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Appendix E-1

Quadriceps muscle strength | Hip extensor muscle strength | Hip abductor muscle strength

Fig. E-1
Representative images showing measurement of lower limb muscle strength.

Appendix E-2

Additional Information About Methods

Method 1: Measurement of Muscle Strength

The maximum isometric strengths of the quadriceps, hip extensors, and hip abductors were measured using a handheld dynamometer, in accordance with a previous study[24]. The dynamometer is a simple tool for objective quantification of muscle strength and is widely used in clinical practice. The maximum force was recorded in Newtons (N), and testing was performed twice. At least 15 seconds of rest was provided between the 2 testing sessions, to allow muscle recovery. The testing position sequence was consistent, beginning with sitting (quadriceps) and progressing to a supine position (hip extensors and abductors) to prevent fatigue due to frequent changes in position. The force-pad of the dynamometer was always held perpendicular to the limb being tested. To provide the moment value (Nm), the lever arm (the length of the femur or tibia) between the hip or knee joint and the dynamometer was measured manually and subsequently was normalized to their body mass (Nm/kg). The mean values from the 2 sessions were used for statistical analysis. All testing was performed on the therapy bed.

Knee Extensor (Quadriceps) Muscle Strength: The individual was instructed to remain seated in an upright position. The knee was placed in 90° of flexion and the dynamometer was attached 10 cm proximal to the lateral malleolus and held in place with an inelastic strap that was looped around the therapy bed and fastened. The length of the straps allowed an isometric contraction to be performed with the knee in 90° of flexion during testing. The individual was instructed to extend the leg for 5 seconds. Strong verbal encouragement was provided to ensure maximum effort.

Hip Extensor Muscle Strength: The individual was instructed to lie supine on the therapy bed. The hip was placed in slight flexion, the knee was straight and in neutral external-internal rotation, and the dynamometer was attached just superior to the lateral epicondyle of the posterior aspect of the femur. The individual was instructed to extend the leg for 5 seconds. Strong verbal encouragement was provided to ensure maximum effort. The other examiner supported the individual’s contralateral limb.

Hip Abductor Muscle Strength: The individual was instructed to lie supine on the therapy bed. The hip was placed in neutral flexion-extension and external-internal rotation, with the knee straight, and the dynamometer was attached just superior to the lateral epicondyle of the femur. The hip and knee were slightly flexed. The individual was instructed to abduct the leg (femur and tibia) for 5 seconds. Strong verbal encouragement was provided to ensure maximum effort. The other examiner supported the individual’s contralateral limb.

Method 2: Radiographic Evaluation of Anatomical Axis Angle

The anatomical axis angle (AAA) was evaluated from an anteroposterior radiograph by a trained examiner (H.I.) using Nazca software (Astrostage), as previously described[42]. AAA was defined as the internal angle formed by the intersection of 2 lines originating 10 cm from the knee joint surfaces, bisecting the femur and tibia and converging at the center of the tips of the tibial spines[43]. The exact distance from the surface of the knee joint at which the femur or tibia was to be bisected was determined by the size of the patient’s leg: a length 1.3 times that of the

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epicondylar line from the medial epicondyle to the lateral epicondyle was used. The measurements of AAA were modified to better reflect mechanical alignment: a sex-specific correction factor of 3.5° for women and 6.4° for men was subtracted[26]. The resulting corrected values were used throughout. The knees were categorized into 3 groups based on corrected AAA: neutral alignment (corrected AAA ≥179° but <182°), varus alignment (corrected AAA <179°), and valgus alignment (corrected AAA ≥182°)[44,45]. To assess intrarater reliability, 100 randomly selected radiographs were reevaluated by the same examiner more than 1 week after the first assessment. The intrarater reliability for measurements of AAA was evaluated and was found to be excellent (intraclass correlation [$ICC_{1,1}$]: 0.98; 95% CI: 0.98 to 0.99).

Method 3: Measurement of Passive Range of Motion of the Knee

The flexion and extension range of motion of both knee joints were measured passively with the individual in the supine position and the use of standard goniometric procedures, following previously validated methods[46]. The axis of the goniometer was placed in line with the center of the knee, the fixed arm was aligned with the greater trochanter and the lateral femoral condyle, and the mobile arm was aligned with the head of the fibula and the lateral malleolus. Negative values for knee-extension range of motion indicated a lack of full extension of the knee joint. Excellent $ICC_{1,1}$ for goniometric measurements of passive range of flexion (0.99) and extension (0.98) have been reported[46].

Method 4: Calculation of Required Sample Size

A sample size calculation was performed using the sample size and power tool in JMP Pro 13.0 (SAS Institute). We found no previous studies comparing lower-limb muscle strength between individuals with and without lateral OA, so we used pilot data of quadriceps strength, including the first 10 individuals in each group (20 individuals in total). The index quadriceps strengths (and standard deviation) were 1.156 ± 0.353 Nm/kg and 1.413 ± 0.636 Nm/kg in individuals with and without lateral OA, respectively. With a power of 0.80 and a significance level of $p < 0.05$, at least 128 individuals were required across 2 groups. Accounting for a potential 10% dropout rate because of exclusion criteria and missing data, we determined that at least 141 individuals were needed for the present study.