:

1. Drill bits to secure the pots were not placed during specimen preparation. This was noticed during the first reproducibility test of the tibiofemoral joint. The specimen was taken down from the robot for placement of drill bits and remounted afterwards. The first reproducibility test (AP laxity at 30 degrees flexion) was repeated after placement of drill bits. The tibiofemoral joint experimentation continued as planned afterwards.
2. For tibiofemoral joint testing, at 0 degrees flexion testing conditions, the robot and the control computer lost communications. The system needed to be rebooted. The experiments continued starting with 0 degrees flexion testing.
3. For tibiofemoral joint testing, the final reproducibility test illustrated a shift in all translations (as observed from robot measured kinematics). The motion analysis measurements of tibiofemoral joint should be checked, if this is indeed the case.
4. Force data was filtered up through 200N 15 degrees PFJ Testing. After this point data was not filtered.
5. We will need to check and see if previous PFJ Testing had force torque filtering. All TFJ Testing did not have filtering.

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oks009

Specimen

Protocol Deviations:

1. X-ray evaluation was not possible due to lack of X-ray imaging of the specimen.

Notes:

1. None.

Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. Dissected and keeping skin-fat-muscle layers from thigh and shank.
2. The orientation of the bone plugs for tibia and femur were adjusted to accommodate motion analysis marker in relation to pot.
3. Skin and fat layers on the posterior side of the knee were removed to accommodate placement of the specimen in transportation fixture for imaging. This was necessitated by the large size of the knee.
4. The femur registration markers were placed to medial, lateral, and posterior sides (alternative configuration).
5. Tibia anatomical landmark measurements were in the order lateral plateau, medial plateau, lateral malleolus (x2), medial malleolus (x2).
6. Femur anatomical landmark measurements were in the order lateral epicondyle, medial epicondyle, epiyhseal line (x4, anterior, inferior, posterior, superior),
7. Patella anatomical landmark measurements were in the order lateral, medial, superior, inferior.
8. The femur registration marker digitization sequence was medial, lateral, posterior.
9. The tibia registration marker digitization sequence was lateral, medial, posterior.
10. Dissected and keeping the femoral head.
11. Dissected and keeping bone from femoral and tibial shafts.
12. More screws (to assemble the Optotrak bone base plugs) need to be purchased for next experimentation.

Joint Imaging

1) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. Skin and fat at the posterior region of the knee were removed to accommodate placement in the transportation fixture.

2) Imaging

Protocol Deviations:

2. None.

Notes:

1. None.

Joint Mechanical testing

1) Equipment preparation

Protocol Deviations:

1. None.

Notes:

1. None.

2) Specimen preparation

Protocol Deviations:

1. None.

Notes:

1. During insertion of pressure sensor to the patellofemoral joint, a fat bursa on the lateral side of the joint was observed.

3) Testing

Protocol Deviations:

1. None.

Notes:

1. During tibiofemoral joint testing, the first passive flexion test completed. During extension, the robot malfunction resulted in large forces and moments to be applied on the knee (>4,000 N compression unfiltered raw data from force transducer in JCS? possibly saturated (check movements based on knee anatomical JCS measured by Optotrak); >1,000 N posterior; >400 N lateral; >30 Nm flexion; >25 Nm valgus, >5 Nm internal rotation - for exact magnitudes check the relevant tdms file). This may have resulted in damage of knee structures. In the second passive flexion test, flexion was completed yet during extension the same malfunction was observed. It may be possible to compare the first passive flexion curve (response of the intact joint) with the second passive flexion curve (response of the potentially damaged joint) to assess any discrepancies due to tissue failure. It may be necessary to consider this specimen as a damaged specimen. The group decided to collect tibiofemoral joint testing data per specifications anyways. The loading and kinematic profiles of the abrupt extension profiles were saved to be able to simulate potentially damage inducing simulation scenarios. If damaged, the laxity and combined loading data may serve modeling & simulation of an injured knee. Callan has a video of the second passive flexion/extension loading profile which may indicate what the robot was doing. He will upload the video to the data management system.

The group needs to evaluate the joint critically during dissection, documenting tissue state by taking pictures.

2. Following robot maintenance, the tibiofemoral joint testing restarted. Passive flexion testing data was qualitatively compared to first passive flexion test (before robot malfunction and large loads being applied to the knee). There was an agreement but this may not warrant lack of any damage to ligaments, menisci, and cartilage.
3. During tibiofemoral joint testing, posterior drawer tests (for 30, 60, and 90 degrees flexion) were repeated due to non-zero (unminimized) external rotation moment.
4. Specifications of all force transducers, specifically the Theta transducer, should be added to the wiki page on infrastructure for joint mechanics testing.
5. Before patellofemoral joint testing, troubleshooting in simVitro (robot control and data collection) needed to be performed. This delayed start of patellofemoral joint testing. Previous scripts to move from tibiofemoral joint testing placement settings to patellofemoral joint testing placement settings did not work due to recent updates to SimVitro. This step was handled manually and the script will need to be updated in future. This does not affect the data.
6. During patellofemoral joint testing, for 60 degrees flexion, the tibiofemoral joint equilibrium state to represent passive flexion seemed deviating from its original state. It may be possible that multiple equilibrium states may exist, i.e particularly for internal/external rotation. The equilibrium state was found without any quadriceps load (rather than a minimal ~10 N load) and experiment was conducted. Testing for 45 degrees flexion was also repeated; the pressure sensor location was adjusted before these repeat tests. It should be noted that tibiofemoral joint kinematics and kinetics were collected at all times.
7. During patellofemoral joint testing, for 60 degrees flexion and 200 N quadriceps loading, kinematics/kinetics data were collected twice whereas pressure data were collected once. The latter kinematics/kinetics data correspond to the pressure data.