# Comparing the Effects of Electrical Muscle Stimulation and Isometric Exercises on Muscular Strengthening on the Contralateral Limb

- Alexis Holthues
- Research of Human Performance ATTR 540

# Background

- Muscle weakness is a common cause of poor functional recovery after injury and disease. (Lee M 2007)

- Cross Education is the performance improvement on the contralateral limb following unilateral exercise training.

  (Toca-Herrera et al 2008, Farthing et al 2005)

# Background

- Theories
  - Muscular adaptation
    - Increase in force generating capacity of the muscle on the contralateral side (Lee M 2007)
  - Neural adaptation
    - Repeated contractions over time, result in permanent and functional changes that change the way the contralateral limb is controlled (Lee M 2007)

- Improve rehabilitation time
  - Do not have to move limb
  - Start rehabilitation earlier
  - Prevent muscle weakness

# Background

- No definite answer on which technique is most effective

# Background

- Electrical muscle stimulation
  - electrically stimulating the nervous and/or muscular cells to produce a muscle action
  - Produces involuntary contractions
- Effects
  - Limit atrophy
  - Limit strength decrease
  - Limit deterioration of functional abilities
  - Increase muscle mass, strength, power and endurance
    (Toca-Herrera et al 2008, Sariyildiz et al 2011, Dreibati et al 2011, Laughman et al 1983)

# Background

- Isometric Exercises
  - produce muscle tension without joint movement
- Beneficial in rehabilitation
  - Joint motion in uncomfortable
  - Immobilized
  - Weakness at a specific point in ROM

    (Laughman et al 1983)
- Effects
  - Increases static strength
  - Decreases atrophy
  - Helps maintain neuromuscular function
  - Muscle pumping action
  - Decrease swelling by removing fluid out of the area

    (Prentice 2009)

# Background

- Dominance
  - Body's preference on what side to use first or more often
- Determined by:
  - Brain
  - Eye
  - Hand
  - Foot

  (Stevens-Smith D 2009)

- The preference of transfer direction of cross education is from dominant to nondominant limb
  - Dominant side is more proficient at acquiring or learning a task than the nondominant side

  (Farthing et al 2005, Sariyildiz et al 2011)

# Previous Research

- ## Isometric Exercises
  (Toca-Herrera et al 2008)

- ## TENS
  (Sariyildiz et al 2011, Bezerra et al 2009)

# Purpose

- To compare the effects of muscle stimulation and isometric exercises in cross education on muscular strengthening of the contralateral limb.

# Hypotheses

- There will be a strength increase in the contralateral limb after one treatment

- Electrical muscle stimulation will have a greater strength increase on the contralateral limb than isometric exercises

# Participants

- 10 volunteer participants
  - 5 in each group
- 3 male and 7 female Manchester University students
- The participants will be obtained through Manchester University student email
  - Approved by Dean Sharfman

# Instrumentation

- Electrical muscle stimulation
  - Transcutaneous electrical nerve stimulator (TENS)
    (Sariyildiz et al 2011, Bezerra et al 2009)
- Isometric Exercises
  - Quadricep contractions
    (Godfrey et al 1979)
- Cybex 340
  - Software HUMAC 2009
  - 3 speeds
    - 60, 180, 240 deg/sec
    (Godfrey et al 1979, Sariylidiz et al 2011, Laughman et al 1983)
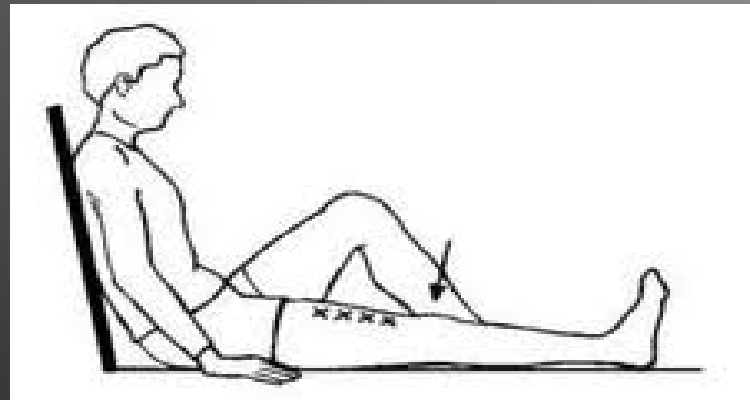
# Procedures

- Step 1
  - Approved by Manchester University IRB
- Step 2
  - Sign consent form
- Step 3
  - Demographic questionnaire
  - Lower limb dominance test
    (Stevens-Smith D 2009)

# Procedures

- Step 4
  - Baseline of quadriceps strength on Cybex 340
- Step 5
  - Treatment
    - Electrical muscle stimulation
      - 10 minutes; intensity maximum tolerable
        (Dreibati et al 2011, Sariyildiz et al 2011, Godfrey et al 1979)
    - Isometric exercises
      - 10 minutes; hold 10 seconds with 50 second rest
        (Laughman et al 1983, Godfrey et al 1979)
- Step 6
  - Test quadriceps strength on Cybex 340

# Statistical Analysis

- All data was entered into a password protected computer

- PASW software

- Independent sample t-test

- Mean scores and mean differences

# Statistical Analysis

- Nonparametric tests
  - Related-Samples Wilcoxon Signed Rank Test
  - Independent Samples Median Test

- Median score and median differences

- Level of significance is at the .05 level

# Results

- Nonparametric Tests
- Improvement between isometric exercises and TENS treatment.
  - Speed of 60 deg/sec
    - P=.524; median=6.000
    - No significant difference
  - Speed of 180 deg/sec
    - P=.527; median=.000
    - No significant difference
  - Speed of 240 deg/sec
    - P=.527; median=-3.500
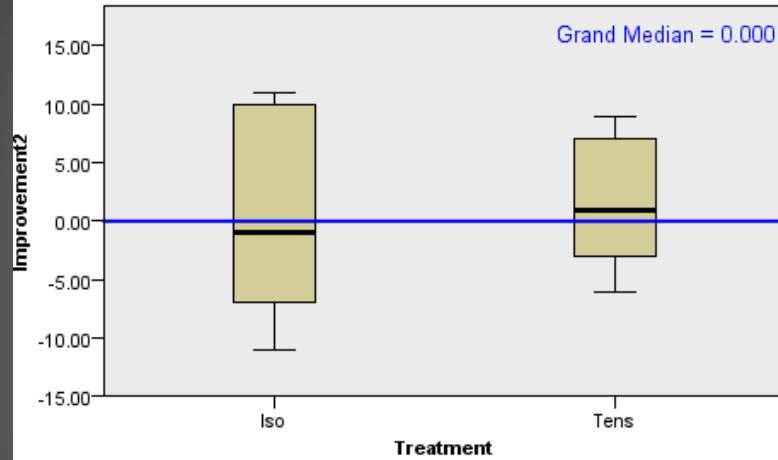    - No significant difference

Independent-Samples Median Test

Grand Median = 6.000
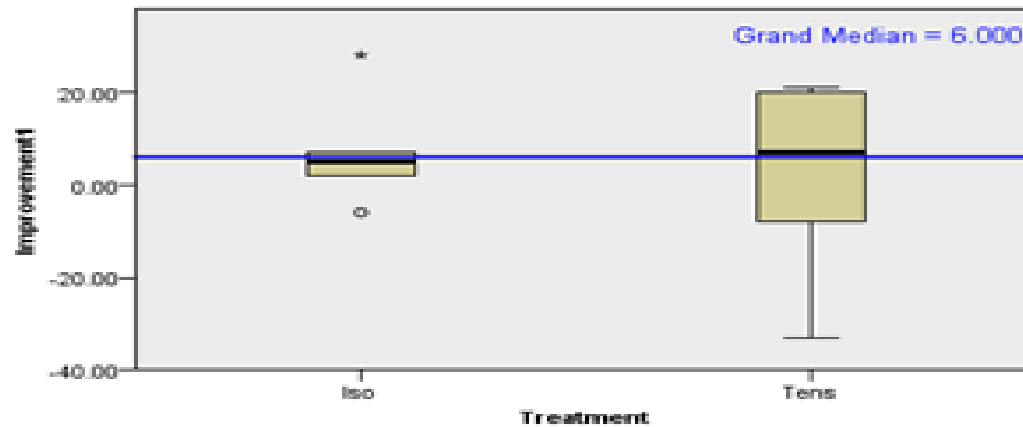
| Total N | 10 |
| --- | --- |
| Median | 6.000 |
| Test Statistic | .400 |
| Degrees of Freedom | 1 |
| Asymptotic Sig. (2-sided test) | .527 |
| Fisher Exact Sig. (2-sided test) | 1.000 |

1. More than 20% of the cells have expected values less than five.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.
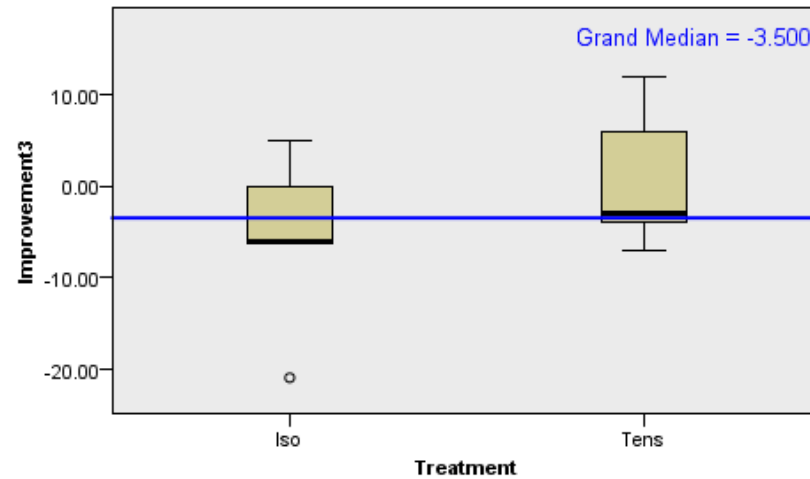
Improvement 1 ( 60 deg/sec)

Improvement 2 ( 180 deg/sec)

Improvement 3 (240 deg/sec)

# Results

- Improvement for the speed 60 deg/sec
  - P=.386
  - No significant difference
- Improvement for the speed 180 deg/sec
  - P=.683
  - No significant difference
- Improvement for the speed 240 deg/sec
  - P=.440
  - No significant difference

Related-Samples Wilcoxon Signed Rank Test
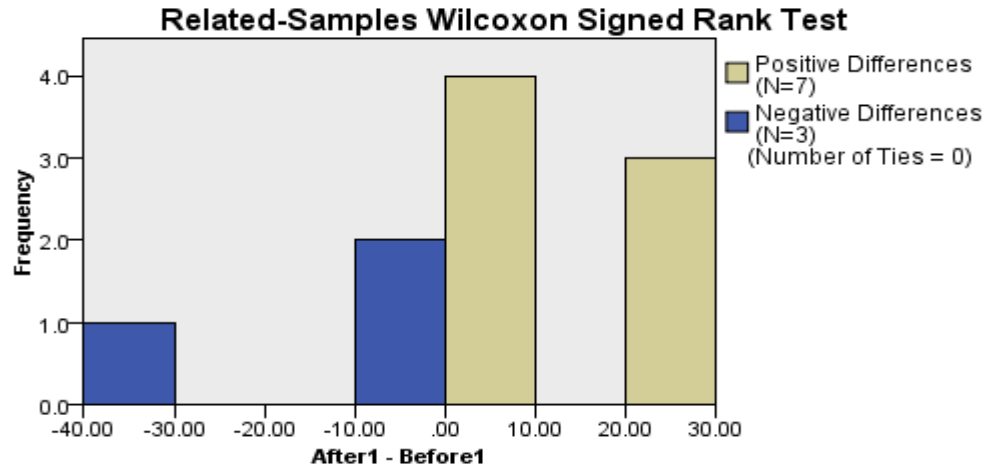
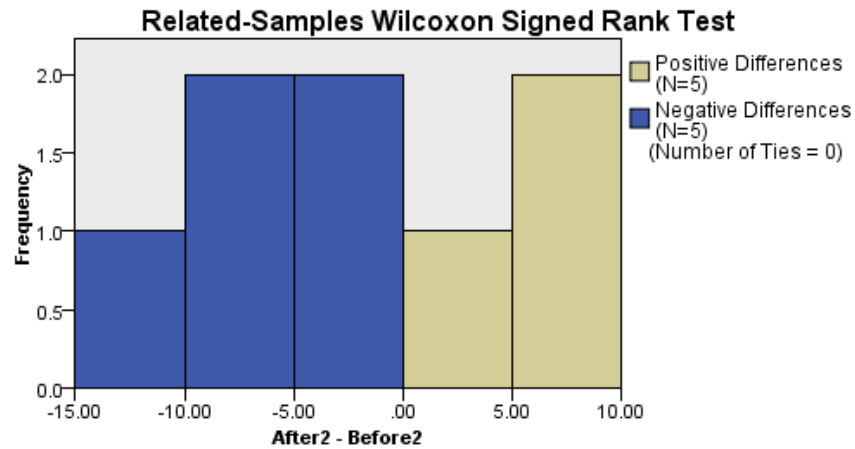| Total N | 10 |
|---|---|
| Test Statistic | 36.000 |
| Standard Error | 9.804 |
| Standardized Test Statistic | .867 |
| Asymptotic Sig. (2-sided test) | .386 |

# Improvement 1 (60 deg/sec)

Related-Samples Wilcoxon Signed Rank Test

| Total N | 10 |
|---|---|
| Test Statistic | 31.500 |
| Standard Error | 9.792 |
| Standardized Test Statistic | .409 |
| Asymptotic Sig. (2-sided test) | .683 |

Improvement 2 (180 deg/sec)

Related-Samples Wilcoxon Signed Rank Test
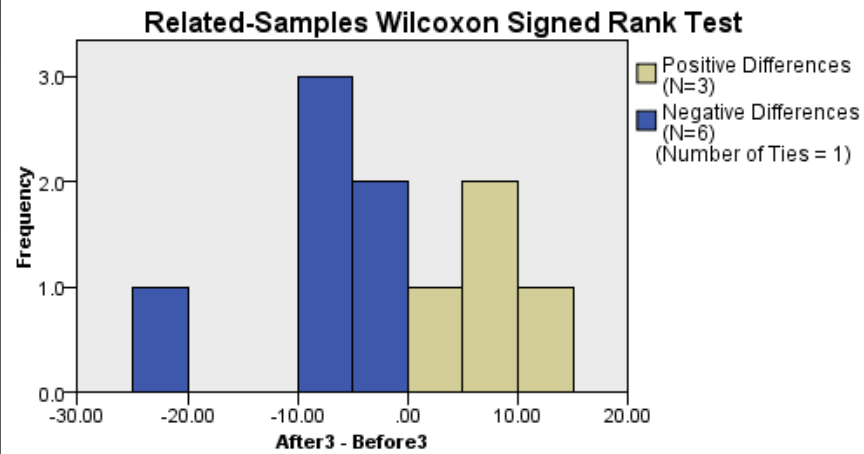
| Total N | 10 |
|---|---|
| Test Statistic | 16.000 |
| Standard Error | 8.411 |
| Standardized Test Statistic | -.773 |
| Asymptotic Sig. (2-sided test) | .440 |

▸ Improvement 3 (240 deg/sec)

# Independent T-test

- The difference between the TENS and isometric exercises at each speed.
  - 60 deg/sec– P=.629
  - 180 deg/sec– P= . 825
  - 240 deg/sec– P= .288

- No significant difference

**Group Statistics**

| | Treatment | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Improvement1 | Tens | 5 | 1.40 | 22.546 | 10.083 |
| | Iso | 5 | 7.20 | 12.637 | 5.652 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Improvement1 | Equal variances assumed | 2.140 | .182 | -.502 | 8 | .629 | -5.800 | 11.559 | -32.454 | 20.854 |
| | Equal variances not assumed | | | -.502 | 6.288 | .633 | -5.800 | 11.559 | -33.772 | 22.172 |

# 60 deg/sec

| | Treatment | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Improvement2 | Iso | 5 | .4000 | 9.88939 | 4.42267 |
| | Tens | 5 | 1.6000 | 6.38749 | 2.85657 |

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | |
| Improvement2 | Equal variances assumed | 1.808 | .216 | -.228 | 8 | .825 | -1.20000 | 5.26498 | -13.34106 | |
| | Equal variances not assumed | | | -.228 | 6.843 | .826 | -1.20000 | 5.26498 | -13.70795 | |

▸ 180 deg/sec

| | Treatment | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Improvement3 | Iso | 5 | -5.6000 | 9.76217 | 4.36578 |
| | Tens | 5 | .8000 | 7.91833 | 3.54119 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | 95% Confidence Interval of the Difference |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | | Lower |
| Improvement3 | Equal variances assumed | .001 | .981 | -1.139 | 8 | .288 | -6.40000 | 5.62139 | | -19.36294 |
| | Equal variances not assumed | | | -1.139 | 7.673 | .289 | -6.40000 | 5.62139 | | -19.45963 |

Table Caption

- 240 deg/sec

# Limitations

- Pad placement is not the same for each participant

- The sample size will be limited due to the size of Manchester University

- Cybex Machine

# Delimitations

▸ Participants were excluded:
   ◦ Exercises on a regular basis for the past year
      (Toca–Herrera et al 2008, Hortobagyi et al 1999, Bezerra et al 2009)
   ◦ Past history of an injury to a lower limb or neuropathology in the past 6 months
      (Hortobagyi et al 1999)
   ◦ Left side dominant

# Conclusion

- There was no significant difference ($P > .05$), therefore reject the null hypothesis that there will be a strength increase in the contralateral limb after one treatment

- There was no significant difference ($P > .05$), therefore reject the null hypothesis that electrical muscle stimulation will have a greater increase on the contralateral limb than isometric exercises.

# Implications and Future Research

- Implications
  - Sample size
  - The number of treatments
  - The amount of effort put forth by the participants

- Future

# Questions?