

Official Title: Immediate And Retention Effects Of Augmented Feedback On Isometric Peak Force And Rate Of Force Development Of Shoulder Rotators

NCT Number: NCT ID not yet assigned.

Ethical approval: Hacettepe University Institutional Review Board approved the protocol for this study (FTREK26/30, 19/02/2026).

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STUDY PROTOCOL

Background: This study aims to investigate the effects of providing immediate augmented feedback on maximal force (peak force) and rate of force development during isometric strength training of the dominant shoulder internal and external rotator muscles.

Study Design: A randomized, cross-over clinical trial.

Participants:

Inclusion Criteria:

- Healthy individuals aged between 18 and 30 years,
- Body Mass Index (BMI) below 30 kg/m²,
- An activity level of 5 or higher according to the Tegner Activity Scale,
- Full active range of motion (ROM) in shoulder flexion, abduction, internal, and external rotation.

Exclusion Criteria:

- Presence of current pain complaints,
- Provocation of symptoms during at least one of the specific shoulder clinical tests (Neer Test, Hawkins-Kennedy Test, Jobe Test, Resisted External Rotation Test, and Apprehension Test),
- History of any upper extremity injury, pain, or surgical intervention within the past 12 months,
- Presence or history of hypertension, cardiovascular diseases, peripheral vascular diseases, deep vein thrombosis, neurological disorders, systemic inflammation, diabetes, cancer, or obesity,

- Unwillingness to participate in the study.

Interventions: A randomized crossover design was used to assess the immediate and retention effects of providing knowledge of results on peak force and rate of force development during isometric training of the dominant shoulder internal and external rotators. Limb dominance was determined by verbally asking participants to identify their preferred throwing arm, and all testing and training protocols were performed exclusively on this dominant side. After a standardized warm-up and a familiarization session to ensure proper technique on the isometric dynamometer (ForceFrame, VALD Performance, Australia), subjects participated in two separate sessions. In a randomized order (determined via a computer-based randomization program), subjects performed the isometric training protocol under two distinct conditions: (I) with KR, and (II) without KR. To ensure adequate rest and recovery and to minimize potential learning effects, a day washout period of at least 5 days was implemented between the two training sessions. The only difference between the two sessions was that, in one condition, participants received immediate augmented feedback during training regarding their peak force and rate of force development after each repetition, whereas in the other condition, no feedback was provided. During each session, testing was conducted at three specific time points without any feedback: before training (pre-test), immediately after training (post-test), and 15 minutes post-training (immediate retention test).

Sample Size: The sample size of the study was determined by an *a priori* power analysis using G*Power (v3.1) software. A similar study in the literature by Jiménez-Alonso et al., which utilized a randomized cross-over experimental protocol and an outcome feedback intervention, was taken as a reference. In that study, the effect size for the performance difference between the outcome feedback and control conditions was reported as 0.78. Based on this effect size, assuming 80% statistical power ($1-\beta$) and a 5% significance level ($\alpha = 0.05$), the power analysis

calculated that a minimum of 15 participants should be included in the study. Accounting for potential dropouts, the study is planned to be conducted with a total of 18 participants.

Data Analysis: Statistical analysis will be performed using SPSS software. The normality of data distribution will be assessed using the Shapiro-Wilk test. Given the cross-over design of the study, differences in peak force and rate of force development between the augmented feedback and no-feedback conditions will be analyzed using Paired Samples t-tests (for normally distributed data) or Wilcoxon Signed-Rank tests (for non-normally distributed data). A p-value of <0.05 will be considered statistically significant.